Preparation by	DOV	Verification by	KER	Approval by	RIW
Date	16-08-2021	Date	16-08-2021	Date	16-08-2021

"For approval"

Expansion Storage Capacity TP3

WEIGHT CALCULATION

SUBSTATION

Client	NESTE	Client number	2307
Project	Expansion Storage Capacity TP3	KH number	68685
Plant	Vlaardingen		
Unit	Tankpit 3	Revision	0
Document Code	2307-B50-CN-2042-0001	Date	16-08-2021

Revision	Description	Date
0	For approval	August 16, 2021

Index

Appendices	Title	Document title
Enclosure 1	Pictures + pile load estimates	Enclosure 1 dd 16 aug 2021.rww

1 INTRODUCTION

Neste Terminal in Rotterdam has the intention to expand the storage capacity of their tank terminal in Vlaardingen.

The expansion of the terminal consists of 15 tanks divided over two tank pits. Both tank pits are connected underground in order to guarantee the buffer capacity of the tank pits. The bundwall shall consist of either a retaining wall or sheet piling wall.

There is a maintenance road between the two tank pits. A new truck loading area with 5 bays is located At the north-east side.

The new tankpits are connected to the existing tankpit and new loading area by means of pipe racks.
On the north side of the new tankpits a recently built tankpit (built in 2017-2018), so-called phase 1, is present. The foundation of these existing tanks in this tank area is on a crushed stone ring on a deep soil improvement.

Another existing tankpit area is present west of the current new site, built approx. 40 y. ago (1960).

The substation, being the subject of this report, is predominantly a RC structure on piles. See pictures in **Enclosure 1** for more info.

Building consist of 2 parts:
- one part, bay width 5,45 m, accommodates the HV-room (High Voltage), the HVAC-room and also 2 Trafos, both in the open air. The layout of this part differs somewhat with the layout of the axes A up to E of the other part;
- the other part, bay width 9 m, accommodates the I-room and E-room.

See also for layout, sections and the 3D-model **Enclosure 1**.

Building is a RC crossbeam structure on piles, with the following dimensions in layout:
- 2 bays in transverse direction with spans of about 5,45 and 9 m, between axes 1 up to 3;
- 4 bays in the longitudinal direction with, for Part 2, spans of about 5,65 m, 6 m and 2x 4,7 m, between axes A up to E.

Between axis 1 and 2 an additional axis has been introduced: axis M (or axis between axis 2 and 3).

The 5 large-span foundation beams on axis A, B, C, D and E, span 9 m each, are supported at mid-span by at least 1 pile, in order to reduce the beam span to 4½ m.

The pile load estimate for the substation (Dutch: gewichtsberekening, acronym: GB), also called a weight calculation, is determined in this report.

2 INPUTDATA

2.1 Dimensions of the substation

Envelope dimensions:
- approx. enveloping dimensions: b*L*h ≈ 21*14½*5 m³;
- Part 1 is approx. 4½ m wide;
- Part 2 is approx. 9 m wide.

See **Enclosure 1** for more and more precise dimensions.

2.2 Consequence class and geotechnical class

Safety class in accordance with basic Eurocode NEN-EN 1990+NB:
- Consequence Class 2 (CC2).

Geotechnical class in accordance with geotechnical Eurocode NEN 9997-1:
- Geotechnical class 2.

2.3 Load factors

Consequence Class 2 implies the following load factors in the ULS:
- for permanent loads: 0,9, 1,2 or 1,35;
- for variable loads: 1,5.

In the SLS:
- all load factors: 1,0.

2.4 Available drawings

New drawings:
- dwg.no. 2307-B50-DW-1432-0001 Rev.3: Piling plan - Substation
- dwg.no. 2307-B50-DW-1745-0001 Rev.1: Ground floor plan - Substation
- dwg.no. 2307-B50-DW-1745-0002 Rev.1: Sections - Substation
- dwg.no. 2307-B50-DW-1745-0003 Rev.1: Walls - Substation
- dwg.no. 2307-B50-DW-2052-0001 Rev.1: Roof plan - Substation
- dwg.no. 2307-B50-DW-2022-0002 Rev.1: Plan drawing – Substation.

2.5 Available geotechnical reports

Geotechnical report by RVB Engineering:
- Geotechnical advice TP03 Neste Terminal, (final) dd. 16 juli 2021.

Pile calculation report by VROOM Funderingstechnieken:
- Berekening wapening Vibro-HBF palen, dd. 15 juli 2021.

2.6 Loads in general

2.6.1 Self-weight of volumes

Self-weight of volumes:

- compacted fill: 18 kN/m³;
- plain concrete: 24 kN/m³;
- reinforced concrete (RC): 25 kN/m³;
- pretensioned concrete (PT): 25 kN/m³;
- steel structures: 78½ kN/m³.

Area loads of structures:

- RC slab in covered spaces (h = 0,25 m): 6¼ kN/m²;
- RC slab in covered spaces (h = 0,3 m): 7½ kN/m²;
- hollow-core roof PT slabs (upper limit): 5 kN/m²;
- facades being RC walls (h = 0,2 m): 5 kN/m²;
- Trafo separation walls (h = 0,3 m): 7½ kN/m².

Line loads:

- RC foundation beams (b*h = 0,65*0,6 m²): 9¾ kN/m¹;
- RC walls as facade (b*h = 0,2*5 m²): 25 kN/m¹;
- RC walls as Trafo-separation (b*h = 0,3*5 m²): 37½ kN/m¹.

2.6.2 Other self-weight

Finishing loads:

- self-weight of computer floors: 1 kN/m²;
- self-weight of screeds: 1½ kN/m²;
- self-weight of roof finish: 1½ kN/m²;
- self-weight of outer façade: ¼ kN/m².

Trafo (= transformer):

- per Trafo (12 tons): 120 kN.

2.6.3 Live loads

Live loads:

- for the 4 covered spaces: 15 kN/m² (all-in upper limit, incl. piping and cables);
- for the open Trafo-araes: 12 kN/m² (all-in upper limit, incl. piping and cables);
- for the roof: 2½ kN/m² (upper limit, incl. light apparatus).

2.6.4 Wind and snow load

Neglected. Wind and snow loads are not governing, unless for lateral pile top loads.
Live load of roof is larger than snow load.

Number of piles is also high: lateral wind load is distributed over a large number of piles.
See also paragraph 3.1.3.

2.7 Load combinations

Vertical loads govern.

Permanent loads and live loads are added and give the sum loads in the SLS on the foundation beam-crossing points on the depicted axes A up to F and 1 up to 3, with an additional axis M between axis 2 and 3.

The loads in the ULS are calculated by multiplication of the loads in the SLS by the load factors as explained in paragraph 2.3.

3 CALCULATION RESULTS

3.1 Pile load estimates in Enclosure 1

The pile loads are estimated in Enclosure 1 with the help of a number of tables.

Line loads and area loads on foundation beams are calculated on a separate page.

First the loads are calculated for area and line loads. Hereafter the load in SLS on each axis-crossing is calculated, for permanent loads and for live loads.

The loads on axis 2 are determined separately, first the right of axis 2, then for the left part of axis 2.

3.1.1 Pile capacity

Pile capacity in accordance with dwg.no. 2307-B50-DW-1432-0001 Rev.3:

Item	Compression kN	Tension kN	Lateral kN
In ULS	950	0	+/-35
In SLS	Not specified	Not specified	Not specified

3.1.2 Vertical loads

Vertical loads in SLS are a summation of the loads explained in paragraph 2.6.

The following loads are determined for the SLS, in accordance with **Enclosure 1**:

Axis	Axis 1 V_{rep} kN	Axis 2 V_{rep} kN	Axis M V_{rep} kN	Axis 3 V_{rep} kN
E	466	717	531	368
D	827	1226	663	656
C	653	1314	872	712
B	497	1216	811	767
A	313	711	598	428

The following loads are determined for the ULS, in accordance with **Enclosure 1**:

Axis	Axis 1 V_{Ed} kN	Axis 2 V_{Ed} kN	Axis M V_{Ed} kN	Axis 3 V_{Ed} kN
E	598	927	693	469
D	1071	1605	890	821
C	847	1704	1155	918
B	644	1576	1091	989
A	398	911	786	540

Minimum number of piles (in total **20**) in accordance with **Enclosure 1** (in SLS):

Axis	Axis 1 n (-)	Axis 2 n (-)	Axis M n (-)	Axis 3 n (-)
E	0,67	1,02	0,76	0,53
D	1,18	1,75	0,95	0,91
C	0,93	1,88	1,25	1,02
B	0,71	1,74	1,16	1,10
A	0,45	1,02	0,86	0,80

Maximum number of piles (in total **30**) by simple rounding-up (!):

Axis	**Axis 1 n (-)**	**Axis 2 n (-)**	**Axis M n (-)**	**Axis 3 n (-)**
E	**1**	**2**	**1**	**1**
D	**2**	**2**	**1**	**2**
C	**1**	**2**	**2**	**2**
B	**1**	**2**	**2**	**2**
A	**1**	**2**	**1**	**1**

See paragraph 4.1.2 for optimization of pile distribution!

3.1.3 Lateral pile top loads

Lateral pile top loads are relatively low due to the large number of piles compared with the possible wind load:

- number of piles, at least: 20 in accordance with **Enclosure 1**;
- assumed pile capacity in SLS: 10 kN per pile in SLS;
- lateral load capacity: $H_{u\ rep} \geq 20*10$ kN = **200 kN**, which is more than sufficient.

Upper limit of lateral wind load H_{rep} versus sum of pile load capacity $H_{u\ rep}$:

- upper limit of wind load in SLS: $H_{rep} < L*h*C_t*p_w = 21*5\ m^2*1{,}3*1\ kN/m^2$ = **136½ kN**;
- clearly, pile capacity is sufficient: $H_{u\ rep} \geq$ **200 kN >>** $H_{rep} <$ **136½ kN**. **OK!**

Check in ULS:

- upper limit of wind load in ULS: $H_{Ed} = 1½*H_{rep} \leq$ **205 kN** $< H_{Rd} = 20*15$ kN = **300 kN**. **OK!**

Lateral pile top capacity, at least:

- in SLS: **+/-10 kN** per pile;
- in ULS: **+/-15 kN** per pile.

3.1.4 Tension pile capacity

Dimensions and self-weight of substation is too large for any wind uplift and lateral wind couples.

No tension on pile tops!

4 PILE LOAD ESTIMATE: RESULTS

4.1 Pile capacity, number of piles and pile depth

4.1.1 Pile forces, rounded

The pile top capacity is as follows:

Item	**Axial load, compression kN**	**Axial load, tension kN**	Lateral load kN
in SLS	**700**	**-**	+/-10
in ULS	**950**	**-**	+/-15

See for lateral load also paragraph 4.2.

4.1.2 Optimized pile distribution and number of piles

Optimized number of piles (in total **25**) by rearranging the simple rounding-up results:

Axis	**Axis 1** **n (-)**	**Axis 2** **n (-)**	**Axis M (axis between axis 2 and 3)** **n (-)**	**Axis 3** **n (-)**
E	**1**	**1**	**1**	**1**
D	**1**	**2**	**1**	**1**
C	**1**	**2**	**1**	**2**
B	**1**	**2**	**1**	**2**
A	**1**	**1**	**1**	**1**

Number of piles:
- optimized: **25 piles**.

4.1.3 Pile Depth

Displacement pile type ∅406/495, cast-in-place, is used in dwg.no. 2307-B50-DW-1432-0001 Rev.3. VROOM uses the same pile.

The pile tip depth in accordance with RVB Engineering report p.33/61 (see copy at end of **Enclosure 1**) is:
- ∅406/495 mm: -24 m NAP.

CPT 3 is governing in RVB Engineering report p.33/61.

4.2 Revised pile drawing

Dwg.no. 2307-B50-DW-1432-0001: "Piling plan – Substation" has been revised into Revision 3.
The lateral load on the pile top is somewhat higher on this revised drawing: **+/-35 kN**.

5 APPENDICES

Enclosures:

- Enclosure 1: Pile load estimate p.11/24.

SUBSTATION
SOME PICTURES

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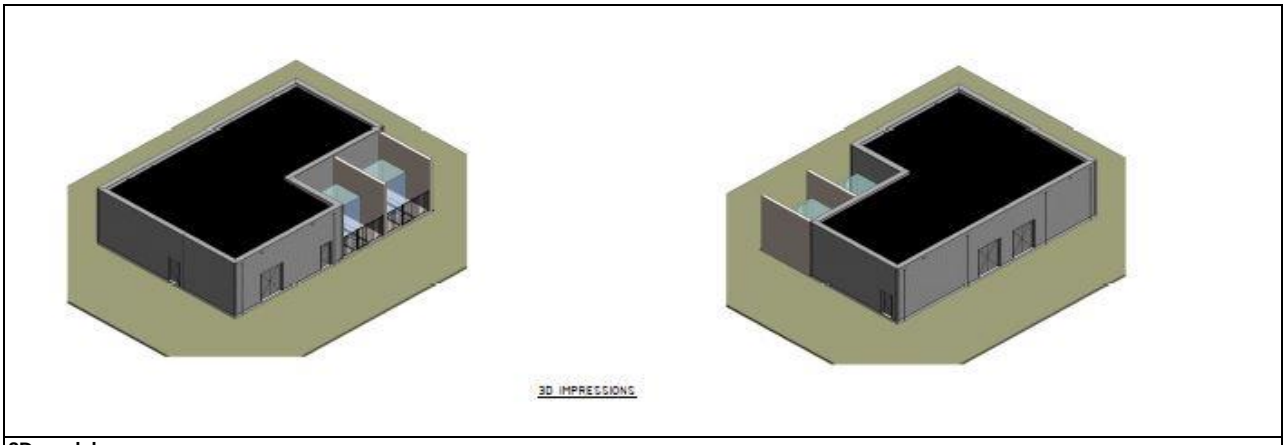
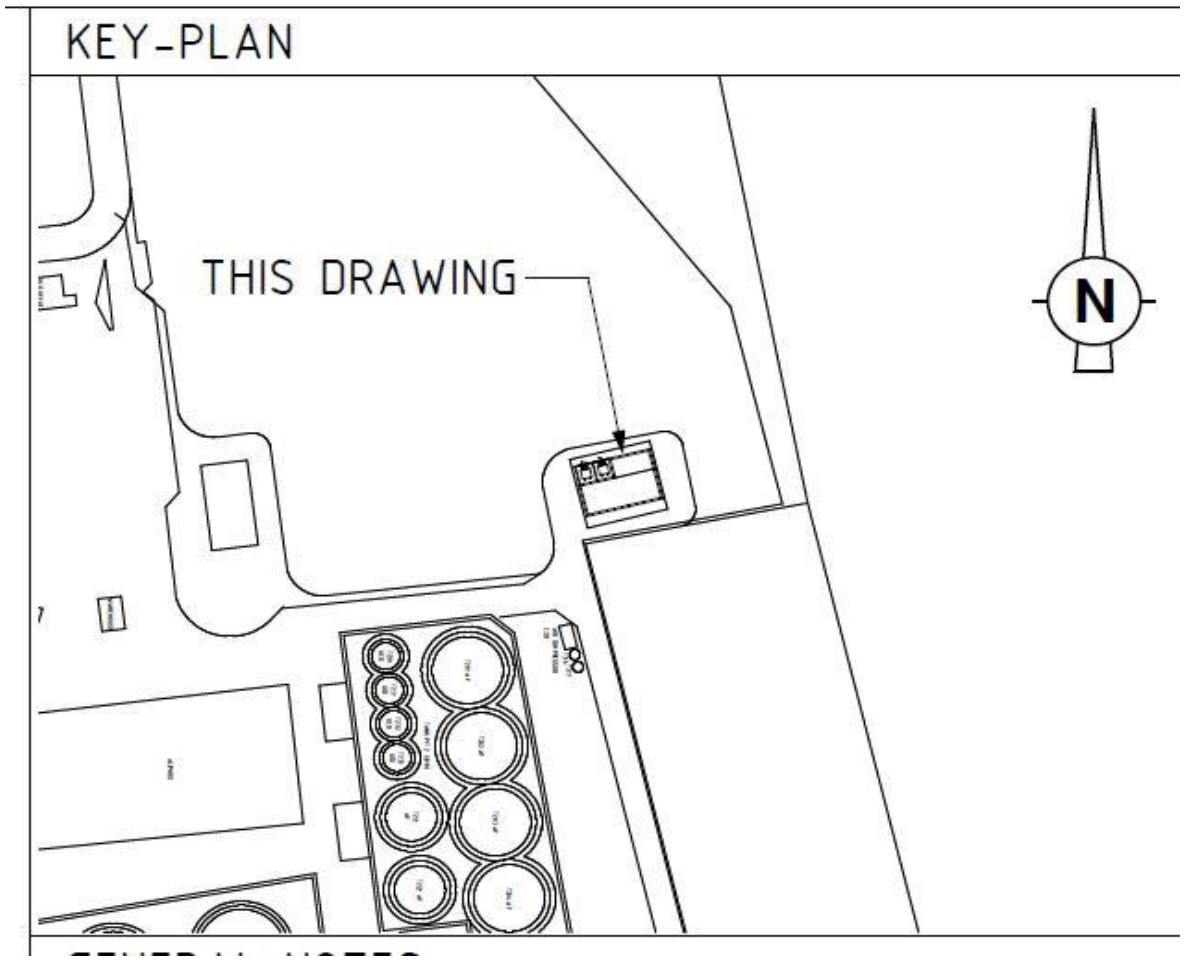


3D-model



Substation in site layout

SUBSTATION
SOME PICTURES

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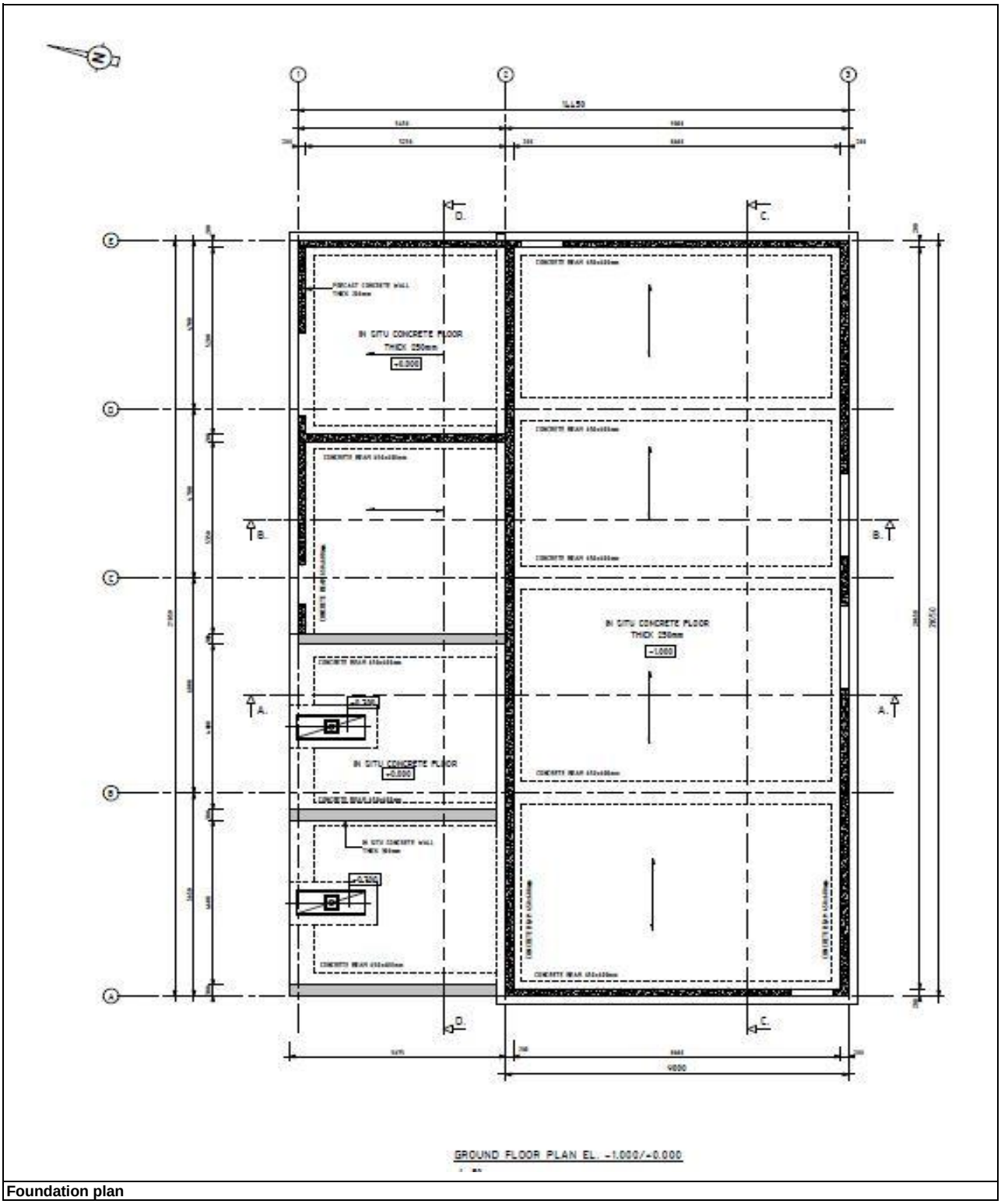

Foundation plan

SUBSTATION
SOME PICTURES

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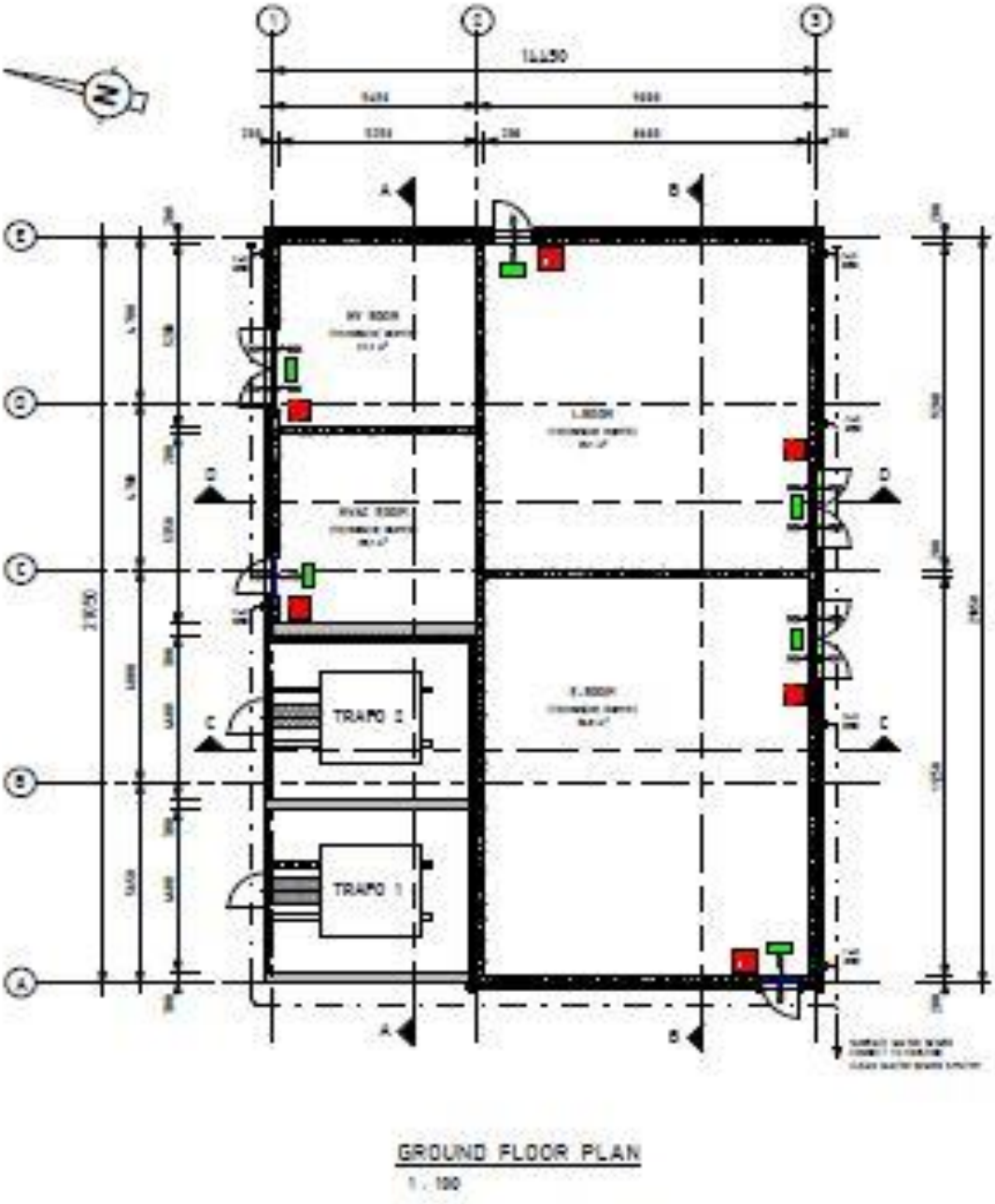

Ground floor plan

SUBSTATION
SOME PICTURES

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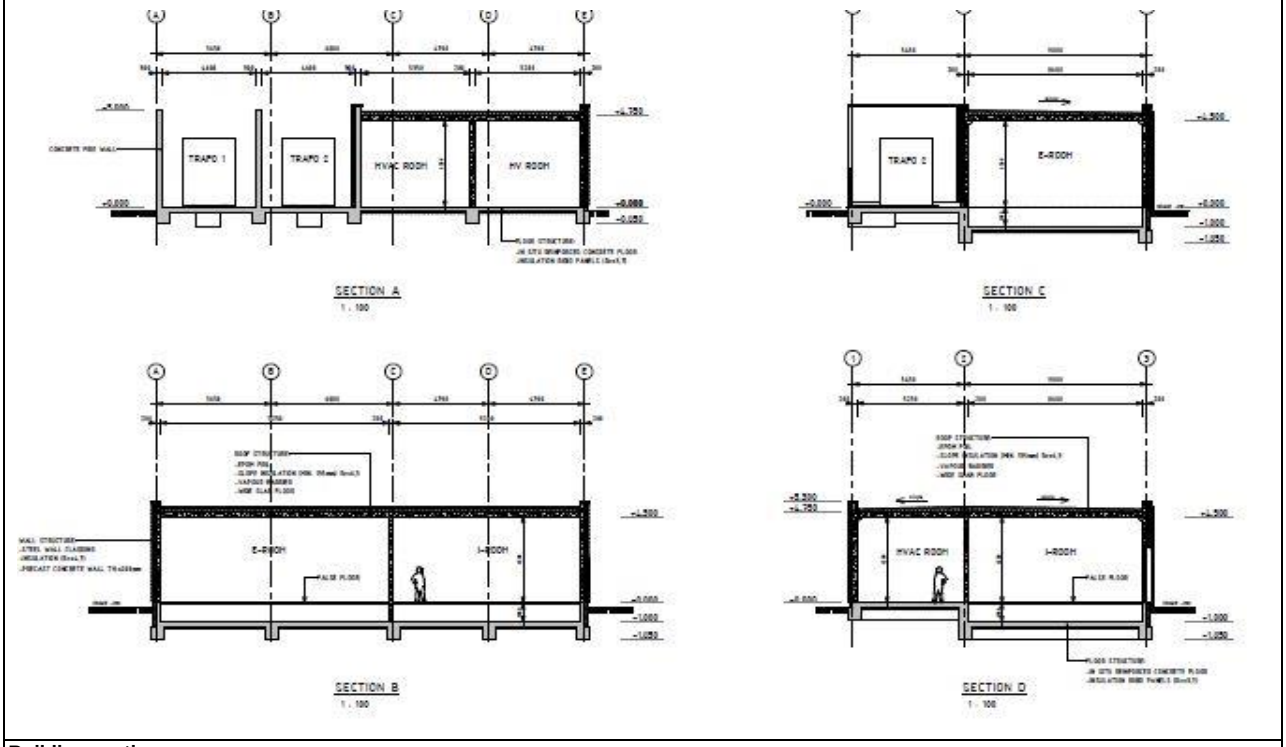

Building sections

SUBSTATION
SOME PICTURES

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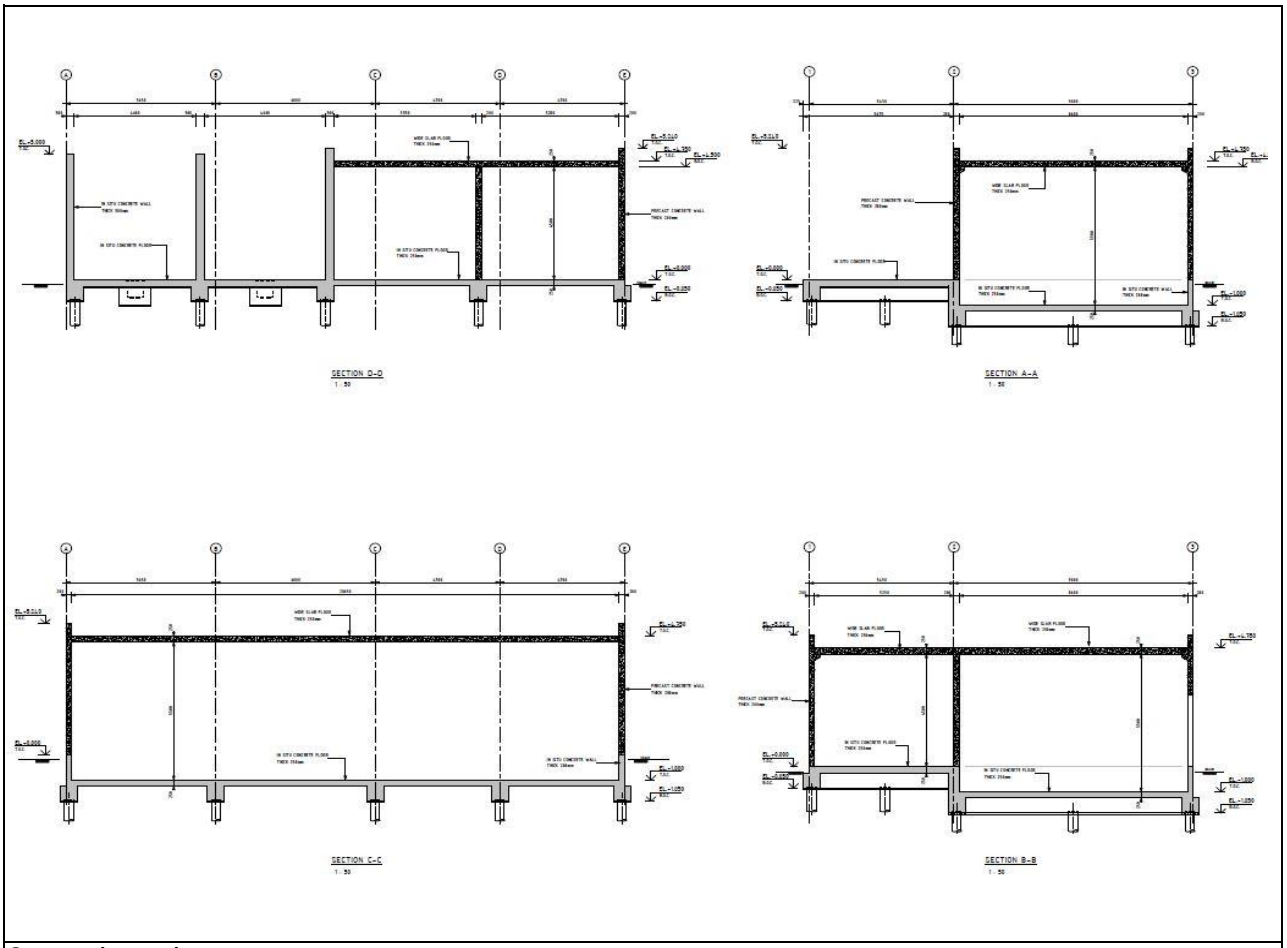

Construction sections

SUBSTATION: I-ROOM + E-ROOM
PILE LOAD ESTIMATE

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PT floor slab: self-weight estimate incl. RC topping and German fire resistance F90											
item	**self-weight + live load**			**actual section loads in SLS**			**allowable in SLS**		**unity ch. in SLS**		
	thick h m	spec.grav. ρ*g kN/m³	**area load p kN/m²**	**span L m**	**bending m_{rep} kNm/m¹**	**shear v_{rep} kN/m¹**	**bending $m_{u\ rep}$ kNm/m¹**	**shear $v_{u\ rep}$ kN/m¹**	**bending uc (-)**	**shear uc (-)**	**are both unity ch. okay?**
PT slab	0,2		3,3								
topping	0,05	25	1,25								
self-w.:			**4,55**								
finish			1								
live load			2,5								
sum of all:			**8,05**	**9**	**81,5**	**36,2**	**119**	**60**	**0,68**	**0,60**	**OK!**

RC foundation beam + RC wall				
item	dimensions		line load	
	width b m	height h m	spec.grav. ρ*g kN/m³	**line load q kN/m¹**
beam	0,65	0,6	25	**9,75**
partition wall	0,2	5,5	25	**27,5**
sum of outer walls				
facade wall	0,2	5,24	25	26,2
low wall	0,3	1	25	7,5
sum of outer walls				**33,7**

floor slab, etc.			
item	height h m	spec.grav. ρ*g kN/m³	**area load p kN/m²**
RC floor slab	0,25	25	**6,25**
Trafo slab	0,3	25	**7,5**
PT roof slab	0,2	25	**5**
screed	0,05	22	**1,1**
computer floor			**1,5**
roof finish			**1,5**
live load on floor			**15**
live load on Trafo-floor			**12**
live load on roof, incl. light apparatus			**2,5**

Trafo: self-weight			**per**
present	**self-w. n*V_{rep} kN**	corners n (-)	**corner V_{rep} kN**
in 2 bays	**120**	4	**30**

live load at axis 1C						
live load HVAC p_1 kN/m²	**live load Trafo p_2 kN/m²**	HVAC C-D L_1 m	Trafo C-B L_2 m	contributions HVAC a_1 (-)	 Trafo a_2 (-)	**equivalent live load p kN/m²**
15	**12**	5,6	4,9	0,533	0,467	**13,6**

RC wall of Trafo-surroundings				
item	dimensions		line load	
	width b m	height h m	spec.grav. ρ*g kN/m³	**line load q kN/m¹**
Trafo-wall	0,3	5	25	**37,5**

SUBSTATION: I-ROOM + E-ROOM
PILE LOAD ESTIMATE

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load of sums on axis 2 and 3

axis crossing	beams length 1 ½L_1 m¹	beams length 2 ½L_2 m¹	beams ½L_1+½L_2 m	floor area A m²	line loads beam q kN/m¹	facade wall q kN/m¹	sum Σq kN/m¹	perrmanent area loads RC slab p kN/m²	computer p kN/m²	PT slab p kN/m²	roof finish p kN/m²	sum Σp kN/m²
2E/3E	2,25	2,35	4,6	5,3	9,75	33,7	43,45	6,25	1,5	5	1,5	14,25
2D/3D	2,25	4,7	6,95	10,6	9,75	33,7	43,45	6,25	1,5	5	1,5	14,25
2C/3C	2,25	5,35	7,6	12,0	9,75	33,7	43,45	6,25	1,5	5	1,5	14,25
2B/3B	2,25	5,825	8,075	13,1	9,75	33,7	43,45	6,25	1,5	5	1,5	14,25
2A/3A	2,25	2,825	5,075	6,4	9,75	33,7	43,45	6,25	1,5	5	1,5	14,25

load of sums on axis 2 and 3

axis crossing	live area loads in SLS floor p kN/m²	roof p kN/m²	live sum p kN/m²	permanent loads in SLS beams V_{rep11} kN	slabs V_{rep12} kN	sum V_{rep1} kN	live load in SLS V_{rep2} kN	load factors perm. γ_F (-)	live γ_F (-)	loads in ULS in ULS V_{Ed1} kN	in ULS V_{Ed2} kN
2E/3E	15	2,5	17,5	200	75	275	93	1,2	1,5	330	139
2D/3D	15	2,5	17,5	302	151	453	185	1,2	1,5	543	278
2C/3C	15	2,5	17,5	330	172	502	211	1,2	1,5	602	316
2B/3B	15	2,5	17,5	351	187	538	229	1,2	1,5	645	344
2A/3A	15	2,5	17,5	221	91	311	111	1,2	1,5	373	167

sum of all on axis 2 and 3

axis crossing	**in SLS V_{rep} kN**	**in ULS V_{Ed} kN**	relative V_{Ed}/V_{rep} (-)
2E/3E	**368**	**469**	1,28
2D/3D	**638**	**821**	1,29
2C/3C	**712**	**918**	1,29
2B/3B	**767**	**989**	1,29
2A/3A	**422**	**540**	1,28

load of sums on axis M, between axis 2 and 3

axis crossing	beams length 1 L_1 m¹	beams length 2 ½L_2 m¹	beams L_1+½L_2 m	floor area A m²	line loads beam q kN/m¹	facade wall q kN/m¹	sum Σq kN/m¹	perrmanent area loads RC slab p kN/m²	computer p kN/m²	PT slab p kN/m²	roof finish p kN/m²	sum Σp kN/m²
ME	4,5	0	4,5	10,6	9,75	33,7	43,45	6,25	2	5	2	14,25
MD	4,5	0	4,5	21,2	9,75	0	9,75	6,25	2	0	0	14,25
MC	4,5	0	4,5	24,1	9,75	27,5	37,25	6,25	2	0	0	14,25
MB	4,5	0	4,5	26,2	9,75	0	9,75	6,25	2	0	0	14,25
MA	4,5	0	4,5	12,7	9,75	33,7	43,45	6,25	2	5	2	14,25

load of sums on axis M, between axis 2 and 3

axis crossing	live area loads in SLS floor p kN/m²	roof p kN/m²	live sum p kN/m²	permanent loads in SLS beams V_{rep11} kN	slabs V_{rep12} kN	sum V_{rep1} kN	live load in SLS V_{rep2} kN	load factors perm. γ_F (-)	live γ_F (-)	in ULS V_{Ed1} kN	in ULS V_{Ed2} kN
ME	15	2,5	17,5	196	151	346	185	1,2	1,5	415	278
MD	15	0,0	15,0	44	301	345	317	1,2	1,5	414	476
MC	15	0,0	15,0	168	343	511	361	1,2	1,5	613	542
MB	15	0,0	15,0	44	374	417	393	1,2	1,5	501	590
MA	15	2,5	17,5	196	181	377	222	1,2	1,5	452	334

sum of all on axis M

axis crossing	**in SLS V_{rep} kN**	**in ULS V_{Ed} kN**	relative V_{Ed}/V_{rep} (-)
ME	**531**	**693**	1,30
MD	**663**	**890**	1,34
MC	**872**	**1155**	1,32
MB	**811**	**1091**	1,35
MA	**599**	**786**	1,31

SUBSTATION: HV-ROOM + HVAC-ROOM
PILE LOAD ESTIMATE

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load of sums on axis 1

axis crossing	beams length 1 ½L_1 m¹	beams length 2 ½L_2 m¹	beams ½L_1+½L_2 m	floor area A m²	line loads beam q kN/m¹	walls q kN/m¹	sum Σq kN/m¹	perrmanent area loads RC slab p kN/m²	screed p kN/m²	PT slab p kN/m²	roof finish p kN/m²	sum Σp kN/m²
1E	2,725	2,7	5,425	7,36	9,75	33,7	43,45	6,25	1,1	5	1,5	13,85
1D	2,725	5,5	8,225	15,0	9,75	33,7	43,45	6,25	1,1	5	1,5	13,85

load of sums on axis 1

axis crossing	live area loads in SLS floor p kN/m²	roof p kN/m²	live sum p kN/m²	permanent loads in SLS beams V_{rep11} kN	slabs V_{rep12} kN	Trafo V_{rep13} kN	sum V_{rep1} kN	live load in SLS V_{rep2} kN	**load factors perm. γ_F (-)**	**live γ_F (-)**	loads in ULS in ULS V_{Ed1} kN	in ULS V_{Ed2} kN
1E	15	2,5	17,5	236	102		338	129	**1,2**	**1,5**	405	193
1D	15	2,5	17,5	357	208		565	262	**1,2**	**1,5**	678	393

sum of all on axis 1

axis crossing	**in SLS V_{rep} kN**	**in ULS V_{Ed} kN**	relative V_{Ed}/V_{rep} (-)
1E	**466**	**598**	1,28
1D	**827**	**1071**	1,30

load of sums on axis 1

axis crossing	**self-weight beams** length 1 ½L_1 m¹	length 2 ½L_2 m¹	beams ½L_1+½L_2 m	beam q kN/m¹	**sum V_{rep11} kN**	floor area A m²	**permanent area loads** RC slab p kN/m²	screed p kN/m²	PT slab p kN/m²	roof finish p kN/m²	sum Σp kN/m²	**sum V_{rep12} kN**
1C	2,725	2,8				7,6	6,25	1,1	5	1,5	13,9	**105,7**
	2,725	2,45				6,7	7,5	0	0	0	7,5	**50,1**
	2,725	5,25	7,975	9,75	**77,8**							**155,7**
1B	2,725	2,45				6,7	7,5	0,0	0,0	0,0	7,5	**50,1**
	2,725	2,45				6,7	7,5	0,0	0,0	0,0	7,5	**50,1**
	2,725	4,9	7,625	9,75	**74,3**							**100,1**
1A	2,725	2,45				6,7	7,5	0,0	0,0	0,0	7,5	**50,1**
	2,725					0,0	0	0,0	0,0	0,0	0,0	**0,0**
	2,725	2,45	5,175	9,75	**50,5**							**50,1**

load of sums on axis 1

axis crossing	floor area A m²	**live area loads in SLS** floor p kN/m²	roof p kN/m²	live sum p kN/m²	**sum V_{rep2} kN**	**self-weight walls +Trafo** length L m	facade q kN/m¹	trafo q kN/m¹	**sum V_{rep13}=q*L kN**	**self-w. Trafo V_{rep14} kN**
1C	7,6	15	2,5	17,5	133,5	2,8	26,2		**73,4**	
	6,7	12		12	80,1	2,725		37,5	**102,2**	
					213,6				**175,5**	**30**
1B	6,7	12	0	12	80,1	2,45			**0,0**	
	6,7	12	0	12	80,1	2,725		37,5	**102,2**	
					160,2				**102,2**	**60**
1A	6,7	12	0	12	80,1	2,45			**0,0**	
	0,0	0	0	0	0,0	2,725		37,5	**102,2**	
					80,1				**102,2**	**30**

load of sums on axis 1

axis crossing	**sum loads in SLS** perm. V_{rep1} kN	live V_{rep2} kN	**sum V_{rep} kN**	**load factors perm. γ_F (-)**	**live γ_F (-)**	**loads in ULS** in ULS V_{Ed1} kN	in ULS V_{Ed2} kN	**in ULS V_{Ed} kN**	relative V_{Ed}/V_{rep} (-)
1C	439,1	213,6	**652,7**	**1,2**	**1,5**	526,9	320,5	**847,3**	1,30
1B	336,7	160,2	**496,9**	1,2	1,5	404,0	240,3	**644,4**	1,30
1A	232,7	80,1	**312,8**	1,2	1,5	279,3	120,2	**399,4**	1,28

SUBSTATION: HV-ROOM + HVAC-ROOM
PILE LOAD ESTIMATE

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load of sums on axis 2, left

axis crossing	beams length 1 ½L_1 m¹	beams length 2 ½L_2 m¹	beams ½L_1+½L_2 m	floor area A m²	line loads beam q kN/m¹	walls q kN/m¹	sum Σq kN/m¹	perrmanent area loads RC slab p kN/m²	screed p kN/m²	PT slab p kN/m²	roof finish p kN/m²	sum Σp kN/m²
2E	2,725	0	2,725	7,36	9,75	33,7	43,45	6,25	1,1	5	1,5	13,85
2D	2,725	0	2,725	15,0	9,75	33,7	43,45	6,25	1,1	5	1,5	13,85

load of sums on axis 2, left

axis crossing	live area loads in SLS floor p kN/m²	roof p kN/m²	live sum p kN/m²	permanent loads in SLS beams V_{rep11} kN	slabs V_{rep12} kN	Trafo V_{rep13} kN	sum V_{rep1} kN	live load in SLS V_{rep2} kN	**load factors perm. γ_F (-)**	**live γ_F (-)**	loads in ULS in ULS V_{Ed1} kN	in ULS V_{Ed2} kN
2E	15	2,5	17,5	118	102		220	129	**1,2**	**1,5**	264	193
2D	15	2,5	17,5	118	208		326	262	**1,2**	**1,5**	391	393

sum of all on axis 2, left

axis crossing	**in SLS V_{rep} kN**	**in ULS V_{Ed} kN**	relative V_{Ed}/V_{rep} (-)
2E	**349**	**457**	1,31
2D	**588**	**785**	1,33

load of sums on axis 2, left

axis crossing	**self-weight beams** length 1 ½L_1 m¹	length 2 ½L_2 m¹	beams ½L_1+½L_2 m	beam q kN/m¹	**sum V_{rep11} kN**	floor area A m²	**permanent area loads** RC slab p kN/m²	screed p kN/m²	PT slab p kN/m²	roof finish p kN/m²	sum Σp kN/m²	**sum V_{rep12} kN**
1C	2,725	0				7,6	6,25	1,1	5	1,5	13,9	**105,7**
	2,725	0				6,7	7,5	0	0	0	7,5	**50,1**
	2,725	0	2,725	9,75	**26,6**							**155,7**
1B	2,725	0				6,7	7,5	0,0	0,0	0,0	7,5	**50,1**
	2,725	0				6,7	7,5	0,0	0,0	0,0	7,5	**50,1**
	2,725	0	2,725	9,75	**26,6**							**100,1**
1A	2,725	0				6,7	7,5	0,0	0,0	0,0	7,5	**50,1**
	2,725					0,0	0	0,0	0,0	0,0	0,0	**0,0**
	2,725	0	2,725	9,75	**26,6**							**50,1**

load of sums on axis 2, left

axis crossing	floor area A m²	**live area loads in SLS** floor p kN/m²	roof p kN/m²	live sum p kN/m²	**sum V_{rep2} kN**	**self-weight walls +Trafo** length L m	facade q kN/m¹	trafo q kN/m¹	**sum V_{rep13}=q*L kN**	**self-w. Trafo V_{rep14} kN**
1C	7,6	15	2,5	17,5	133,5	2,8	26,2		**73,4**	
	6,7	12		12	80,1	2,725		37,5	**102,2**	
					213,6				**175,5**	**30**
1B	6,7	12	0	12	80,1	0			**0,0**	
	6,7	12	0	12	80,1	2,725		37,5	**102,2**	
					160,2				**102,2**	**60**
1A	6,7	12	0	12	80,1	0			**0,0**	
	0,0	0	0	0	0,0	2,725		37,5	**102,2**	
					80,1				**102,2**	**30**

load of sums on axis 2, left

axis crossing	**sum loads in SLS** perm. V_{rep1} kN	live V_{rep2} kN	**sum V_{rep} kN**	**load factors perm. γ_F (-)**	**live γ_F (-)**	**loads in ULS** in ULS V_{Ed1} kN	in ULS V_{Ed2} kN	**in ULS V_{Ed} kN**	relative V_{Ed}/V_{rep} (-)
1C	387,9	213,6	**601,5**	**1,2**	**1,5**	465,4	320,5	**785,9**	1,31
1B	288,9	160,2	**449,1**	1,2	1,5	346,7	240,3	**587,0**	1,31
1A	208,8	80,1	**288,9**	1,2	1,5	250,6	120,2	**370,8**	1,28

SUBSTATION: ALL BAYS
PILE LOAD ESTIMATE in SLS

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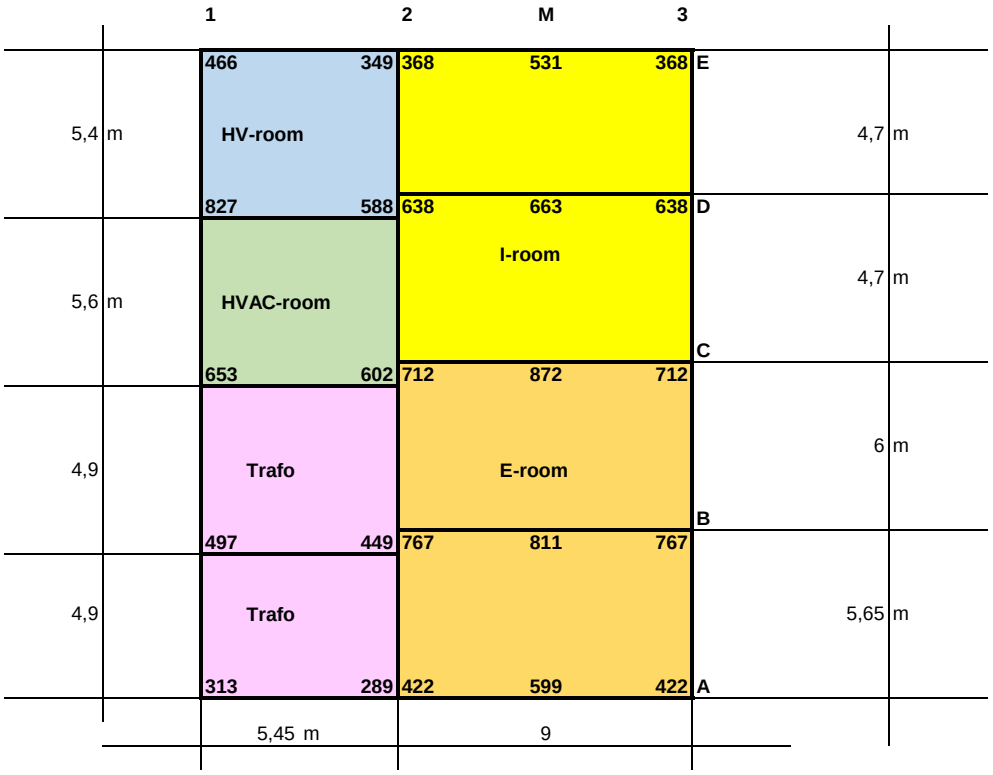

Loads per location in SLS

SUBSTATION: ALL BAYS
PILE LOAD ESTIMATE in ULS

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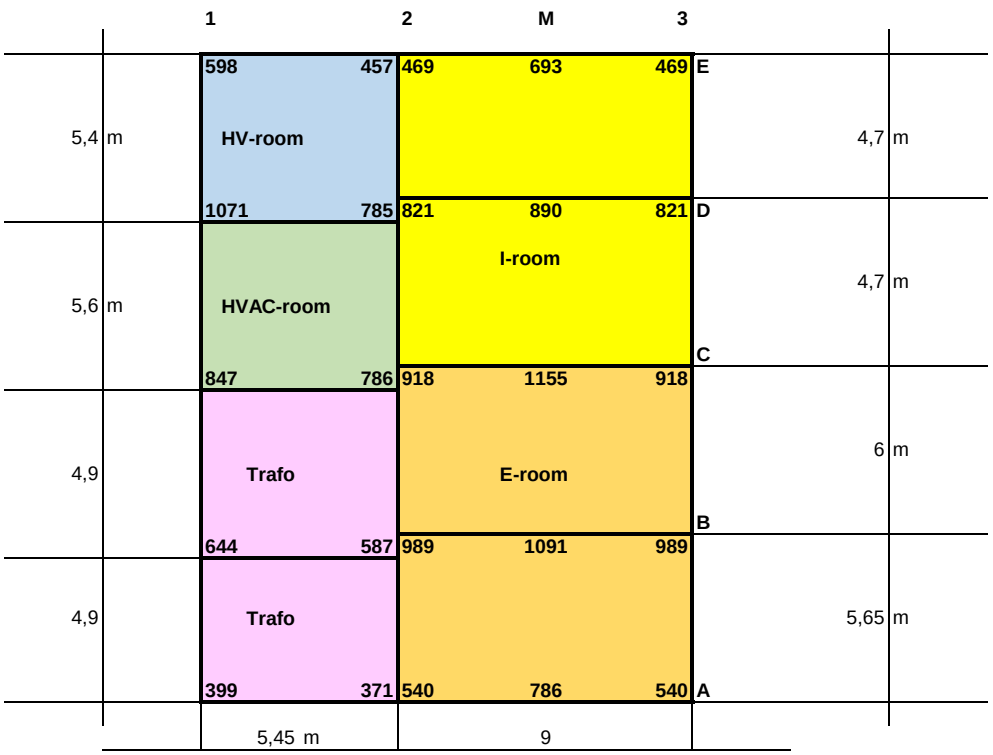

Loads per location in ULS

SUBSTATION: ALL BAYS
PILE LOAD ESTIMATE in SLS

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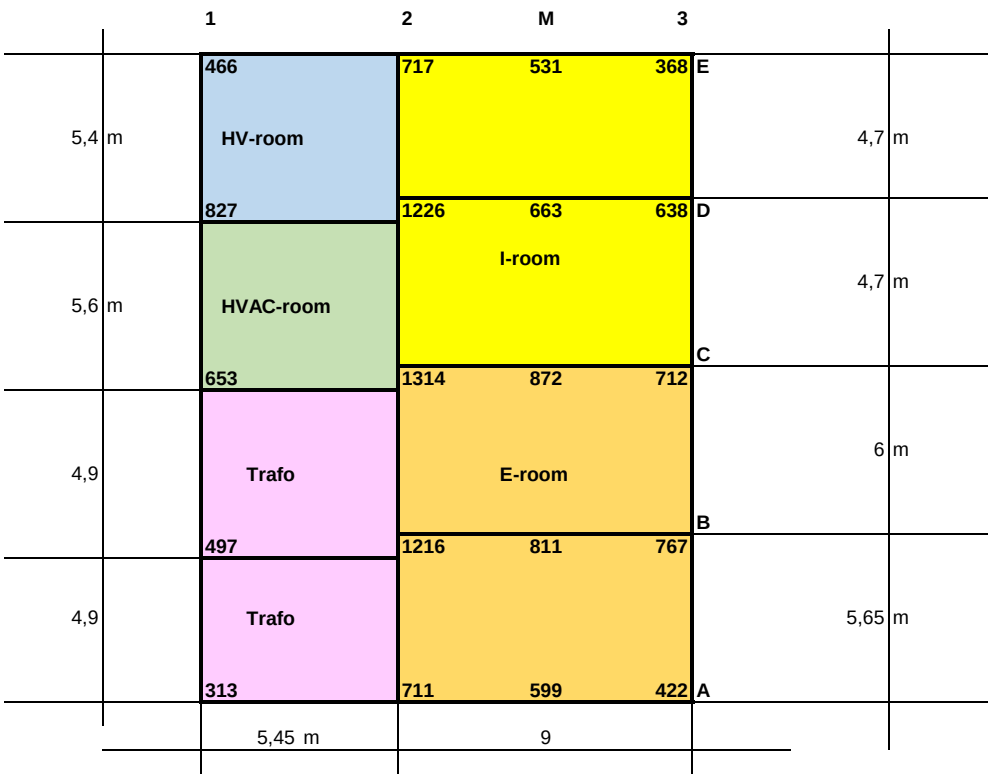

Loads per location in SLS, with axis 2 in addition

loads per axis crossings in SLS				
axis	axis 1 V_{rep} kN	axis 2 V_{rep} kN	axis M V_{rep} kN	axis 3 V_{rep} kN
axis E	466	717	531	368
axis D	827	1226	663	638
axis C	653	1314	872	712
axis B	497	1216	811	767
axis A	313	711	599	422

max. load per pile				
in SLS	**max. $V_{u\ rep}$ kN**	**max. $V_{u\ rep}$ kN**	**max. $V_{u\ rep}$ kN**	**max. $V_{u\ rep}$ kN**
all piles	**700**	**700**	**700**	**700**

number of piles, not rounded					
axis	axis 1 V_{rep} kN	axis 2 V_{rep} kN	axis M V_{rep} kN	axis 3 V_{rep} kN	**sum of 4 axes ΣV_{rep} kN**
axis E	0,67	1,02	0,76	0,53	2,97
axis D	1,18	1,75	0,95	0,91	4,79
axis C	0,93	1,88	1,25	1,02	5,07
axis B	0,71	1,74	1,16	1,10	4,70
axis A	0,45	1,02	0,86	0,60	2,92
5 axes	3,94	7,41	4,96	4,15	**20**

number of piles, simply rounded					
axis	**axis kN n kN**	**axis kN n kN**	**axis kN n kN**	**axis kN n kN**	**sum of 4 axes Σn kN**
axis E	**1**	**2**	**1**	**1**	**5**
axis D	**2**	**2**	**1**	**1**	**6**
axis C	**1**	**2**	**2**	**2**	**7**
axis B	**1**	**2**	**2**	**2**	**7**
axis A	**1**	**2**	**1**	**1**	**5**
5 axes	**6**	**10**	**7**	**7**	**30**

See p.9/24 for the optimized end result!!!

SUBSTATION: ALL BAYS
PILE LOAD ESTIMATE in ULS

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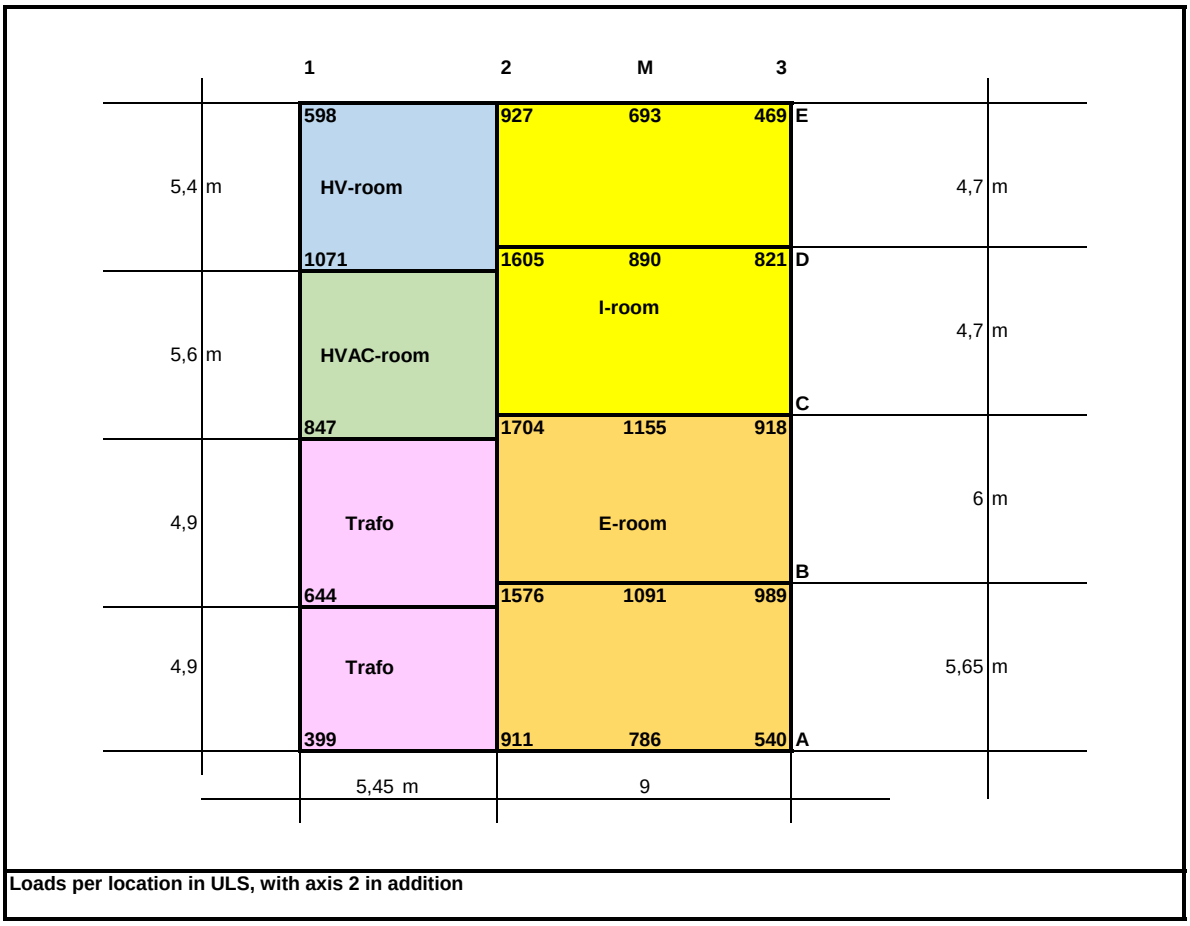

Loads per location in ULS, with axis 2 in addition

loads per axis crossings in ULS				
axis	axis 1 V_{Ed} kN	axis 2 V_{Ed} kN	axis M V_{Ed} kN	axis 3 V_{Ed} kN
axis E	598	927	693	469
axis D	1071	1605	890	821
axis C	847	1704	1155	918
axis B	644	1576	1091	989
axis A	399	911	786	540

max. load per pile				
in ULS	max. V_{Rd} kN	max. V_{Rd} kN	max. V_{Rd} kN	max. V_{Rd} kN
all piles	950	950	950	950

number of piles, not rounded					
axis	axis 1 V_{rep} kN	axis 2 V_{rep} kN	axis M V_{rep} kN	axis 3 V_{rep} kN	sum of 4 axes ΣV_{rep} kN
axis E	0,63	0,98	0,73	0,49	2,83
axis D	1,13	1,69	0,94	0,86	4,62
axis C	0,89	1,79	1,22	0,97	4,87
axis B	0,68	1,66	1,15	1,04	4,53
axis A	0,42	0,96	0,83	0,57	2,77
5 axes	3,75	7,08	4,86	3,93	**19,6**

number of piles, simply rounded					
axis	axis kN n kN	axis kN n kN	axis kN n kN	axis kN n kN	sum of 4 axes Σn kN
axis E	1	1	1	1	4
axis D	2	2	1	1	6
axis C	1	2	2	1	6
axis B	1	2	2	2	7
axis A	1	1	1	1	4
5 axes	6	8	7	6	**27**

The SLS is however governing, not the ULS. See previous sheet.

SUBSTATION: RVB Engineering report
PILE LOAD CAPACITY AND PILE TIP DEPTH

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7.8.1 *Bearing capacity ULS*

The bearing capacity of the piles are given for multiple pile tip elevation in table below. The full results and calculation are shown in appendix 8.

Table 25: Bearing capacity Substation

CPT	Ground level	Pile tip level	Bearing capacity $R_{c;net;d}$ [kN]					
	[mNAP]	[mNAP]	Ø380(464)	Ø406(495)	Ø457(560)	Ø508(620)	Ø559(680)	□380x380
1	3,87	-22,00	932,00	1025,00	987,00	1401,00	1636,00	783,00
		-23,00	1028,00	1128,00	1155,00	1565,00	1799,00	873,00
		-24,00	1341,00	1500,00	1583,00	2163,00	2491,00	1123,00
2	3,42	-20,00	-	21,00	20,00	204,00	324,00	-
		-21,00	509,00	586,00	580,00	927,00	1121,00	330,00
		-22,00	732,00	820,00	818,00	1223,00	1444,00	539,00
		-23,00	941,00	1000,00	885,00	1252,00	1458,00	731,00
		-24,00	965,00	1072,00	1101,00	1504,00	1733,00	741,00
		-25,00	1046,00	1192,00	1312,00	1844,00	2152,00	807,00
		-26,00	1319,00	1459,00	1553,00	2084,00	2422,00	1061,00
3	3,56	-21,00	365,00	391,00	346,00	664,00	830,00	179,00
		-22,00	551,00	627,00	607,00	985,00	1185,00	331,00
		-23,00	715,00	797,00	787,00	1173,00	1379,00	483,00
		-24,00	1062,00	1177,00	1179,00	1694,00	1965,00	779,00
		-25,00	1204,00	1320,00	1356,00	1893,00	2179,00	906,00
		-26,00	1306,00	1454,00	1530,00	2120,00	2485,00	1001,00

ØPile diameter (base diameter)

Pile Ø406/495 mm is applicable.
Pile load in ULS is 950 kN (compression).