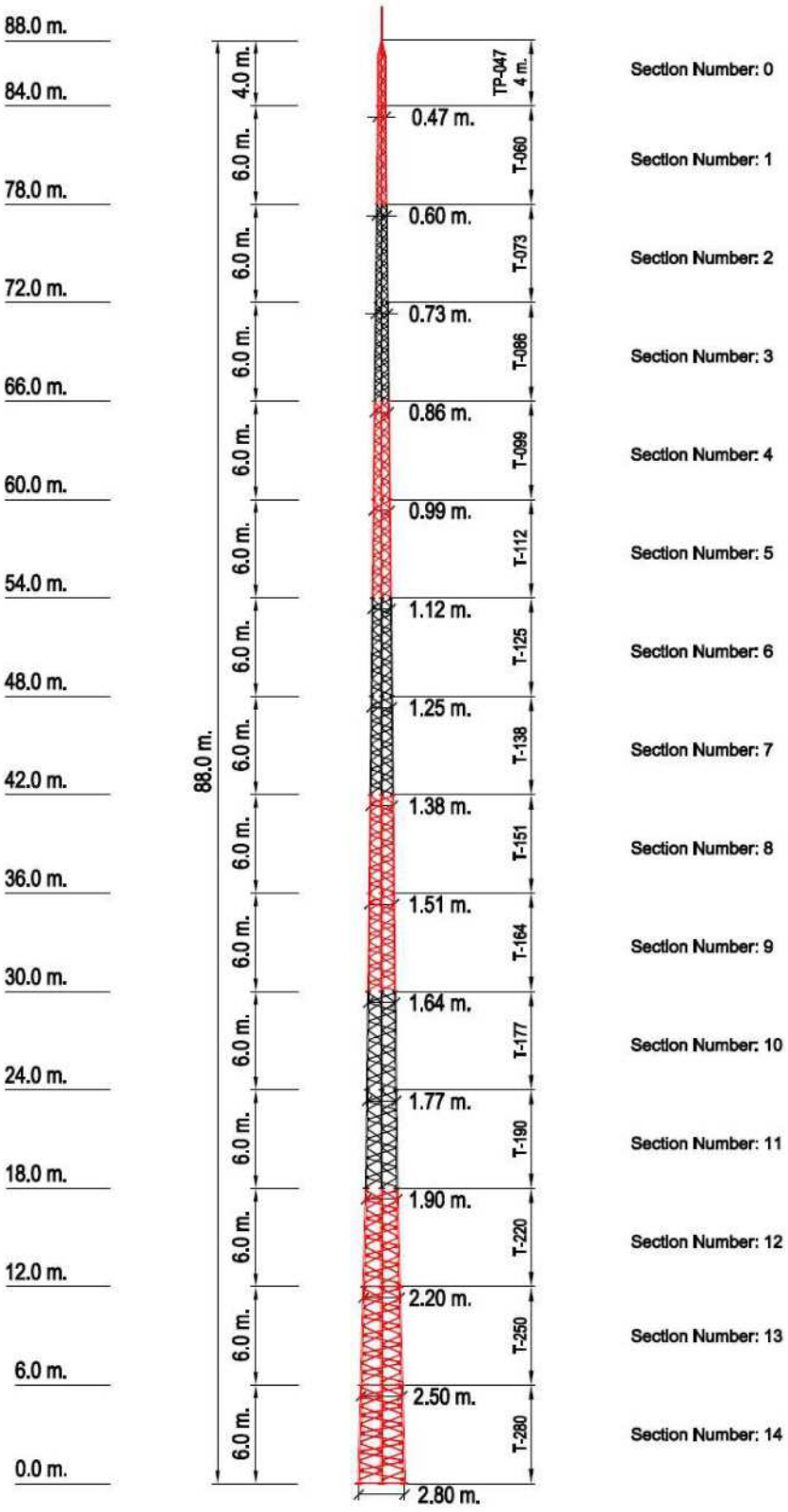

N° de plano 7	CAMACHO BARCELON DAVID - 18442029P Firmado digitalmente por CAMACHO BARCELON DAVID - 18442029P Fecha: 2023.09.01 12:27:54 +02'00'	A4	SECCIONES DE LA TORRE
Fecha: 13/07/2023		Versión 1 / Sustituye a –	
Dibujado: David Camacho	DAVID CAMACHO BARCELÓN N° COLEGIADO 8995	Escala S/E	TORRE METEOROLÓGICA AUTOSOPORTADA EN PARQUE EÓLICO MIRAVETE TITULAR: PARQUE EÓLICO MIRAVETE S.L.
Revisado: Jorge Urbano			

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Lifting 88 m

Nº de plano	8
Fecha:	13/07/2023
Dibujado:	David Camacho
Revisado:	Jorge Urbano

CAMACHO BARCELON DAVID - 18442029P
Firmado digitalmente por CAMACHO BARCELON DAVID - 18442029P
Fecha: 2023.09.01 12:28:14 +02'00'

DAVID CAMACHO BARCELÓN
Nº COLEGIADO 8995

A4

Versión	Sustituye a
1	—

Escala S/E

PESO DE LA TORRE Y LEVANTAMIENTO

TORRE METEOROLÓGICA AUTOSOPORTADA
EN PARQUE EÓLICO MIRAVETE
TITULAR: PARQUE EÓLICO MIRAVETE S.L.

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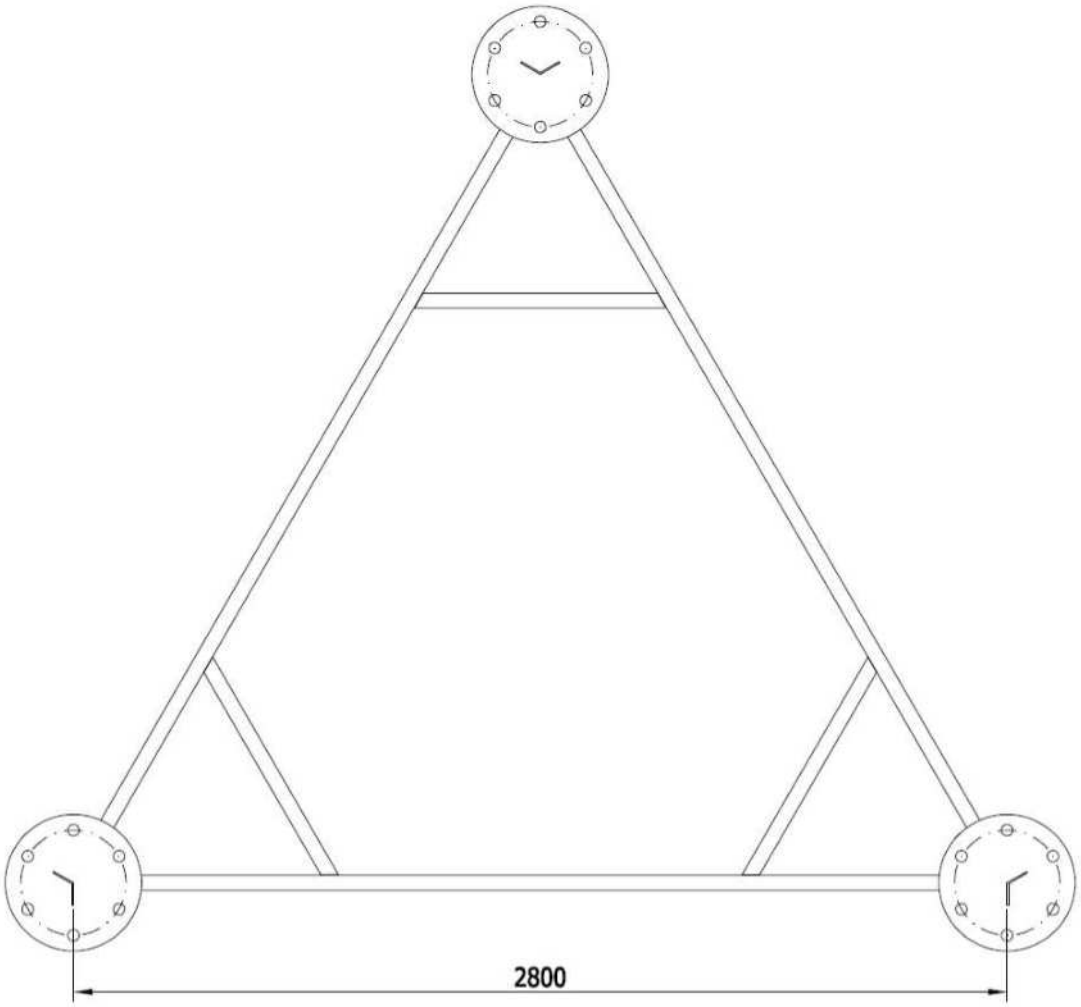

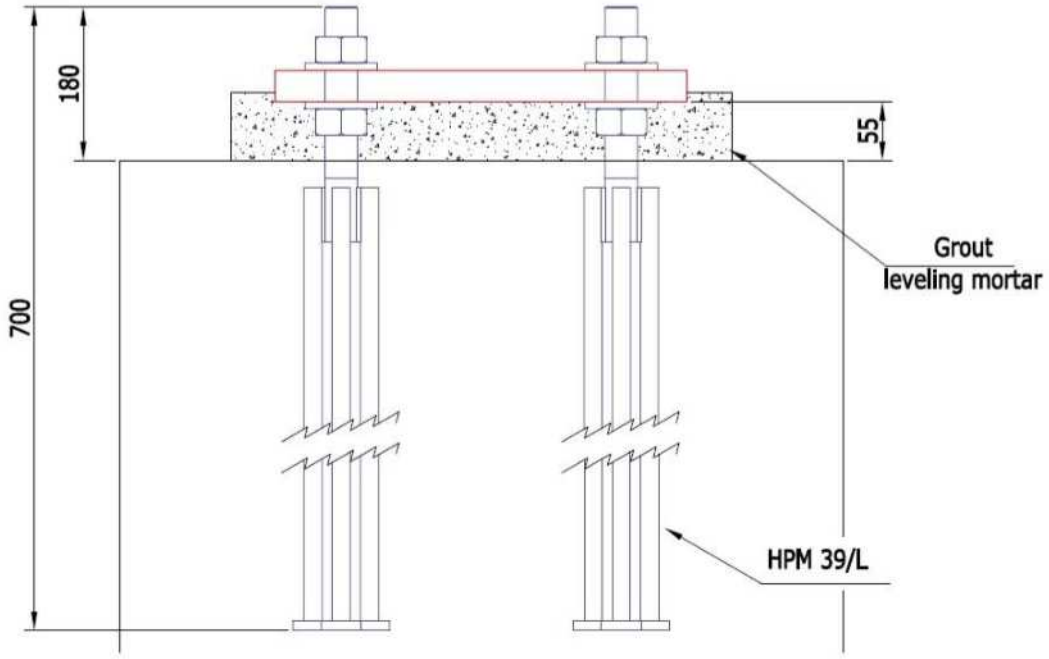

N° de plano 9	CAMACHO BARCELON DAVID - 18442029P Firmado digitalmente por CAMACHO BARCELON DAVID - 18442029P Fecha: 2023.09.01 12:28:32 +02'00'	A4	FUNDACIÓN Y PERNOS	IDNAMIC
Fecha: 13/07/2023		Versión 1 / Sustituye a –		
Dibujado: David Camacho	DAVID CAMACHO BARCELÓN N° COLEGIADO 8995	Escala S/E	TORRE METEOROLÓGICA AUTOSOPORTADA EN PARQUE EÓLICO MIRAVETE TITULAR: PARQUE EÓLICO MIRAVETE S.L.	C/ Isaac Newton 36 50830 Villanueva de Gállego www.idnamic.com
Revisado: Jorge Urbano				

DOCUMENTO 4

ANEXOS TÉCNICOS

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Estudener Energías Renovables S.L.
Polígono Industrial Val de Maestro s/n
50.830 Villanueva de Gállego (Spain)
+34 976 186 499 · estudener@estudener.com

May 2022

Project identification:

Reference:		Costumer:		Costumer ref.:	
Localisation:		Department:		Country:	
Tower type:	Self-supporting	Tower height:	88,0 m	Tower model	NL088W27I20R1

Calculation parameters:

Basic wind speed [Vb,0]	27,0 m/s	97,2 km/h
Basic wind speed [Vb]	27,0 m/s	97,2 km/h
Wind speed at top [Vm]	38,3 m/s	138,0 km/h
Peak wind speed [Vp]	53,4 m/s	192,1 km/h
Ice thickness / weight	20 mm	720 kg/m³

Calculation hypothesis. In case of being different a new calculation is needed

Partial factors for ultimate limit state:

Terrain category	II
Reliability class	1
dead load: γ_G	1,00
γ_W; γ_{ice};	1,20
ψ_W ; ψ_{ice}:	0,50
k factor:	0,45

Ancillaries

	low level	top level	weight	flat wind drag	round wind drag
At top	87 m	88 m	105,0 kg	1,0 m²	1,0 m²
Ladder	0 m	88 m	2,0 kg/m	0,02 m²/m	0,01 m²/m
Linelife	0 m	88 m	0,5 kg/m	0,01 m²/m	0,01 m²/m

Tower description:

	Section	Height	Min width	Max width	Legs section	Brace section
0	AS-047-036-14 VE05	4,0 m	0,470 m	0,470 m	36/4	RD 14
1	AS-060-035-14 VE05	6,0 m	0,470 m	0,600 m	RD 35	RD 14
2	AS-073-040-14 VE05	6,0 m	0,600 m	0,730 m	RD 40	RD 14
3	AS-086-045-16 VE05	6,0 m	0,730 m	0,860 m	RD 45	RD 16
4	AS-099-050-18 VE05	6,0 m	0,860 m	0,990 m	RD 50	RD 18
5	AS-112-055-20 VE05	6,0 m	0,990 m	1,120 m	RD 55	RD 20
6	AS-125-055-22 VE05	6,0 m	1,120 m	1,250 m	RD 55	RD 22
7	AS-138-065-26 VE05	6,0 m	1,250 m	1,380 m	RD 65	RD 26
8	AS-151-070-30 VE05	6,0 m	1,380 m	1,510 m	RD 70	RD 30
9	AS-164-070-28 VE05	6,0 m	1,510 m	1,640 m	RD 70	RD 28
10	AS-177-075-28 VE05	6,0 m	1,640 m	1,770 m	RD 75	RD 28
11	AS-190-075-28 VE05	6,0 m	1,770 m	1,900 m	RD 75	RD 28
12	AS-220-075-42 VE05	6,0 m	1,900 m	2,200 m	RD 75	42/4
13	AS-250-075-42 VE05	6,0 m	2,200 m	2,500 m	RD 75	42/4
14	AS-280-080-42 VE05	6,0 m	2,500 m	2,800 m	RD 80	42/4
Total		88,0 m				

Tower main frecuency without ice	0,410 Hz	
Tower main frecuency with ice	0,342 Hz	
Theorical weight	11364 kg	111,48 kN

Codes:

Calculation:	Eurocode 0: Basis of structural design. Eurocode 1: Actions on structures. UNE-EN 1991 Part 1.4: General actions. Wind actions. UNE-EN 1991-1-1 Part 1.1: General rules and rules for buildings Eurocode 3: Design of steel structures. UNE-EN 1993-1-1 Part 1.1: General rules and rules for buildings. UNE-EN 1993-1-11 Part 1.11: Design of structures with tension components UNE-EN 1993-3-1 Part 3.1: Towers, masts and chimneys - Towers and masts ISO 12494: Atmospheric icing of structures
Execution:	EN 1090 Execution of steel structures and aluminium structures
Galvanisation:	EN ISO 1461 Hot dip galvanized coatings on fabricated iron and steel articles.
Painting:	EN ISO 12944 Corrosion protection of steel structures by protective paint systems.

Calculation results by section

		without ice		with ice	
	Section Name	Worst ratio	Sec. factor	Worst ratio	Security factor
0	AS-047-036-14 VE05	36%	2,78	36%	2,78
1	AS-060-035-14 VE05	63%	1,59	62%	1,61
2	AS-073-040-14 VE05	67%	1,49	65%	1,54
3	AS-086-045-16 VE05	67%	1,49	64%	1,56
4	AS-099-050-18 VE05	84%	1,19	79%	1,27
5	AS-112-055-20 VE05	79%	1,27	73%	1,37
6	AS-125-055-22 VE05	95%	1,05	87%	1,15
7	AS-138-065-26 VE05	72%	1,39	64%	1,56
8	AS-151-070-30 VE05	69%	1,45	61%	1,64
9	AS-164-070-28 VE05	79%	1,27	69%	1,45
10	AS-177-075-28 VE05	84%	1,19	72%	1,39
11	AS-190-075-28 VE05	94%	1,06	80%	1,25
12	AS-220-075-42 VE05	97%	1,03	82%	1,22
13	AS-250-075-42 VE05	100%	1,00	84%	1,19
14	AS-280-080-42 VE05	87%	1,15	72%	1,39
Worst		**100%**	**1,00**	**87%**	**1,15**

	Worst ratio	Security factor
Global result	100%	1,00

Calculation results by load combination

Load cases:

LC1: Self weight

LC2: Ice weight - Class G

LC3: Wind 0°

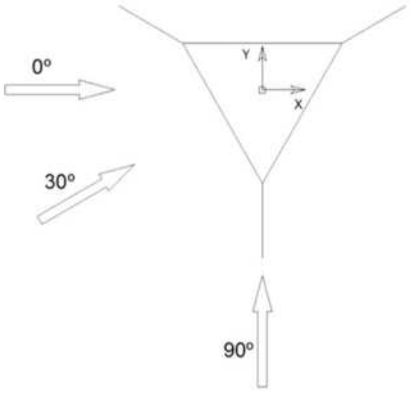
LC4: Wind 0° with Ice

LC5: Wind 30°

LC6: Wind 30° with Ice

LC7: Wind 90°

LC8: Wind 90° with Ice



According to EN 1993-3-1 point C.6, it must be considerate two combinations of wind and ice for simetric and asimetric ice. Therefore, it must be considerate the following combinations:

- Dominant ice and wind concomitante:

$$\gamma_G G_k + \gamma_{ice} Q_{k,ice} + \gamma_W k \psi_W Q_{k,w}$$

- Dominant wind and ice concomitante:

$$\gamma_G G_k + \gamma_W k Q_{k,w} + \gamma_{ice} \psi_{ice} Q_{k,ice}$$

Result combinations:

RC1: 1 * LC1

RC2: 1 * LC1 + 1,2 * LC2

RC3: 1 * LC1 + 1,2 * LC2 + 0,6 * LC4

RC4: 1 * LC1 + 1,2 * LC2 + 0,6 * LC6

RC5: 1 * LC1 + 1,2 * LC2 + 0,6 * LC8

RC6: 1 * LC1 + 1,2 * LC3

RC7: 1 * LC1 + 1,2 * LC5

RC8: 1 * LC1 + 1,2 * LC7

RC9: 1 * LC1 + 0,6 * LC2 + 1,2 * LC4

RC10: 1 * LC1 + 0,6 * LC2 + 1,2 * LC6

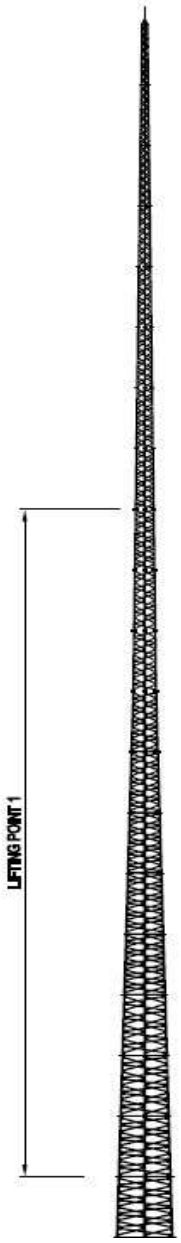
RC11: 1 * LC1 + 0,6 * LC2 + 1,2 * LC8

Result Combination	Description	Worst ratio	Security factor
RC1	1 * LC1	4%	25,00
RC2	1 * LC1 + 1,2 * LC2	5%	20,00
RC3	1 * LC1 + 1,2 * LC2 + 0,6 * LC4	39%	2,56
RC4	1 * LC1 + 1,2 * LC2 + 0,6 * LC6	45%	2,22
RC5	1 * LC1 + 1,2 * LC2 + 0,6 * LC8	30%	3,33
RC6	1 * LC1 + 1,2 * LC3	87%	1,15
RC7	1 * LC1 + 1,2 * LC5	100%	1,00
RC8	1 * LC1 + 1,2 * LC7	75%	1,33
RC9	1 * LC1 + 0,6 * LC2 + 1,2 * LC4	75%	1,33
RC10	1 * LC1 + 0,6 * LC2 + 1,2 * LC6	87%	1,15
RC11	1 * LC1 + 0,6 * LC2 + 1,2 * LC8	63%	1,59

Tower Lifting

Tower specifications:

Height:	88,0 m
N. of sections:	15
Weight:	11364 kg
Lifting:	☑ 1 part
	☐ 2 parts
Lifting point 1:	43 m
Weight part 1:	11364 kg
Lifting Height:	45 m



Lifting calculation

Section Number	Worst ratio	Weights
0	14%	107 kg
1	26%	220 kg
2	50%	274 kg
3	56%	357 kg
4	70%	429 kg
5	73%	538 kg
6	75%	591 kg
7	71%	818 kg
8	95%	1028 kg
9	93%	1014 kg
10	77%	1073 kg
11	38%	1131 kg
12	14%	1195 kg
13	36%	1231 kg
14	51%	1358 kg
Worst	95%	11364 kg

For more detail, see the drawing sketch

Loads on foundation

	Without ice	With ice
Vertical load	113,2 kN	131,3 kN
Horizontal load	53,1 kN	40,9 kN
Bending moment	2299 kNm	1883 kNm
Twisting moment	0,050 kNm	0,040 kNm

Detailed loads on foundation

Dimensions:

l	2.800 mm
a	808 mm
b	1.617 mm
d	800 mm

Foundation bolts:

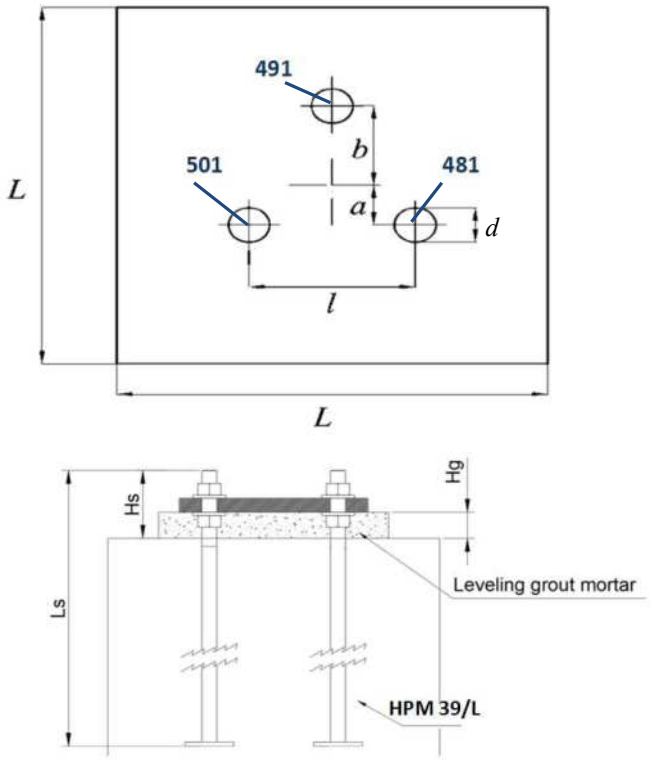
bolts per plate	6
bolts diameter	HPM 39/L
bolts lehgth (Ls)	700 mm

Bolt positioning:

protruding bolt part (Hs)	180 mm
grout height (Hg)	60 mm

Grout characteristics:

minimum grout strength	30 N/mm²
pressure exerted by the tower	5,56 N/mm²



Qa (CR7) **Load hypothesis without ice**

Node	**N** (kN)	**Mx** (kNm)	**My** (kNm)	**Qx** (kN)	**QY** (kN)	**T** (kNm)
501	-984,82	-0,74	0,60	30,54	15,65	0,02
481	436,28	-0,18	0,63	12,12	-7,12	0,16
491	435,39	-0,47	0,58	3,31	18,01	-0,13

Qa (CR10) **Load hypothesis with ice**

Node	N (kN)	Mx (kNm)	My (kNm)	Qx (kN)	QY (kN)	T (kNm)
501	-819,60	-0,52	0,38	24,08	12,87	0,02
481	344,98	-0,09	0,39	9,30	-5,66	0,12
491	343,35	-0,36	0,41	2,02	13,24	-0,10

N: Vertical load (negative compression, positive traction)

Mx: Moment X (negative clock turn forward, positive clock turn back)

My: Moment Y (negative clock turn forward, positive clock turn back)

Qx: Shear X

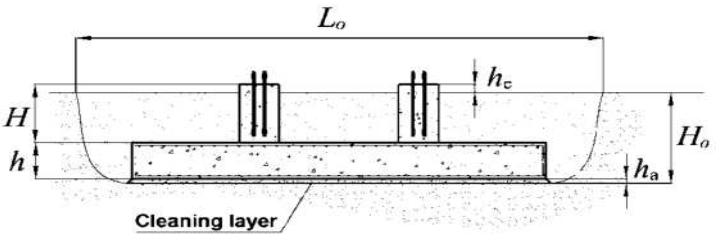
Qy: Shear Y

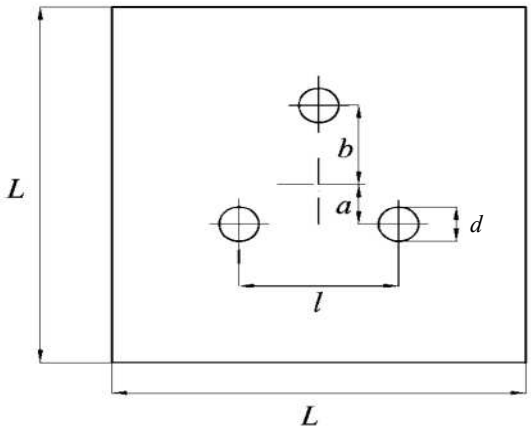
T: Torque (negative clock turn forward, positive clock turn back)

TOWER FOUNDATION

Dimensions:

L	8.000 mm
h	700 mm
H	1.000 mm
d	800 mm
l	2.800 mm
a	808 mm
b	1.617 mm
h_a	100 mm
h_e	100 mm
H_o	1.700 mm
L_o	8.500 mm





Required soil strain:

For permanent actions: ≥ 96 KPa

For accidental actions: ≥ 147 KPa

A geotechnical study is necessary .

Materials

Filling: ≥ 16 kN/m³

Reinforcement steel:

Top grid: Ø20 c/25

Bottom grid: Ø20 c/25

S 500 f_{yk} = 500 MPa Partial factor: γ_S = 1.15

Concrete class:

C30/37 f_{ck} = 30 MPa Partial factor: γ_C = 1.50

Foundation bolts		
Number	Diameter	Length
6	M39	700 mm

Foundation bolts and acilliaries are provided with the tower.

Quantities:

Digging	Concrete	
Total	**C30/37**	**Clear cover**
122,8 m³	**54,6 m³**	**7,9 m³**

Reinforcement Steel				
S-500	**S-500**	**S-500**	**S-500**	**S-500**
Ø10	Ø12	Ø16	Ø20	**Total**
26 kg	273 kg	0 kg	3280 kg	**3579 kg**

These data are the result of a preliminary calculation. A specific calculation is needed for any emplacement.

Codes:

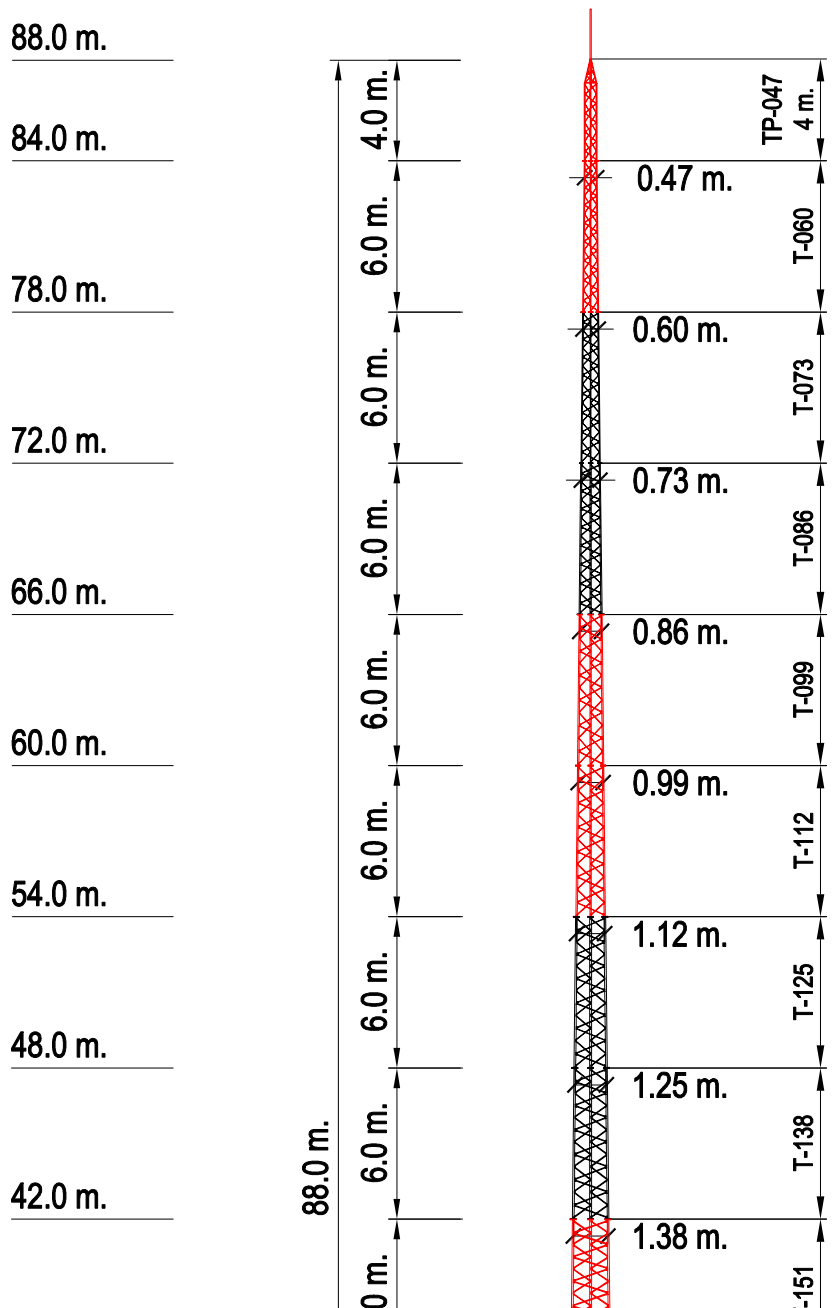
Eurocode 0: Basis of structural design.

Eurocode 2: Design of concrete structures

EN 1992-1-1: General rules and rules for buildings

Eurocode 4: Design of composite steel and concrete structures

EN 1994-1-1: General rules and rules for buildings



Section Number: 0

Section Number: 1

Section Number: 2

Section Number: 3

Section Number: 4

Section Number: 5

Section Number: 6

Section Number: 7

Section Number: 8

Section Number: 9

Section Number: 10

Section Number: 11

Section Number: 12

Section Number: 13

Section Number: 14

	Date	Name	Revision		Sign
Drawn by	--/05/2022	A. H. S.	Date Rev.		
Checked by	-	-	Code		

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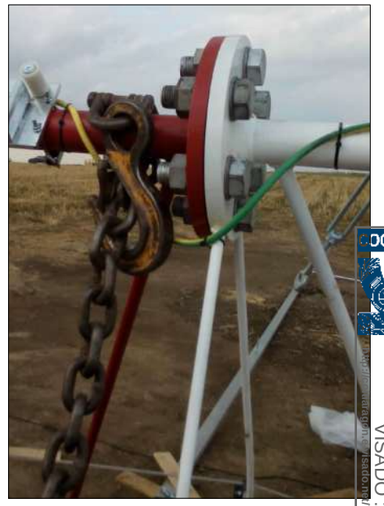
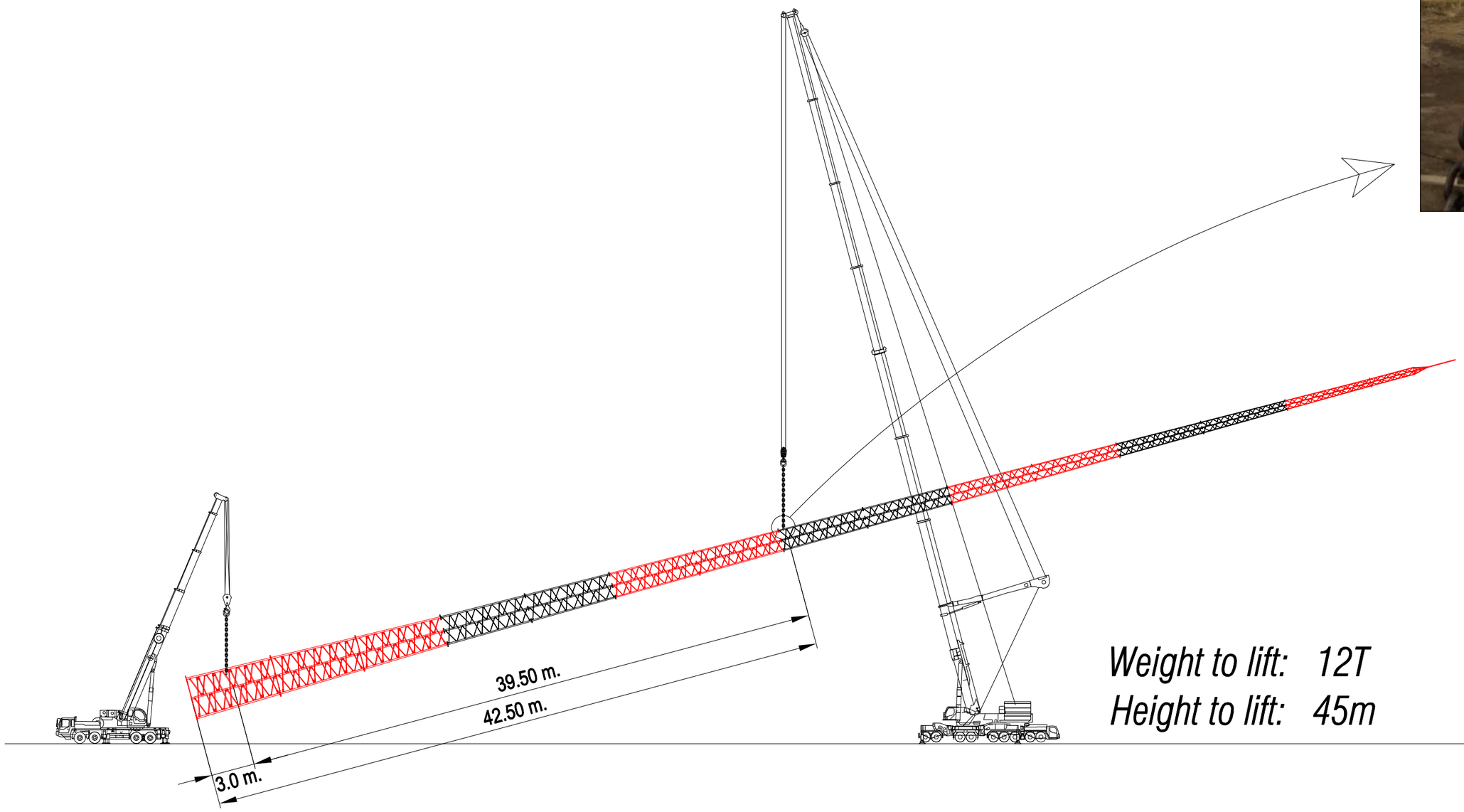
Project:	*SELF SUPPORTING NL088W27I20R1*	Scale: 1:300	
Title:	*Color Sketch Tower*	Project Nº.:	NL088W27I20R1
		Layaout Nº.:	-

Lifting 88 m





Weight to lift: 12T
Height to lift: 45m

Weight to lift: 3T
Height to lift: 5m

TOTAL Weight to lift: 12T

	Date	Name	Revision		Sign
Drawn by	--/05/2022	A. H. S.	Date Rev.		
Checked by	-	-	Code		
Project:	SELF SUPPORTING NL088W27I20R1				
Title:	Tower weights and lifting				

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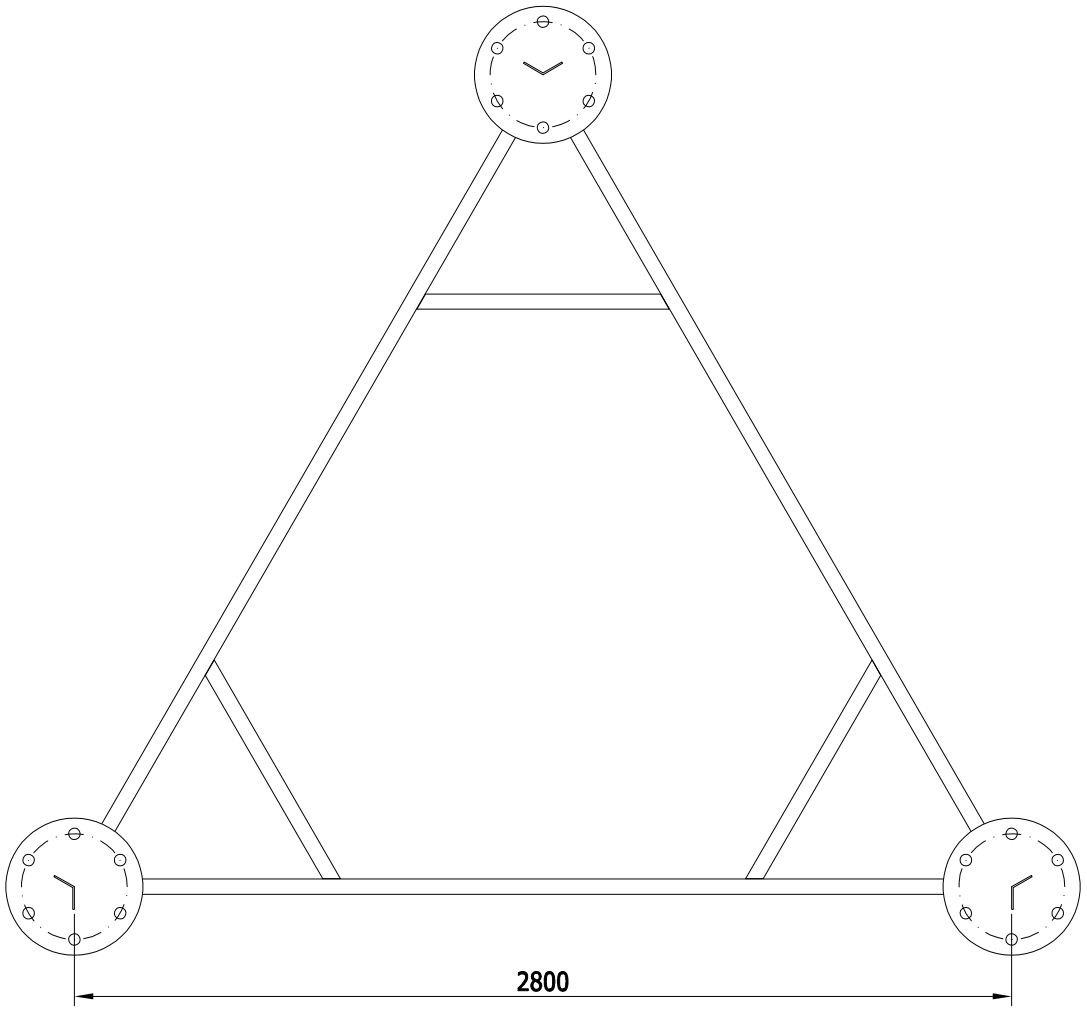
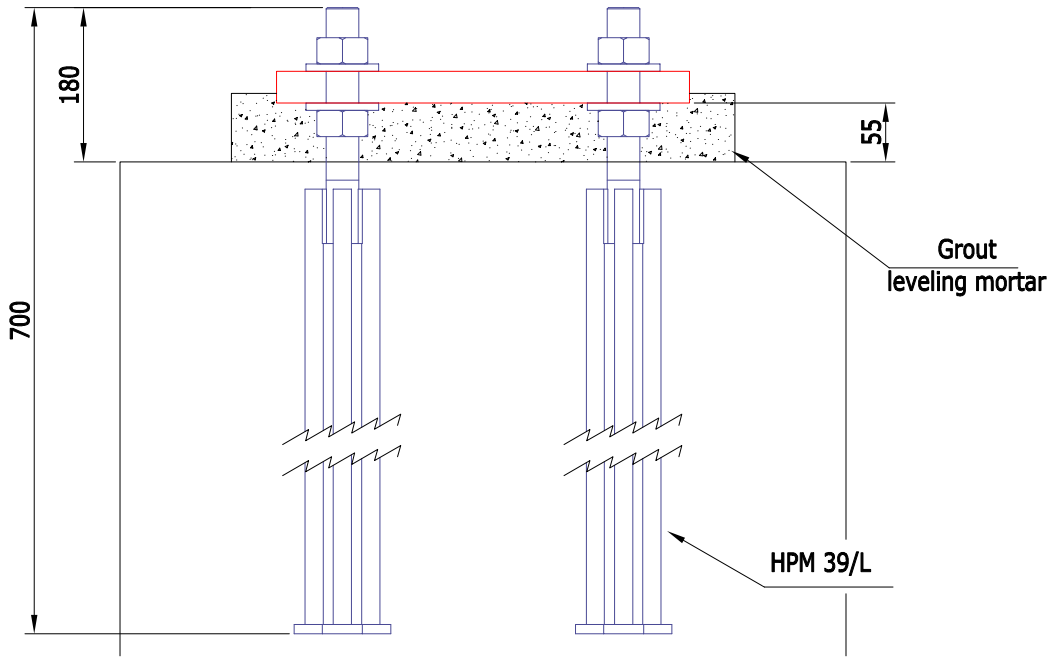
Scale: 1:300

Project Nº.: NL088W27I20R1

Layaout Nº.: -





	Date	Name	Revision		Sign
Drawn by	--/05/2022	A. H. S.	Date Rev.		
Checked by	-	-	Code		

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Project:	SELF SUPPORTING NL088W27I20R1	Scale: 1:25	
Title:	Bolt Foundation Sketch	Project Nº.:	NL088W27I20R1
		Layaout Nº.:	-

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