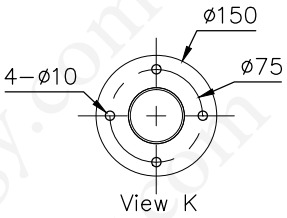
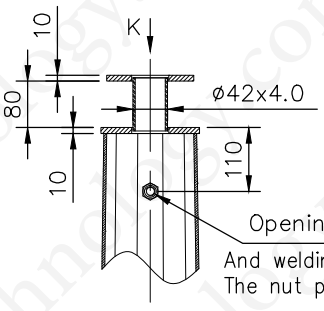
GENERAL NOTES.

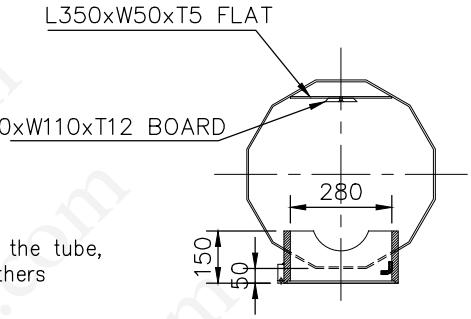
1. FIRST ANGLE PROJECTION.
2. WELDING SYMBOLS ARE TO AWS D1.1
3. HOT DIP GALVANIZED TO ISO1461
4. POLE IS 16 SIDES



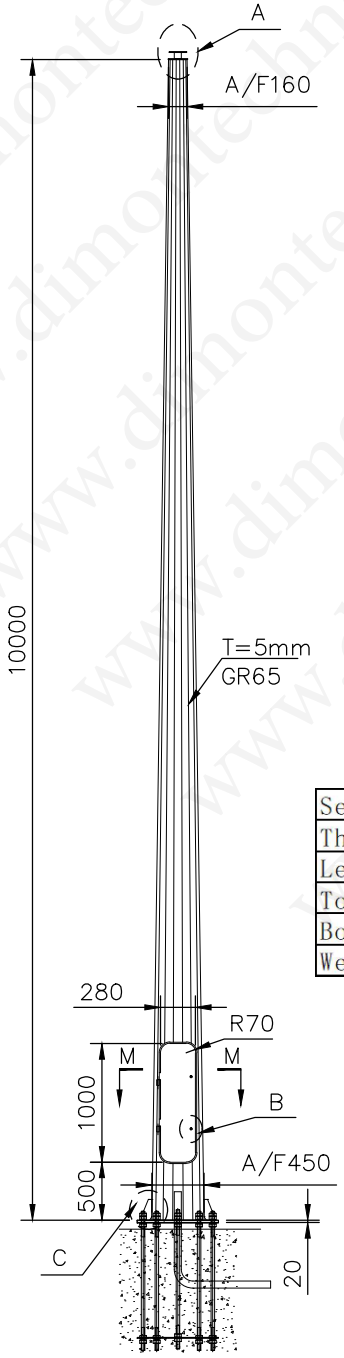
View K

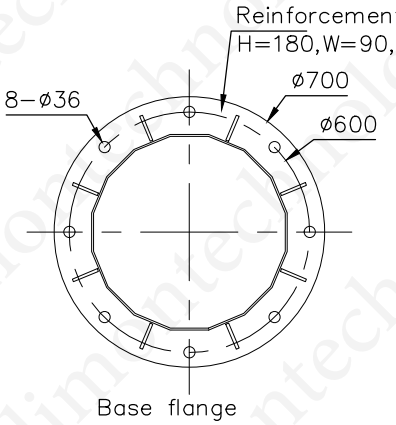


Detail A

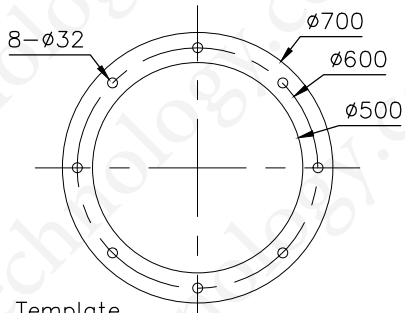


Detail M-M



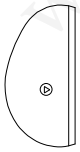


Base flange
GR50

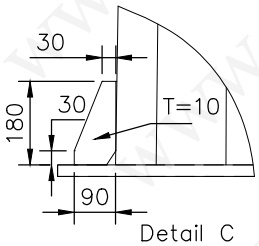


Template

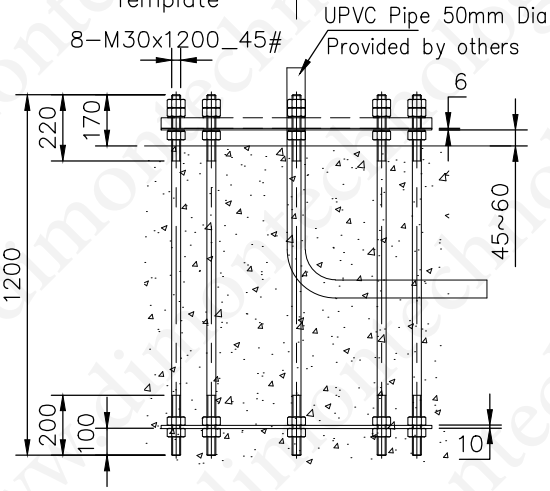
Section#	1st
Thickness(mm):	5.0
Length(m):	10.000
Top(mm):	160.0
Bottom(mm):	450.0
Weight(kg):	373.0



Detail B



Detail C
Reinforcement plate

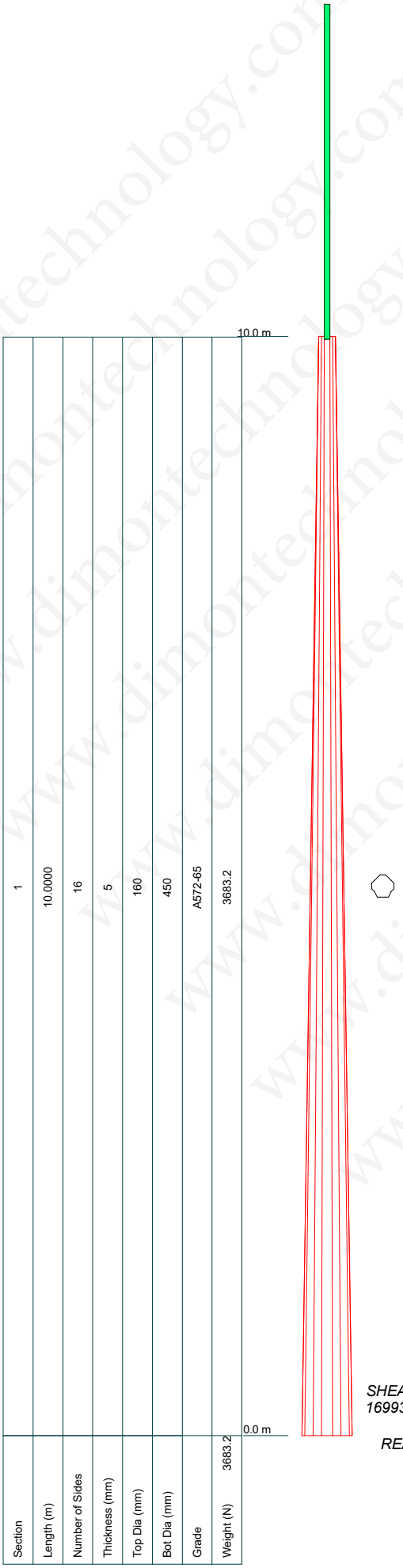


Detail of Anchor bolt
Provided by others

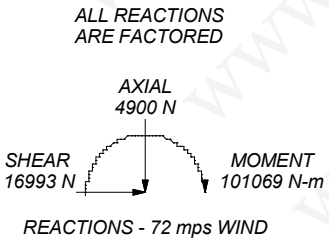
DIMON TECHNOLOGY

CLIENT	
TITLE	QD211231-10M POLE

			DRAWN	WZL 2021.04.06	MATERIAL		MANUFACTURING ORDER
			ENGR		THK(mm)		
			CHECKED		WT(kg)		
REV ID.	DATE	REVISION DESCRIPTION	SPECIFICATIONS		SCALE		VERSION:



Section	Length (m)	Number of Sides	Thickness (mm)	Top Dia (mm)	Bot Dia (mm)	Grade	Weight (N)
1	10.0000	16	5	160	450	A572-65	3683.2
							3683.2



DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
lightning rod	11.5		

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A572-65	448159 kPa	551580 kPa			

TOWER DESIGN NOTES

1. Tower designed for Exposure D to the TIA-222-G Standard.
2. Tower designed for a 72 mps basic wind in accordance with the TIA-222-G Standard.
3. Tower Structure Class II.
4. Topographic Category 1 with Crest Height of 0.0000 m
5. TOWER RATING: 25.7%

tnxTower	Job	Page
ÉÏº£°²²®¹¤ÒµÉè±¸ÓÐÏÞ¹Ë¾ * MERGEFORMAT	10m-72mps	1 of 6
	Project	Date 09:44:30 04/06/21
Phone: *** FAX: ***	Client	Designed by zelong.wen

Tower Input Data

The tower is a monopole.
This tower is designed using the TIA-222-G standard.
The following design criteria apply:

Basic wind speed of 72 mps.
Structure Class II.
Exposure Category D.
Topographic Category 1.
Crest Height 0.0000 m.
A non-linear (P-delta) analysis was used.
Pressures are calculated at each section.
Stress ratio used in pole design is 1.
Local bending stresses due to climbing loads, feed line supports, and appurtenance mounts are not considered.

Options

	Consider Moments - Legs		Distribute Leg Loads As Uniform		Use ASCE 10 X-Brace Ly Rules
	Consider Moments - Horizontals		Assume Legs Pinned	√	Calculate Redundant Bracing Forces
	Consider Moments - Diagonals	√	Assume Rigid Index Plate		Ignore Redundant Members in FEA
	Use Moment Magnification	√	Use Clear Spans For Wind Area		SR Leg Bolts Resist Compression
√	Use Code Stress Ratios	√	Use Clear Spans For KL/r	√	All Leg Panels Have Same Allowable
√	Use Code Safety Factors - Guys	√	Retension Guys To Initial Tension		Offset Girt At Foundation
	Escalate Ice		Bypass Mast Stability Checks		Consider Feed Line Torque
	Always Use Max Kz	√	Use Azimuth Dish Coefficients		Include Angle Block Shear Check
	Use Special Wind Profile	√	Project Wind Area of Appurt.		Use TIA-222-G Bracing Resist. Exemption
√	Include Bolts In Member Capacity	√	Autocalc Torque Arm Areas		Use TIA-222-G Tension Splice Exemption
√	Leg Bolts Are At Top Of Section		Add IBC .6D+W Combination		Poles
√	Secondary Horizontal Braces Leg		Sort Capacity Reports By Component	√	Include Shear-Torsion Interaction
	Use Diamond Inner Bracing (4 Sided)	√	Triangulate Diamond Inner Bracing		Always Use Sub-Critical Flow
	SR Members Have Cut Ends		Treat Feed Line Bundles As Cylinder		Use Top Mounted Sockets
	SR Members Are Concentric		Ignore KL/ry For 60 Deg. Angle Legs		Pole Without Linear Attachments
					Pole With Shroud Or No Appurtenances
					Outside and Inside Corner Radii Are Known

Tapered Pole Section Geometry

Section	Elevation m	Section Length m	Splice Length m	Number of Sides	Top Diameter mm	Bottom Diameter mm	Wall Thickness mm	Bend Radius mm	Pole Grade
L1	10.0000-0.0000	10.0000		16	160	450	5	20	A572-65 (448159 kPa)

Tapered Pole Properties

Section	Tip Dia. mm	Area mm^2	I mm^4	r mm	C mm	I/C mm^3	J mm^4	It/Q mm^2	w mm	w/t
L1	162	2472	7503608	55	82	91956	15120830	1222	22	4.378
	458	7098	177564067	158	230	773700	357816670	3509	80	15.92

Tower Elevation m	Gusset Area (per face) m^2	Gusset Thickness mm	Gusset Grade	Adjust. Factor A_f	Adjust. Factor A_r	Weight Mult.	Double Angle Stitch Bolt Spacing Diagonals mm	Double Angle Stitch Bolt Spacing Horizontals mm	Double Angle Stitch Bolt Spacing Redundants mm
L1 10.0000-0.0000				1	1	1			

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral m / Vert m / m	Azimuth Adjustment rad	Placement m		C_AA_A Front m^2	C_AA_A Side m^2	Weight N
lightning rod	C	None		0.0000	11.5000	No Ice	0.6000	0.6000	400.00

Tower Pressures - No Ice

$G_H = 1.100$

Section Elevation m	z m	K_Z	q_z kPa	A_G m^2	Face	A_F m^2	A_R m^2	A_{leg} m^2	Leg %	C_AA_A In Face m^2	C_AA_A Out Face m^2
L1	4.2986	1.03	3.21	3.100	A	0.000	3.100	3.100	100.00	0.000	0.000
10.0000-0.0000					B	0.000	3.100		100.00	0.000	0.000
					C	0.000	3.100		100.00	0.000	0.000
					D	0.000	3.100		100.00	0.000	0.000

Tower Forces - No Ice - Wind Normal To Face

Section Elevation m	Add Weight N	Self Weight N	Face	e	C_F	q_z kPa	D_F	D_R	A_E m^2	F N	w Nlm	Ctrl. Face
L1	0.00	3683.17	A	1	0.75	3.21	1	1	3.100	8209.62	820.96	D
10.0000-0.0000			B	1	0.75		1	1	3.100			
0			C	1	0.75		1	1	3.100			
			D	1	0.75		1	1	3.100			
Sum Weight:	0.00	3683.17						OTM	35290 N-m	8209.62		

Tower Forces - No Ice - Wind 45 To Face

Section Elevation m	Add Weight N	Self Weight N	Face	e	C_F	q_z kPa	D_F	D_R	A_E m^2	F N	w Nlm	Ctrl. Face
L1	0.00	3683.17	A	1	0.75	3.21	1	1	3.100	8209.62	820.96	D
10.0000-0.000			B	1	0.75		1	1	3.100			
0			C	1	0.75		1	1	3.100			
			D	1	0.75		1	1	3.100			
Sum Weight:	0.00	3683.17						OTM	35290 N-m	8209.62		

Force Totals

Load Case	Vertical Forces N	Sum of Forces X N	Sum of Forces Z N	Sum of Overturning Moments, M_x N-m	Sum of Overturning Moments, M_z N-m	Sum of Torques N-m
Leg Weight	3683.17					
Bracing Weight	0.00					
Total Member Self-Weight	3683.17			0	0	
Total Weight	4083.17			0	0	
Wind 0 rad - No Ice		0.00	-10620.85	-63019	0	0
Wind 1 rad - No Ice		7510.07	-7510.07	-44561	-44561	0
Wind 2 rad - No Ice		10620.85	0.00	0	-63019	0

Load Combinations

Comb. No.	Description
1	Dead Only
2	1.2 Dead+1.6 Wind 0 rad - No Ice
3	0.9 Dead+1.6 Wind 0 rad - No Ice
4	1.2 Dead+1.6 Wind 1 rad - No Ice
5	0.9 Dead+1.6 Wind 1 rad - No Ice
6	1.2 Dead+1.6 Wind 2 rad - No Ice
7	0.9 Dead+1.6 Wind 2 rad - No Ice

Maximum Member Forces

Section No.	Elevation m	Component Type	Condition	Gov. Load Comb.	Axial N	Major Axis Moment N-m	Minor Axis Moment N-m
L1	10 - 0	Pole	Max Tension	1	0.00	0	0

Section No.	Elevation m	Component Type	Condition	Gov. Load Comb.	Axial N	Major Axis Moment N-m	Minor Axis Moment N-m
			Max. Compression	6	-4887.45	-101069	0
			Max. Mx	6	-4887.45	-101069	0
			Max. My	2	-4887.45	0	101069
			Max. Vy	6	16996.91	-101069	0
			Max. Vx	2	-16996.91	0	101069

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical N	Horizontal, X N	Horizontal, Z N
Pole	Max. Vert	6	4899.80	-16993.35	0.00
	Max. H_x	3	3674.85	0.00	16993.35
	Max. H_z	2	4899.80	0.00	16993.35
	Max. M_x	2	101069	0.00	16993.35
	Max. M_z	6	101069	-16993.35	0.00
	Max. Torsion	4	0	-12016.12	12016.12
	Min. Vert	5	3674.85	-12016.12	12016.12
	Min. H_x	6	4899.80	-16993.35	0.00
	Min. H_z	1	4083.17	0.00	0.00
	Min. M_x	1	0	0.00	0.00
	Min. M_z	1	0	0.00	0.00
	Min. Torsion	5	0	-12016.12	12016.12

Tower Mast Reaction Summary

Load Combination	Vertical N	$Shear_x$ N	$Shear_z$ N	Overturning Moment, M_x N-m	Overturning Moment, M_z N-m	Torque N-m
Dead Only	4083.17	0.00	0.00	0	0	0
1.2 Dead+1.6 Wind 0 rad - No Ice	4899.80	0.00	-16993.35	-101069	0	0
0.9 Dead+1.6 Wind 0 rad - No Ice	3674.85	0.00	-16993.35	-101006	0	0
1.2 Dead+1.6 Wind 1 rad - No Ice	4899.80	12016.12	-12016.12	-71467	-71467	0
0.9 Dead+1.6 Wind 1 rad - No Ice	3674.85	12016.12	-12016.12	-71422	-71422	0
1.2 Dead+1.6 Wind 2 rad - No Ice	4899.80	16993.35	0.00	0	-101069	0
0.9 Dead+1.6 Wind 2 rad - No Ice	3674.85	16993.35	0.00	0	-101006	0

Solution Summary

	Sum of Applied Forces			Sum of Reactions			
Load Comb.	PX N	PY N	PZ N	PX N	PY N	PZ N	% Error
1	0.00	-4083.17	0.00	0.00	4083.17	0.00	0.000%
2	0.00	-4899.80	-16993.35	0.00	4899.80	16993.35	0.000%

Load Comb.	Sum of Applied Forces PX N	PY N	PZ N	Sum of Reactions PX N	PY N	PZ N	% Error
3	0.00	-3674.85	-16993.35	0.00	3674.85	16993.35	0.000%
4	12016.12	-4899.80	-12016.12	-12016.12	4899.80	12016.12	0.000%
5	12016.12	-3674.85	-12016.12	-12016.12	3674.85	12016.12	0.000%
6	16993.35	-4899.80	0.00	-16993.35	4899.80	0.00	0.000%
7	16993.35	-3674.85	0.00	-16993.35	3674.85	0.00	0.000%

Non-Linear Convergence Results

Load Combination	Converged?	Number of Cycles	Displacement Tolerance	Force Tolerance
1	Yes	4	0.00000001	0.00000001
2	Yes	4	0.00000001	0.00000001
3	Yes	4	0.00000001	0.00000001
4	Yes	4	0.00000001	0.00000001
5	Yes	4	0.00000001	0.00000001
6	Yes	4	0.00000001	0.00000001
7	Yes	4	0.00000001	0.00000001

Maximum Tower Deflections - Design Wind

Section No.	Elevation m	Horz. Deflection m	Gov. Load Comb.	Tilt rad	Twist rad
L1	10 - 0	0.16	6	0.0343	0.0000

Critical Deflections and Radius of Curvature - Design Wind

Elevation m	Appurtenance	Gov. Load Comb.	Deflection m	Tilt rad	Twist rad	Radius of Curvature m
11.5000	lightning rod	6	0.16	0.0343	0.0000	Inf

Compression Checks

Pole Design Data

Section No.	Elevation m	Size	L m	L_u m	Kl/r	A mm^2	P_u N	ϕP_n N	Ratio $\frac{P_u}{\phi P_n}$
L1	10 - 0 (1)	TP450x160x5	10.0000	10.0000	63.1	7098	-4887.44	2247516.78	0.002

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	Project	Date 09:44:30 04/06/21
Phone: *** FAX: ***	Client	Designed by zelong.wen

Pole Bending Design Data

Section No.	Elevation m	Size	M_{ux} N-m	ϕM_{nx} N-m	Ratio $\frac{M_{ux}}{\phi M_{nx}}$	M_{uy} N-m	ϕM_{ny} N-m	Ratio $\frac{M_{uy}}{\phi M_{ny}}$
L1	10 - 0 (1)	TP450x160x5	101069	396325	0.255	0	396325	0.000

Pole Shear Design Data

Section No.	Elevation m	Size	Actual V_u N	ϕV_n N	Ratio $\frac{V_u}{\phi V_n}$	Actual T_u N-m	ϕT_n N-m	Ratio $\frac{T_u}{\phi T_n}$
L1	10 - 0 (1)	TP450x160x5	16996.92	1817898.75	0.009	0	800679	0.000

Pole Interaction Design Data

Section No.	Elevation m	Ratio $\frac{P_u}{\phi P_n}$	Ratio $\frac{M_{ux}}{\phi M_{nx}}$	Ratio $\frac{M_{uy}}{\phi M_{ny}}$	Ratio $\frac{V_u}{\phi V_n}$	Ratio $\frac{T_u}{\phi T_n}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	10 - 0 (1)	0.002	0.255	0.000	0.009	0.000	0.257 ✔	1.000	4.8.2 ✔

Section Capacity Table

Section No.	Elevation m	Component Type	Size	Critical Element	P N	ϕP_{allow} N	% Capacity	Pass Fail
L1	10 - 0	Pole	TP450x160x5	1	-4887.44	2247516.78	25.7	Pass
							Summary	
							Pole (L1) 25.7	Pass
							RATING = 25.7	**Pass**

Calculation of Baseplate with Gussets

Anchor bolt, baseplate, gussets and weld are calculated separately below, TIA/EIA-222-G is used for analysis reference

1. The basic input data of the baseplate, see figure 1 below:

Pole shaft-governing reactions:

M (moment) =	102	kN.m
Fs (shear) =	17	kN
Fz (vertical) =	5	kN

Bottom pole shaft geometric:

Pole bottom diameter, d =	450	mm
Base plate flat-flat diameter, D =	700	mm
Base plate thickness, T_{bp} =	20	mm
Base plate yield stress, σ_{bp} =	290	MPa

Anchor bolts geometric:

Bolt circle diameter, D_{bc} =	600	mm
Bolt quantity, Q_{bt} =	8	
Bolt diameter, D_{bt} =	30	mm
Bolt net area, An =	561	mm2
Bolt tensile stress, Fub =	600	MPa

Gussets geometric:

Gussets height, H_g =	180	mm
Gussets width, W_g =	125	mm
Gussets thickness, T_g =	10	mm
Gussets yield stress, σ_g =	450	MPa
D1 =	75	mm

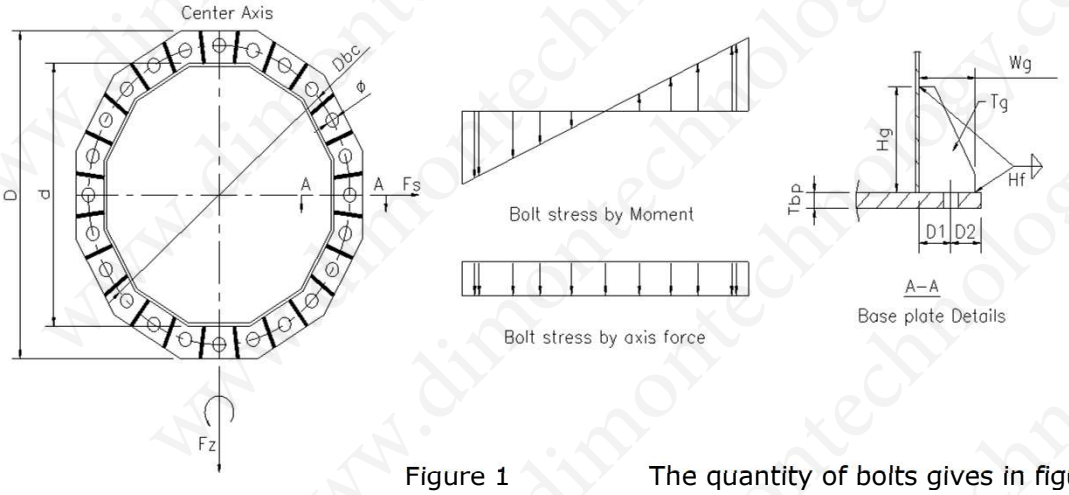

Figure 1

The quantity of bolts gives in figure 1 is not ture.

2. Anchor bolts calculation:

a. Anchor bolt axis force:

Bolt force by the axis reaction, Fz:

$$N_{axis} = \frac{F_Z}{Q_{bt}} = \quad 0.625 \quad \text{kN}$$

Maximum bolt force by the moment M:

$$N_{max} = \frac{M \times X_1}{\sum X_i^2} = \quad 85 \quad kN$$

take axis Y as the centeral line of bending.
I is the serial number of each bolt.

Distance from bolt to central axis:

	x	y
1	300.0	0.0
2	212.1	212.1
3	0.0	300.0
4		
5		
6		
7		
8		
9		
10		
11		
12		

Combined maximun force in bolt:

$$Pu = N_{axis} + N_{max} = 85.625 \quad kN$$

b. Anchor bolt shear force:

$$Vu = \frac{F_S}{Q_{bt}} = \quad 2.125 \quad kN$$

c. Anchor bolt strength check:
According to TIA, for anchor rods, the following interaction equation shall be satisfied:

$$\left(\frac{P_u + \frac{V_u}{\eta}}{\phi R_{nt}}\right) \le 1$$

where:
ϕ 0.75
Pu = larger of compression or tension force
Vu = shear force (direct shear and torsion components) corresponding to Pu
Rnt = nominal tensile strength of anchor rod as per 4.9.6.1 = Fub An

$$Rnt = Fub * An = \quad 336.6 \quad kN$$

η 0.4

Here $\left(\frac{P_u + \frac{V_u}{\eta}}{\phi R_{nt}}\right)$ = 0.36

Anchor bolts check: OK!

3. Baseplate calculation
From figure 2 right, we can get,

$$L_x = D_{bc} \times \frac{\pi}{Q_{bt}} = \quad 235.6 \quad mm$$

Ly = 125.0 mm

Take the base plate as a 3-sides support elastic plate applied with even distributed loading, the load in the plate is:

$$q = \frac{P_u}{L_x \times L_y} = \quad 2.91 \quad MPa$$

$$L_y / L_x = \quad 0.53$$

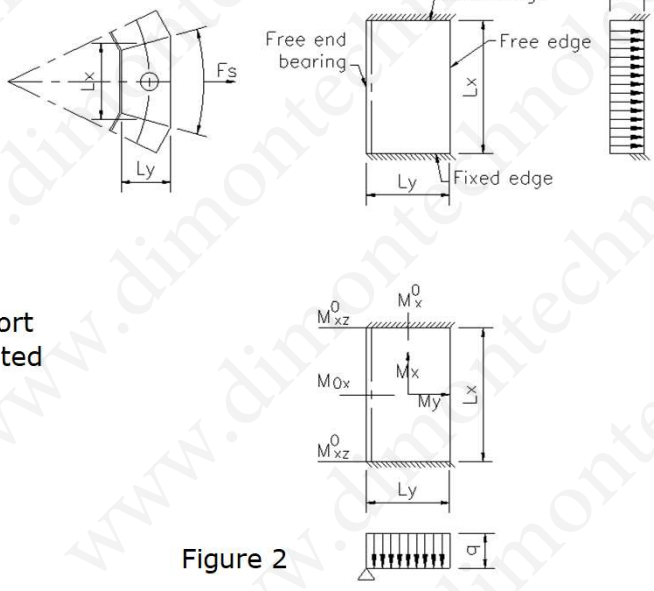

Figure 2

So we can get the moment coefficient from the right table below:

$M_{coef} = M_x^o =$ -0.0575

The maximum force is:

$N_{p1} = M_x^o \times q \times L_x^2 =$ -9279.2 N

Analysis of base plate :

The required minimum thickness is

$$T_{min} > \sqrt{\frac{5N_p}{\sigma}}$$

so we can get:

$$\sigma = \left|\frac{5N_{p1}}{T_{bp}^2}\right| = \quad 116.0 \text{ MPa}$$

Baseplate allowable normal stress is

290 MPa

Base plate check: OK!

Ly/Lx	Mx	My	Mox	M°x	M°xz
0.30	0.0143	0.0087	0.0223	-0.0396	-0.0447
0.35	0.0174	0.0106	0.0267	-0.0443	-0.0450
0.40	0.0201	0.0122	0.0306	-0.0485	-0.0446
0.45	0.0226	0.0136	0.0338	-0.0522	-0.0437
0.50	0.0248	0.0148	0.0363	-0.0556	-0.0426
0.55	0.0267	0.0157	0.0383	-0.0587	-0.0413
0.60	0.0284	0.0165	0.0399	-0.0615	-0.0401
0.65	0.0299	0.0170	0.0411	-0.0640	-0.0389
0.70	0.0313	0.0174	0.0420	-0.0663	-0.0379
0.75	0.0325	0.0177	0.0426	-0.0684	-0.0370
0.80	0.0336	0.0178	0.0431	-0.0703	-0.0363
0.85	0.0346	0.0178	0.0434	-0.0720	-0.0358
0.90	0.0355	0.0178	0.0436	-0.0735	-0.0354
0.95	0.0363	0.0177	0.0437	-0.0748	-0.0351
1.00	0.0370	0.0175	0.0437	-0.0760	-0.0350
1.10	0.0382	0.0171	0.0437	-0.0781	-0.0351
1.20	0.0392	0.0166	0.0436	-0.0797	-0.0356
1.30	0.0399	0.0160	0.0436	-0.0809	-0.0363
1.40	0.0405	0.0155	0.0435	-0.0819	-0.0371
1.50	0.0409	0.0150	0.0434	-0.0825	-0.0380
1.75	0.0415	0.0141	0.0433	-0.0835	-0.0405
2.00	0.0418	0.0134	0.0433	-0.0839	-0.0430

4. Gussets calculation

Take the gusset as a short cantilever beam:

a. Gussets stress check:

Shear stress check:

Effective shear stress is:

$$\tau = \frac{Pu}{H_g \times T_g} = \quad 47.6 \text{ MPa}$$

<

Allowable shear stress:

$$\tau_g = \frac{\sigma_g}{\sqrt{3}} = \quad 259.8 \text{ MPa}$$

Normal stress check:

$$W = \frac{T_g \times H_g^2}{6} = \quad 54000 \text{ mm3}$$

$M = Pu \times D_1 =$ 6421.9 N.m

Effective normal stress is

$$\sigma = \frac{M}{W} = \quad 118.9 \text{ MPa}$$

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Allowable normal stress

$\sigma_g =$ 450 MPa

Gussets stress check: OK!