FOUNDATION CALCULATION SHEET

One-Stop Solution for Foundation

TITLE	DESCRIPTION
PROJECT/JOB NO.	Revise F2-F3
PROJECT/JOB NAME	7.5 MW. Power Plant Stream Turbine
CLIENT NAME	SAHAGREEN FOREST
SITE NAME	KAMPANGPET
DOCUMENT NO.	
REFERENCE NO.	
STRUCTURE NAME	Revise F2-F3
LOAD COMBINATION GROUP	

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APPR'D	APPR'D

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AFES	Calculation Sheet of Foundation	Project Na. : 7.5 MW. Power Plant Stream..	
		Project No. : Revise F2-F3	
		Client : SAHAGREEN F...	Page 1

FOUNDATION LISTS

Group Name	No.	Description	No.	Description
F-3	1	F-3		
F-2	2	F-2		

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CONTENTS

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1. GENERAL

1.1 CODE & STANDARD

Items	Description
Design Code	American Concrete Institute (ACI 318) [Metric]
Horizontal Force for Wind	UNIFORM BUILDING CODE (UBC-1997)
Horizontal Force for Seismic	UNIFORM BUILDING CODE [UBC-1997]
Unit System	Input : MKS, Output : MKS, Calculation Unit : IMPERIAL

1.2 MATERIALS & UNIT WEIGHT

Items	Value
Concrete (f'c : compressive strength)	280.000 kgf/cm^2
Lean Concrete (Lf'c : compressive strength)	240.000 kgf/cm^2
Reinforcement (#3 ~ #5 , yield strength)	4000.000 kgf/cm^2
Reinforcement (#6 ~ , yield strength)	4000.000 kgf/cm^2
Rs (Soil unit weight)	1.700 ton/m^3
Rc (Concrete unit weight)	2.400 ton/m^3
Es (Steel Modulus of Elasticity)	2.040 x 10^6 kgf/cm^2
Ec (Concrete Modulus of Elasticity)	252976.800 kgf/cm^2

- Pile Capacity

Items	Value
Pile Name	PHC-12
Footing List	F-3, F-2
Diameter	300 mm
Length	14 m
Thick	10 mm
Shape	Square
Capacity (Ha , Ua , Va)	2 , 15 , 30 tonf

1.3 SUBSOIL CONDITION & SAFETY FACTORS

Items	Description
Allowable Increase of Soil (Wind)	33.33 %
Allowable Increase of Soil (Seismic)	33.33 %
Allowable Increase of Soil (Test)	20 %
Allowable Increase of Pile Horizontal (Wind)	33.33 %
Allowable Increase of Pile Horizontal (Seismic)	33.33 %
Allowable Increase of Pile Horizontal (Test)	20 %
Allowable Increase of Pile Vertical (Wind)	33.33 %
Allowable Increase of Pile Vertical (Seismic)	33.33 %
Allowable Increase of Pile Vertical (Test)	20 %
Allowable Increase of Pile Uplift (Wind)	0 %
Allowable Increase of Pile Uplift (Seismic)	0 %
Allowable Increase of Pile Uplift (Test)	0 %

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Safety factor against overturning for OVM1(FO1)	1.5
Safety factor against overturning for OVM2(FO2)	1.5
Safety factor against overturning for OVM3(FO3)	1.5
Safety factor against overturning for OVM4(FO4)	1.9
Safety factor against sliding for the SL1(FS1)	1.5
Safety factor against sliding for the SL2(FS2)	1.8
Safety factor against sliding for the SL3(FS3)	1.5
Safety factor against sliding for the SL4(FS4)	1.5
Friction factor (μ)	.35

1.4 LOAD COMBINATION

Index	Load Case Name	Load Case Description
1	SW	SELF WEIGHT
2	DL	DEAD LOAD

1.4.1 Group - F-3

Footing List = F-3

Comb . ID	Load Combination for Reinforcement
1	1.0 SW + 1.0 DL

1.4.2 Group - F-2

Footing List = F-2

Comb . ID	Load Combination for Reinforcement
1	1.0 SW + 1.0 DL

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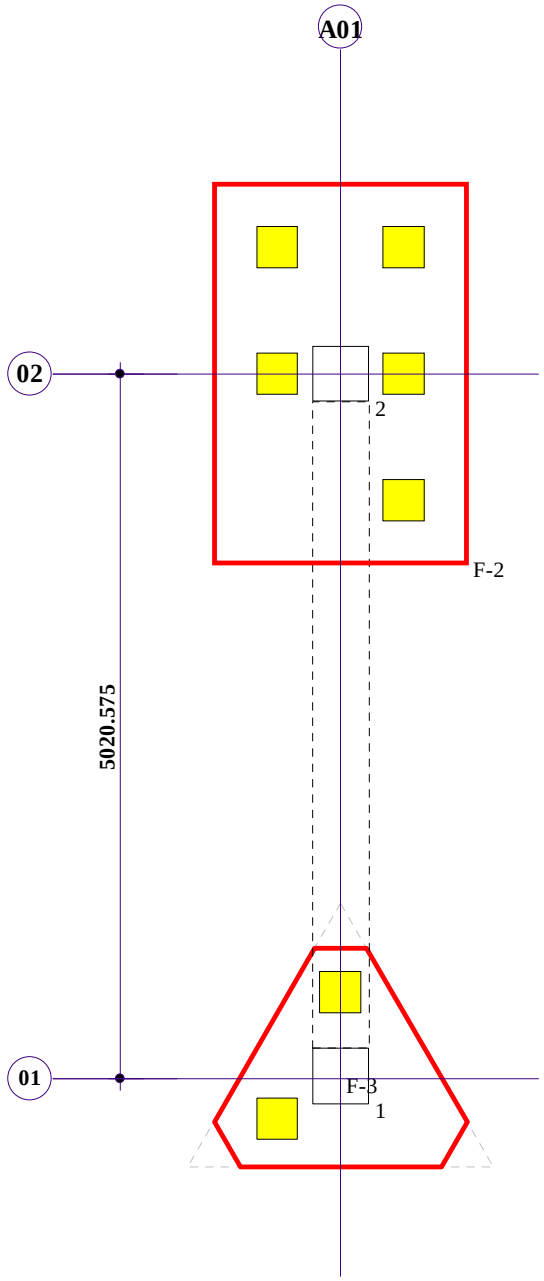
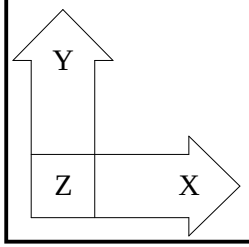
2. DRAWING





REFERENCE DWGS

NO.	DWG NO.	DWG TITLE

NOTES

* OUTPUT UNIT : mm

7.5 MW. Power Plant Stream Turbine PROJECT

FOUNDATION LOCATION PLAN

Revise F2-F3

SQUAD CHECK	PROCESS	PIPING	VESSELS	STRUCT.	ELEC.	INST.

SCALE	JOB NO.	MICROFILM NO.
AS SHOWN	Revise F2-F3	

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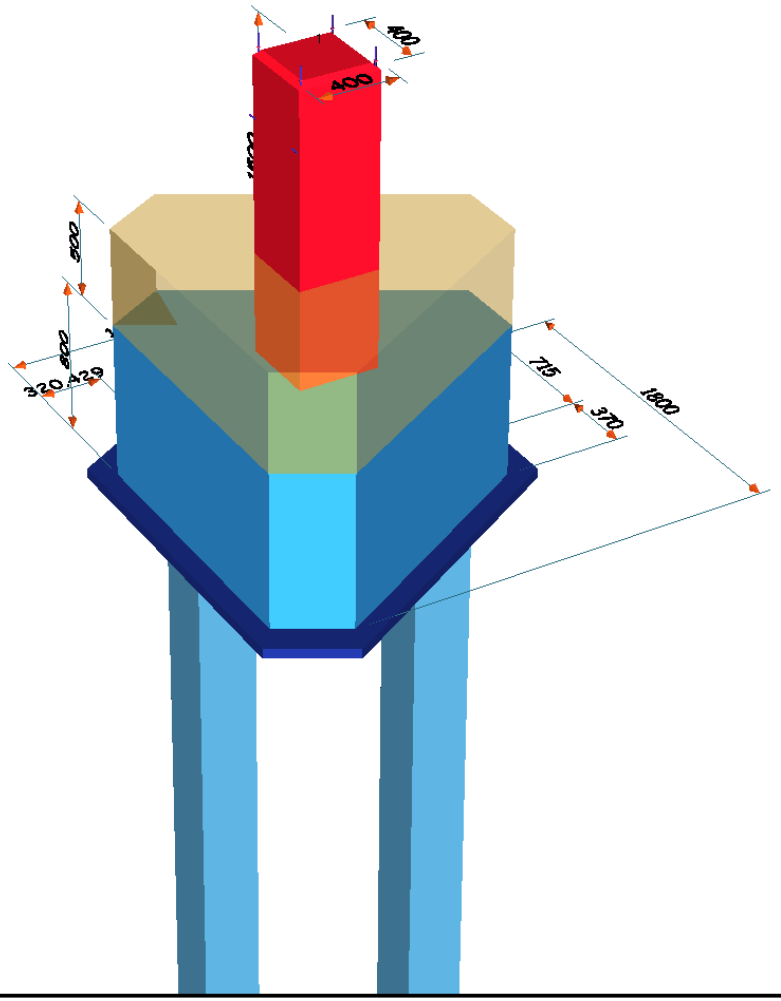
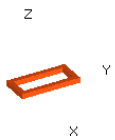
2.2 DETAIL SKETCH





OUTPUT UNIT : mm

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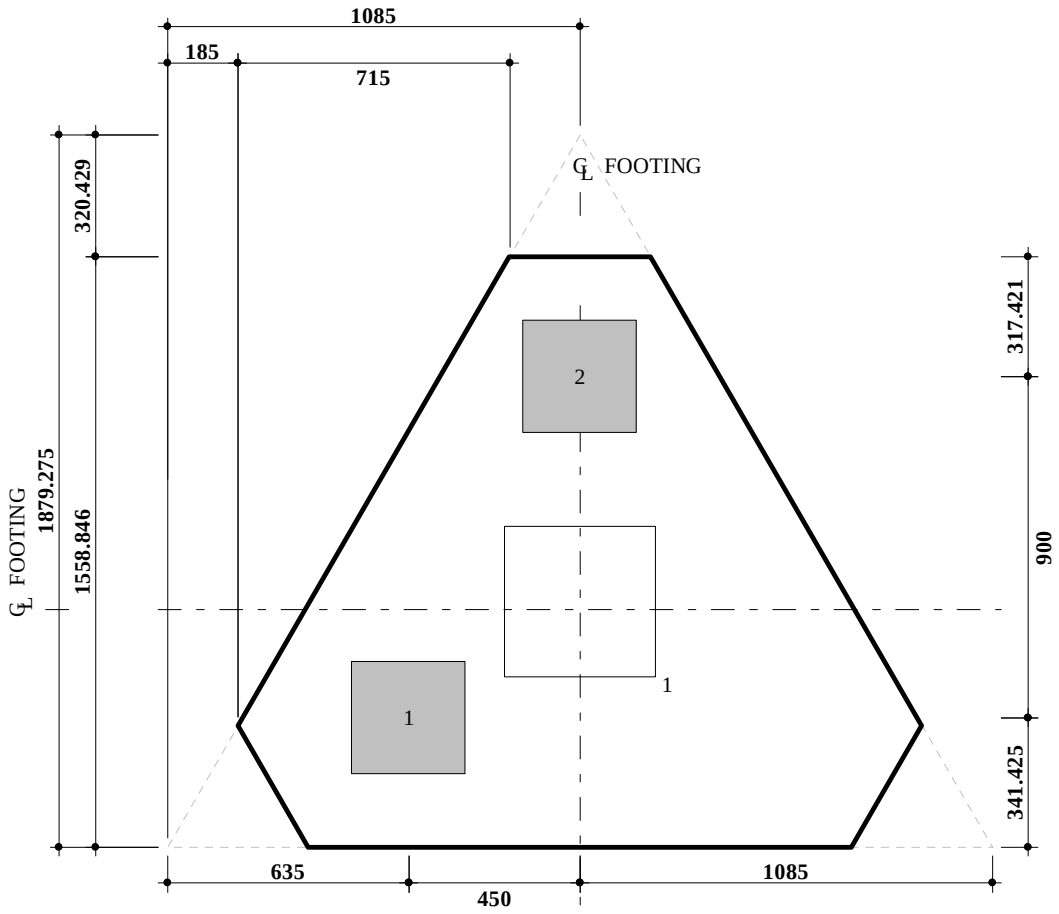

FOUNDATION PLAN

REFERENCE DWGS

NO.	DWG NO.	DWG TITLE

NOTES

*** PILE**
2-??300 PHC-12
*** ANCHOR BOLT**
1X4-M12 ANC. BOLTS (TYPE TYPE L)

*** OUTPUT UNIT : mm**

7.5 MW. Power Plant Stream Turbine PROJECT

FOUNDATION DETAIL FOR

F-3

SQUAD CHECK	PROCESS	PIPING	VESSELS	STRUCT.	ELEC.	INST.

REV.	DATE	DESCRIPTION	DRWN	CHKD	APPD	APPD	APPD

SCALE	JOB NO.	MICROFILM NO.
AS SHOWN	Revise F2-F3	

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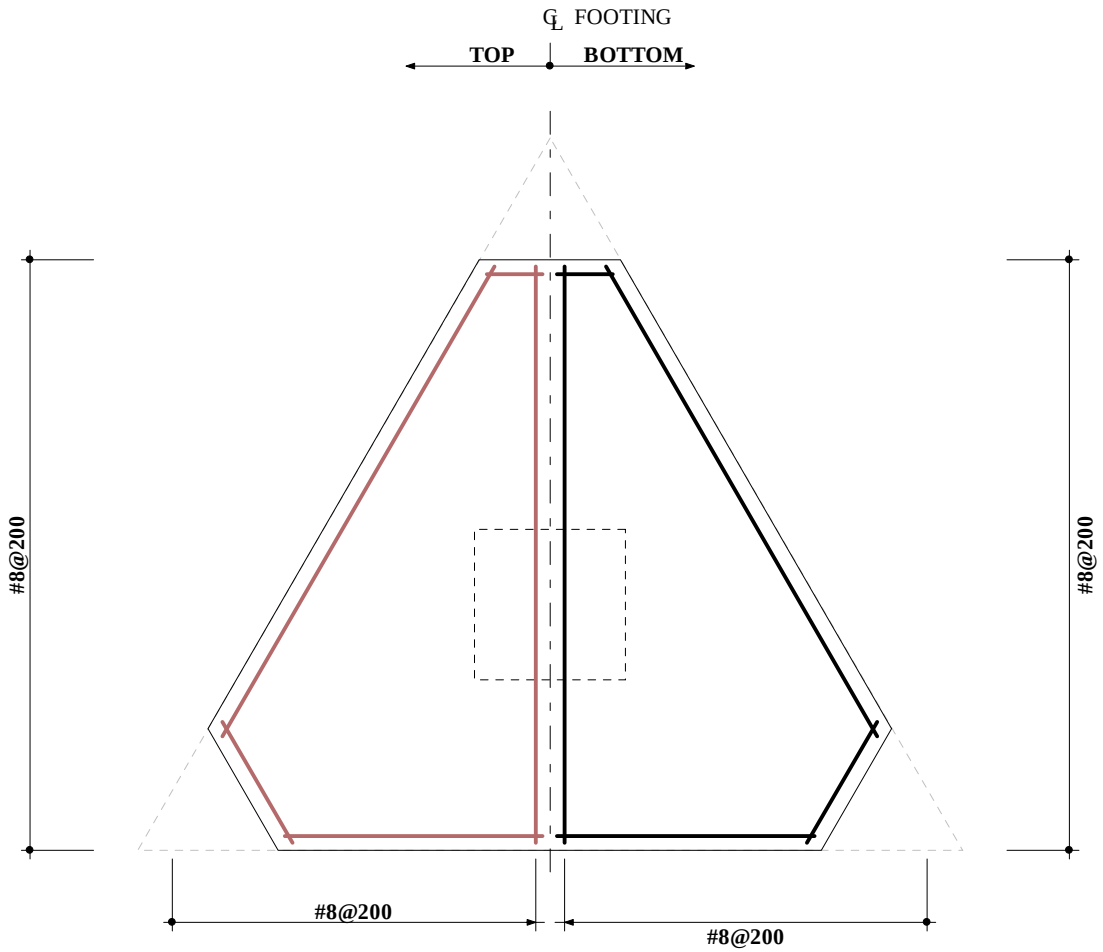

REINFORCEMENT PLAN

REFERENCE DWGS		
NO.	DWG NO.	DWG TITLE

NOTES

* PILE
  2-??300 PHC-12
* ANCHOR BOLT
  1X4-M12 ANC. BOLTS (TYPE TYPE L)

* OUTPUT UNIT : mm

7.5 MW. Power Plant Stream Turbine PROJECT

FOUNDATION DETAIL FOR

F-3

SQUAD CHECK	PROCESS	PIPING	VESSELS	STRUCT.	ELEC.	INST.

REV.	DATE	DESCRIPTION	DRWN	CHKD	APPD	APPD	APPD

SCALE	JOB NO.	MICROFILM NO.
AS SHOWN	Revise F2-F3	

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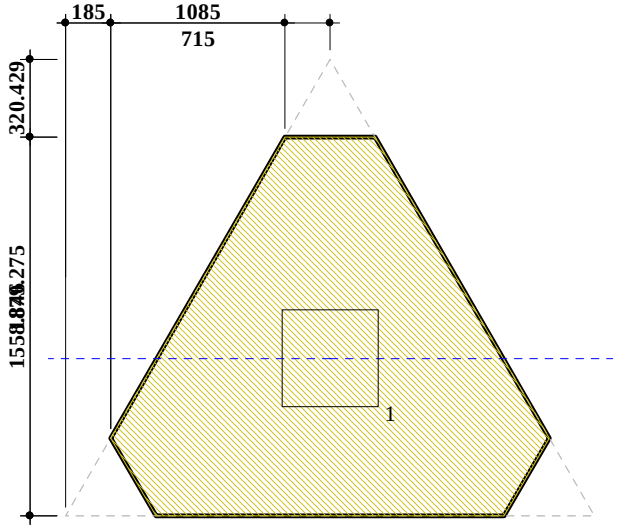

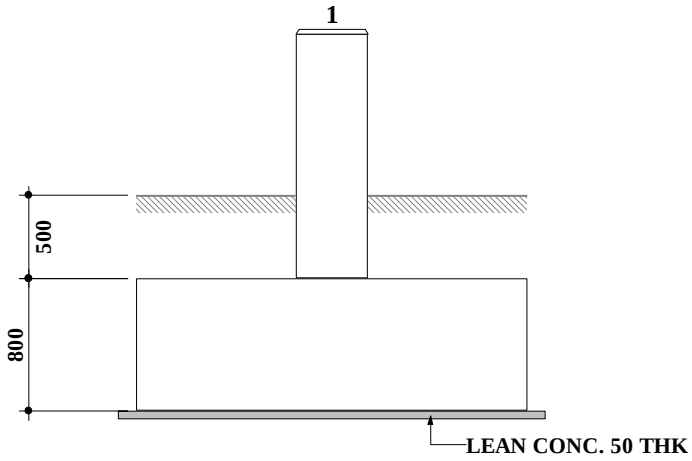

ELEVATION (S1) - X

OUTPUT UNIT : mm

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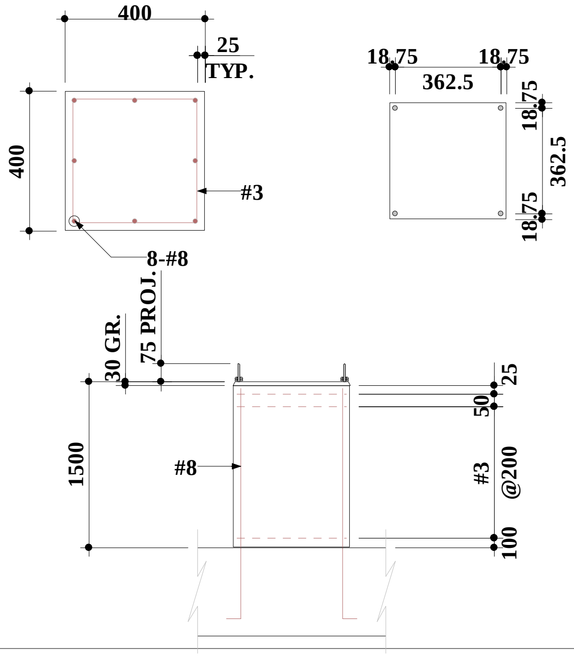
Item No.	F-3

1		
		

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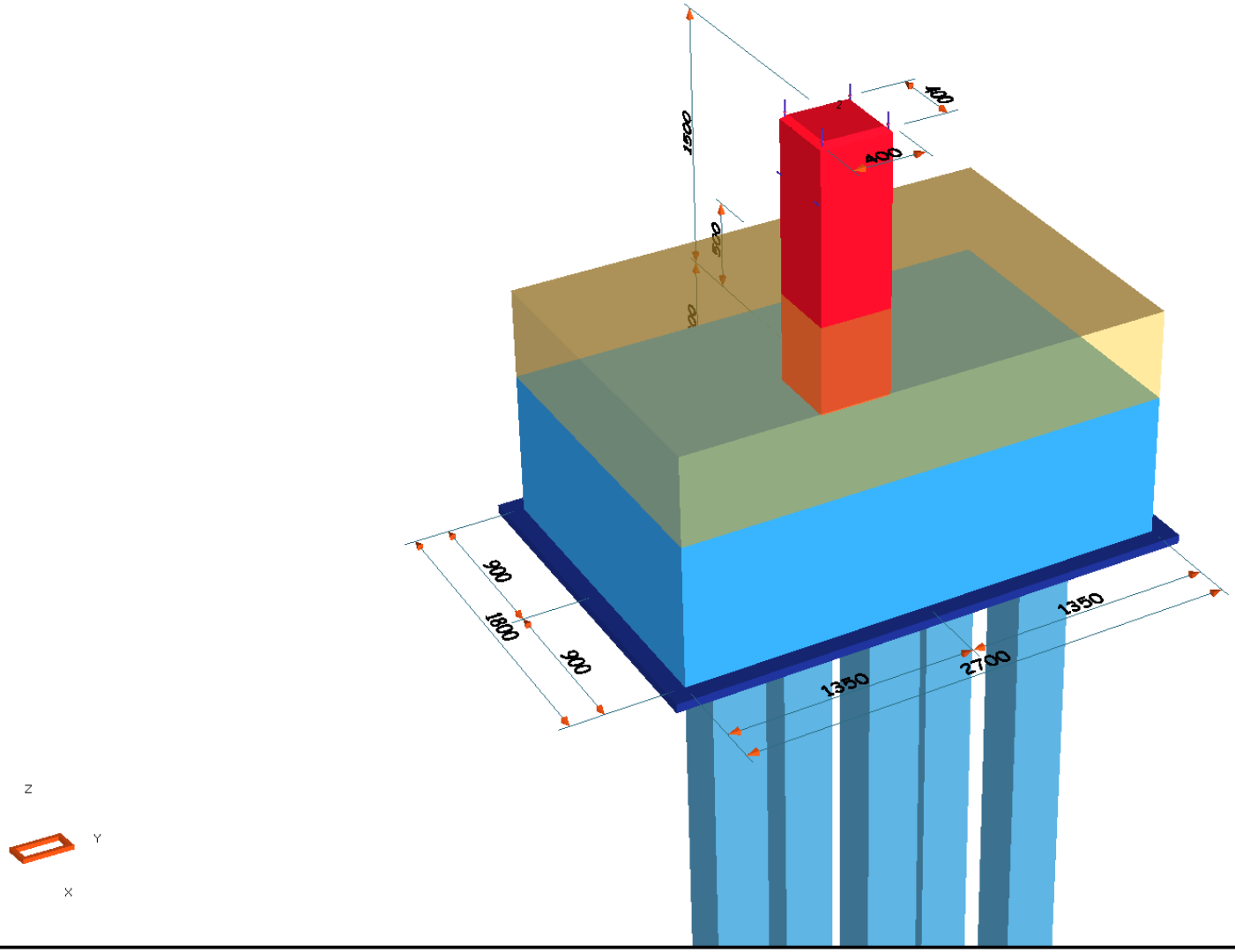
2.2 DETAIL SKETCH



OUTPUT UNIT : mm

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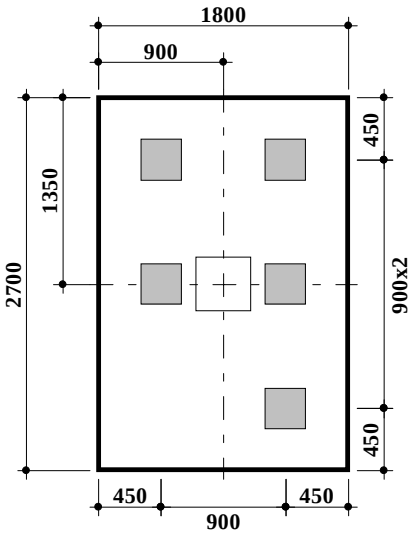
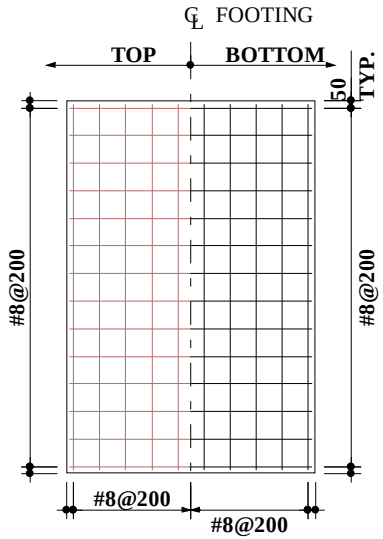
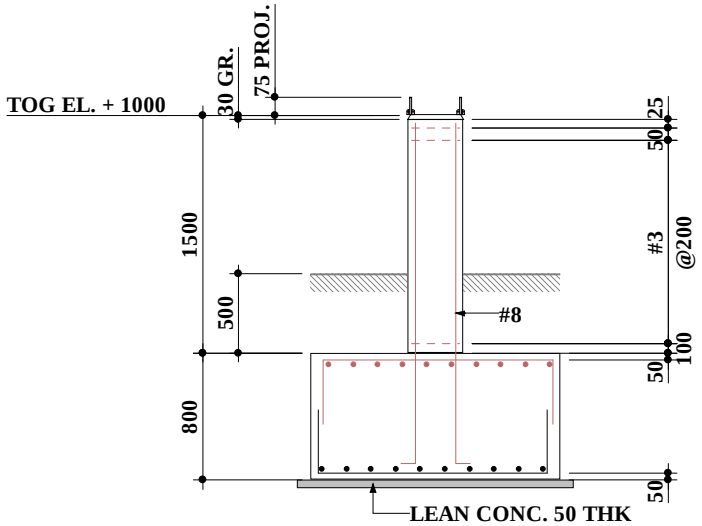


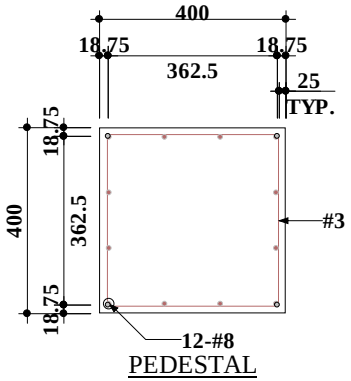
FOUNDATION PLAN



FOOTING REINF. PLAN



SECTION



PEDESTAL

REFERENCE DWGS

NO.	DWG NO.	DWG TITLE

NOTES

* PILE
  5-??300 PHC-12
* ANCHOR BOLT
  1X4-M12 ANC. BOLTS (TYPE TYPE L)

* OUTPUT UNIT : mm

7.5 MW. Power Plant Stream Turbine PROJECT

FOUNDATION DETAIL FOR

F-2

SQUAD CHECK	PROCESS	PIPING	VESSELS	STRUCT.	ELEC.	INST.

REV.	DATE	DESCRIPTION	DRWN	CHKD	APPD	APPD	APPD

SCALE	JOB NO.	MICROFILM NO.
AS SHOWN	Revise F2-F3	

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AFES	Calculation Sheet of Foundation	Project Na. : 7.5 MW. Power Plant Stream..
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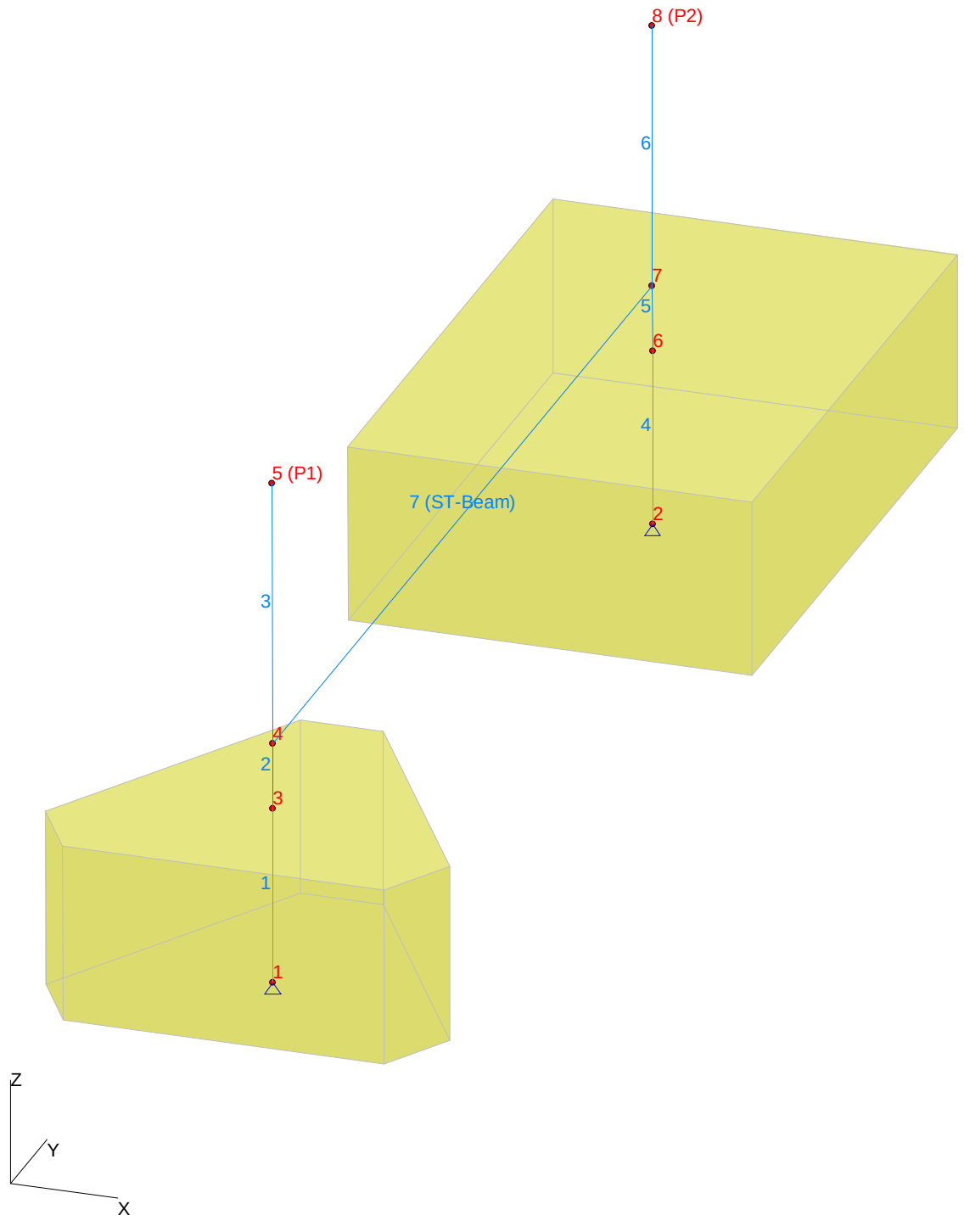
		Client : SAHAGREEN F... / Page 13

3. FRAME ANALYSIS

3.1 FRAME DRAWING

Sturcture 1



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3.2 FRAME ANALYSIS DATA

3.2.1 Structure 1

▸▸ Member and Force

Unit (tonf,tonf-m)

Member	LC#		Axial	Shear-Y	Shear-Z	Torsion	Moment-Y	Moment-Z
1	1	i	-114.5	0	-.714	0	0	0
		j	-114.5	0	-.714	0	.571	0
2	1	i	-113.9	0	-.714	0	.571	0
		j	-113.9	0	-.714	0	.785	0
3	1	i	-112.5	0	0	0	0	0
		j	-112.5	0	0	0	0	0
4	1	i	-235.4	0	.714	0	0	0
		j	-235.4	0	.714	0	-.571	0
5	1	i	-234.8	0	.714	0	-.571	0
		j	-234.8	0	.714	0	-.785	0
6	1	i	-233.3	0	0	0	0	0
		j	-233.3	0	0	0	0	0
7	1	i	-.714	-1.44	0	0	0	-.785
		j	-.714	1.44	0	0	0	-.785

▸▸ Support Reactions

Unit (tonf,tonf-m)

Joint	LC#	Force-X	Force-Y	Force-Z	Moment-X	Moment-Y	Moment-Z
1	1	0	.714	114.52	0	0	0
2	1	0	-.714	235.37	0	0	0

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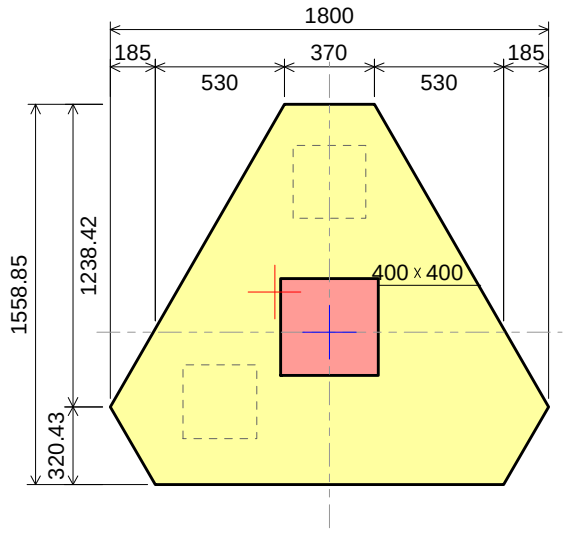
4. FOUNDATION DATA

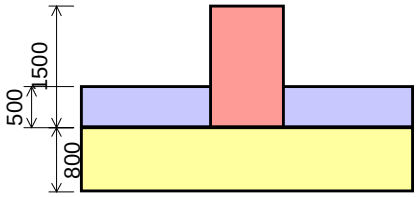
4.1 FOOTING AND SECTION DATA

(mm)



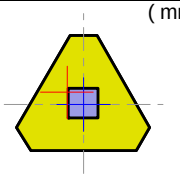
The Origin coordinate
The Center of Gravity (0,0) mm
The Center of Pile (-225,165) mm

Ft. Name	F-3
Ft. Type	
Area	1.861 m^2
Ft. Thickness	800.00 mm
Ft. Volume	1.489 m^3
Ft. Weight	3.574 tonf
Soil Height	500.00 mm
Soil Volume	0.851 m^3
Soil Weight	1.447 tonf
Buoyancy	Not Consider
Self Weight (except Pr.SW)	5.020 tonf



Section Data

(mm)



Ft.Name	Direction	Ft. Volume	Soil Volume	Pier Wt
F-3	All Direct	1.489 m^3	0.851 m^3	0.576 tonf
Sec.Name	**Section Area**	**Ft. Weight**	**Soil Weight**	**Total Weight**
S1	1.861 m^2	3.574 tonf	1.447 tonf	5.596 tonf

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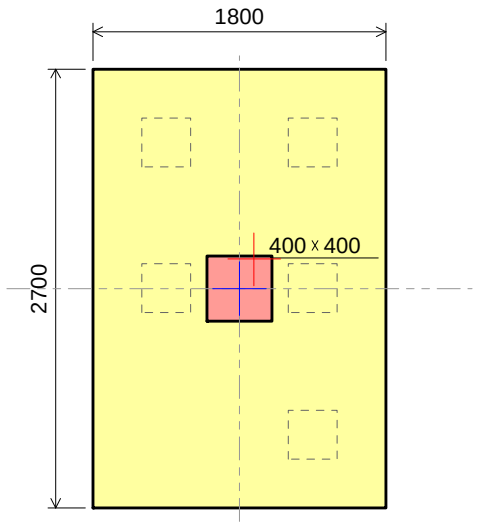
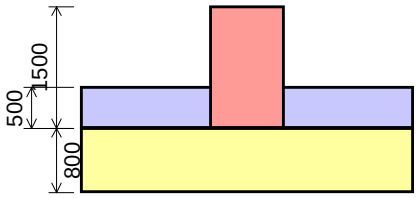
(mm)



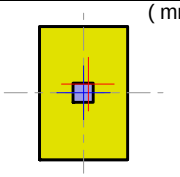
The Origin coordinate
The Center of Gravity (0,0) mm
The Center of Pile (90,180) mm

Ft. Name	F-2
Ft. Type	ISO
Area	4.860 m^2
Ft. Thickness	800.00 mm
Ft. Volume	3.888 m^3
Ft. Weight	9.331 tonf
Soil Height	500.00 mm
Soil Volume	2.350 m^3
Soil Weight	3.995 tonf
Buoyancy	Not Consider
Self Weight (except Pr.SW)	13.326 tonf



Section Data

(mm)



Ft.Name	Direction	Ft. Volume	Soil Volume	Pier Wt
F-2	All Direct	3.888 m^3	2.350 m^3	0.576 tonf
Sec.Name	**Section Area**	**Ft. Weight**	**Soil Weight**	**Total Weight**
S1	4.860 m^2	9.331 tonf	3.995 tonf	13.902 tonf

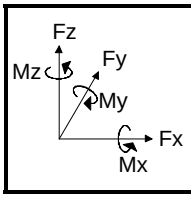
4.2 PIER DATA

Off X , Off Y is offset position from the Center of the footing
If Pier Shape is Circle or Circle wall, Pl is a Diameter. and Pw is a Inner Diameter
Area is pier concrete area
Weight is pier and inner soil weight in case circle wall except Tank1 Type(Circle Ring Footing Shape)

Unit(Length : mm , Weight : tonf , Area : m^2)

Ft.Name	Pr.Name	Shape	Pl	Pw	Ph	Area	Weight	Off X	Off Y
F-3	1	Rectangle	400.000	400.000	1500.000	0.160	0.576	0.000	20.575
F-2	2	Rectangle	400.000	400.000	1500.000	0.160	0.576	0.000	0.000

4.3 LOAD CASE



Input the point loads in the global coordinate system direction. Positive directions of moments (shown in the sketch) are based on the right hand rule.

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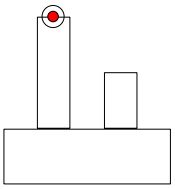
Index	Load Case Name	Load Case Description
1	SW	SELF WEIGHT
2	DL	DEAD LOAD

Unit(tonf , tonf-m)

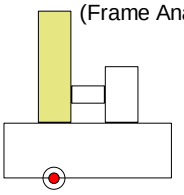
Ft.Name	Pr.Name	Load Case	Fx	Fy	Fz	Mx	My
F-3	1	1	0	0	-.58	0	0
		2	0	0	-112.5	0	0
	Footing SW		0.000	0.000	-5.020	0.000	0.000
F-2	2	1	0	0	-.58	0	0
		2	0	0	-233.35	0	0
	Footing SW		0.000	0.000	-13.326	0.000	0.000

4.4 LOAD COMBINATION

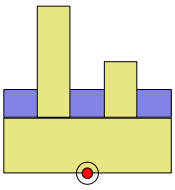
In Pier Top
without Self Weight



In Footing Bottom
with Pier Self Weight,
But without Footing Self Weight,
(Frame Analysis)



In Footing Bottom Center
with Pier & Footing Self Weight & Soil Weight,
Case PileType
in centroid of Pile Group
Case NonPileType
in centroid of Footing



4.4.1 Load Combination in Pier Top (Without SW)

Group 1 - F-3

Unit(tonf , tonf-m)

Ft.Name	Pr.Name	L.Comb.	ΣFx	ΣFy	ΣFz	ΣMx	ΣMy
F-3	1	1	0.000	0.000	-112.500	0.000	0.000

Group 2 - F-2

Unit(tonf , tonf-m)

Ft.Name	Pr.Name	L.Comb.	ΣFx	ΣFy	ΣFz	ΣMx	ΣMy
F-2	2	1	0.000	0.000	-233.355	0.000	0.000

4.4.2 Load Combination in Footing Bottom (With Pier SW)

Group 1 - F-3

Unit(tonf , tonf-m)

Ft.Name	Pr.Name	L.Comb.	ΣFx	ΣFy	ΣFz	ΣMx	ΣMy
F-3	1	1	0.000	-0.714	-114.520	0.000	0.000

Group 2 - F-2

Unit(tonf , tonf-m)

Ft.Name	Pr.Name	L.Comb.	ΣFx	ΣFy	ΣFz	ΣMx	ΣMy
F-2	2	1	0.000	0.714	-235.370	0.000	0.000

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		Project No. : Revise F2-F3	
		Client : SAHAGREEN F...	Page 18

4.4.3 Load Combination in Footing Bottom Center (With Pier & Footing SW)

Load Combination of Elastic Condition

There is no Load Combination

Load Combination of Ultimate Condition

ⓟ : PileType

Group 1 - F-3

- C.G. of Load is coordinate from left bottom. Unit : mm

Unit(tonf , tonf-m)

Ft.Name	Sec.Nam	L.Comb.	ΣFx	ΣFy	ΣFz	ΣMx	ΣMy	C.G. of Loads
F-3ⓟ	S1	1	0.000	-0.714	-119.540	17.365	26.897	900.0 , 646.1

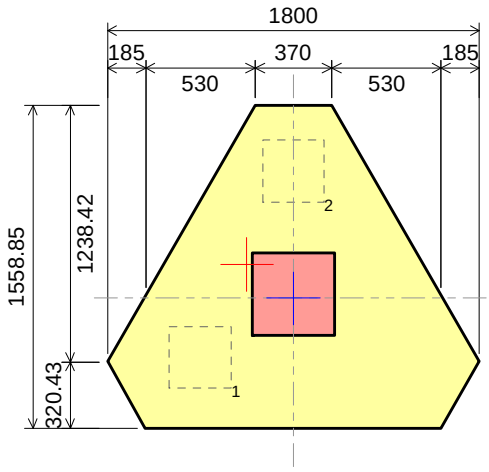
Group 2 - F-2

- C.G. of Load is coordinate from left bottom. Unit : mm

Unit(tonf , tonf-m)

Ft.Name	Sec.Nam	L.Comb.	ΣFx	ΣFy	ΣFz	ΣMx	ΣMy	C.G. of Loads
F-2ⓟ	S1	1	0.000	0.714	-248.696	44.765	-22.383	900.0 , 1350.0

4.4.4 Pile Reaction Table



Footing Name	F-3
Section Name	-
Pile Name	PHC-12
Pile Shape	Square
Pile Number	2 EA
Pile Diameter	300 mm
LC Type	Stability

Origin Point (0,0) mm

The Center of Gravity (0,0) mm

The Center of Pile (-225,165) mm

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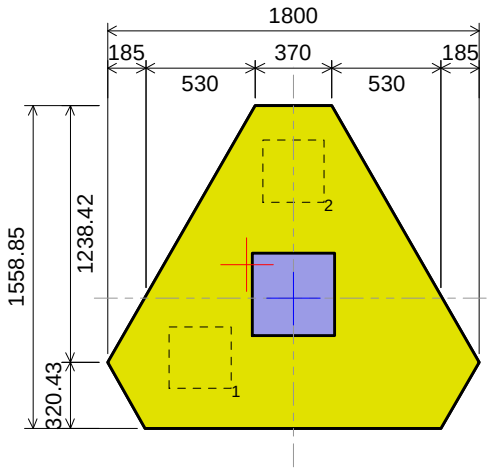


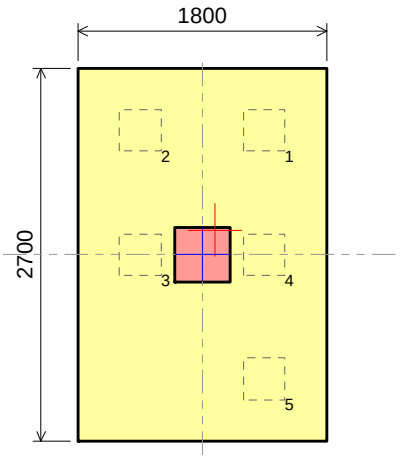
Footing Name	F-3
Section Name	S1
Pile Name	PHC-12
Pile Shape	Square
Pile Number	2 EA
Pile Diameter	300 mm
LC Type	Reinforce

Origin Point (0,0) mm
The Center of Gravity (0,0) mm
The Center of Pile (-225,165) mm

· LC : 1, (1.0 SW + 1.0 DL)

Unit (mm,tonf)

No.	Name	Pile Geometry		Bi-Axial	Shear (Hor)	Ra	Ua	Ha
		X	Y	XY-Dir.	XY-Dir.			
1	PHC-12	-450	-285	19.29	.36	30	15	2
2	PHC-12	0	615	100.25	.36	30	15	2



Footing Name	F-2
Section Name	-
Pile Name	PHC-12
Pile Shape	Square
Pile Number	5 EA
Pile Diameter	300 mm
LC Type	Stability

Origin Point (0,0) mm
The Center of Gravity (0,0) mm
The Center of Pile (90,180) mm

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AFES	Calculation Sheet of Foundation	Project Na. : 7.5 MW. Power Plant Stream..
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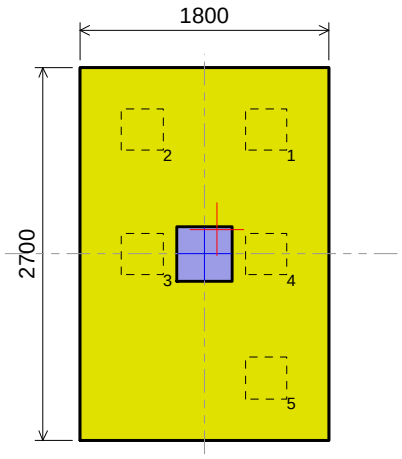

Footing Name	F-2
Section Name	S1
Pile Name	PHC-12
Pile Shape	Square
Pile Number	5 EA
Pile Diameter	300 mm
LC Type	Reinforce

Origin Point (0,0) mm
The Center of Gravity (0,0) mm
The Center of Pile (90,180) mm

· LC : 1, (1.0 SW + 1.0 DL)

Unit (mm,tonf)

No.	Name	Pile Geometry		Bi-Axial	Shear (Hor)	Ra	Ua	Ha
		X	Y	XY-Dir.	XY-Dir.			
1	PHC-12	450	900	27.24	.14	30	15	2
2	PHC-12	-450	900	47.96	.14	30	15	2
3	PHC-12	-450	0	65.73	.14	30	15	2
4	PHC-12	450	0	45	.14	30	15	2
5	PHC-12	450	-900	62.77	.14	30	15	2

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5. CHECK OF STABILITY

There is no Static LoadCombination

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6. DESIGN OF FOOTING

6.1 DESIGN MOMENT AND SHEAR FORCE

Footing design is in accordance with unltimate strength method at footing bottom.

Calculated total pier load as

$\Sigma Q = \Sigma Fz$ - Self Weight Factor x (Soil Weight + Footing Weight)

Ft.Name : Footing Name , Sec.Name : Strip Name for Footing Reinforcement Design

Dir. : Direction , L.Comb. : Load Combination Index , Sl or Sw : Strip X or Y width

6.1.1 Data

Group 1 - F-3

Unit(mm , tonf , tonf-m)

Ft.Name	Sec.Nam	Dir.	L.Comb.	Fl or Fw	Sl or Sw	ΣFz	ΣM	ΣQ
F-3φ	S1	X	1	2170.00	2170.00	119.540	26.90	114.520
	S1	Y	1	2170.00	2170.00	119.540	17.365	114.520

Group 2 - F-2

Unit(mm , tonf , tonf-m)

Ft.Name	Sec.Nam	Dir.	L.Comb.	Fl or Fw	Sl or Sw	ΣFz	ΣM	ΣQ
F-2φ	S1	X	1	1800.00	2700.00	248.696	-22.38	235.370
	S1	Y	1	2700.00	1800.00	248.696	44.765	235.370

6.1.2 Design Parameters

Yield Strength - #3 ~ #5 : f_y1 , #6 ~ : f_y2

f_cl : Clear Cover for edge of footing reinforcement

f_clt : Clear Cover for top of footing reinforcement

fp_clb : Clear Cover for bottom of footing reinforcement (Pile Foundation)

Loc. : Location of Critical Point from left side of footing

Unit(kgf/cm^2,mm)

ϕ(Flexure)	ϕ(Shear)	f'c	fy1	fy2	f_cl	f_clt	fp_clb
.85	.8	280.00	4000.00	4000.00	50.0	50.0	50.0

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6.2 REQUIRED REINFORCEMENT

6.2.1 Reinforcement Formula

- Shrinkage and temperature reinforcement ---- ACI CODE 7.12.2

$As \geq = fac \cdot b \cdot h$, fac = following

Area of shrinkage and temperature reinforcement shall provide at least the following ratio of reinforcement area to gross concrete area, but not less than 0.0014

(a) Slabs where Grade 40 or 50 deformed bars are used 0.0020

(b) Slabs where Grade 60 deformed bars or welded wire reinforcement are used.....0.0018

(c) Slabs where reinforcement with yield stress exeeding 60,000 psi measured at a yield strain of 0.35 percent is used ..... $\frac{0.0018 \times 60{,}000}{f_y}$

- Required Reinforcement by Analysis

$As \geq As_2$

- At every section of flexural members where tensile reinforcement is required

$As \geq As_5 \geq As_4$ ---- ACI Eq (10-3)

- The requirements of Eq (10-3) need not be applied, if every section As provided is at least one -third greater then that required by analysis ---- ACI CODE 10.5.3

$As_2 = \rho_{req} \cdot b \cdot d$

$As_3 = 1.333\ \rho_{req} \cdot b \cdot d$

$As_4 = \frac{200}{f_y} \cdot b \cdot d$

$As_5 = \frac{3\sqrt{f_{ck}}}{f_y} \cdot b \cdot d$

$As_{max} = 0.75\ \rho_b \cdot b \cdot d$

$\rho_b = 0.85 \times \beta_1 \times \frac{f_{ck}}{f_y} \times \frac{0.003 \times E_s}{0.003 \times E_s + f_y}$

Selected As = Max (As_1 , As_2 , Min (As_3 , Max (As_4 , As_5)))

If Selected As < Using As < As_{max} , then OK!!

Note : The reinforcement is calculated bases on the maximum moment under the foundation in each direction. But, the 'ISO' , 'OCT' , 'HEX' , 'COMB' , 'TANK1' foundations are calaulated as face pier

Where,

$Rn = \frac{Mu}{\phi bd^2}$, $\phi = .85$, $\rho.req = \frac{0.85 \cdot fck}{fy} \times \left(1 - \sqrt{1 - \frac{2Rn}{0.85fck}} \right)$

6.2.2 Check of Footing Reinforcement

Group 1 - F-3

◉ Footing Name : F-3 GroupType : Irregular

- X direction (All Width)

Sec.Name	L.Comb.		Using Bar (mm)	Loc. (m)	Width b (m)	d (cm)	As (cm^2)
S1	1	top	9 - #8 @ 200	0.900	1.559	73.730	45.604
	1	botom	9 - #8 @ 200	0.900	1.559	73.730	45.604

Sec.Name	L.Comb.		Mu (tonf-m)	Rn	ρ·Req
S1	1	top	-	-	-
	1	bottom	-	-	-

Sec.Name	L.Comb.		As_1(cm^2)	As_2(cm^2)	As_3(cm^2)	As_4(cm^2)	As_5(cm^2)	As_{max}(cm^2)
S1	1	top	11.224	-	-	40.403	38.246	263.643
	1	bottom	11.224	-	-	40.403	38.246	263.643

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Sec.Name	L.Comb.		Using As(cm^2)	Select As(cm^2)	Result
S1	1	top	45.604	11.224	OK
	1	bottom	45.604	11.224	OK

- Y direction (All Width)

Sec.Name	L.Comb.		Using Bar (mm)	Loc. (m)	Width b (m)	d (cm)	As (cm^2)
S1	1	top	10 - #8 @ 200	0.320	1.800	71.190	50.671
	1	botom	7 - #8 @ 200	0.847	1.192	71.190	35.470

Sec.Name	L.Comb.		Mu (tonf-m)	Rn	ρ.Req
S1	1	top	-	-	-
	1	bottom	15.947	3.106	0.0008

Sec.Name	L.Comb.		As_1(cm^2)	As_2(cm^2)	As_3(cm^2)	As_4(cm^2)	As_5(cm^2)	As_{max}(cm^2)
S1	1	top	12.960	-	-	45.046	42.641	293.941
	1	bottom	8.582	6.632	8.841	29.830	28.237	194.649

Sec.Name	L.Comb.		Using As(cm^2)	Select As(cm^2)	Result
S1	1	top	50.671	12.960	OK
	1	bottom	35.470	8.841	OK

Group 2 - F-2

◉ Footing Name : F-2 GroupType : Isolated

- X direction (All Width)

Sec.Name	L.Comb.		Using Bar (mm)	Loc. (m)	Width b (m)	d (cm)	As (cm^2)
S1	1	top	14 - #8 @ 200	0.900	2.700	73.730	70.939
	1	botom	14 - #8 @ 200	1.100	2.700	73.730	70.939

Sec.Name	L.Comb.		Mu (tonf-m)	Rn	ρ.Req
S1	1	top	-	-	-
	1	bottom	31.087	2.492	0.0006

Sec.Name	L.Comb.		As_1(cm^2)	As_2(cm^2)	As_3(cm^2)	As_4(cm^2)	As_5(cm^2)	As_{max}(cm^2)
S1	1	top	19.440	-	-	69.980	66.244	456.642
	1	bottom	19.440	12.467	16.618	69.980	66.244	456.642

Sec.Name	L.Comb.		Using As(cm^2)	Select As(cm^2)	Result
S1	1	top	70.939	19.440	OK
	1	bottom	70.939	19.440	OK

- Y direction (All Width)

Sec.Name	L.Comb.		Using Bar (mm)	Loc. (m)	Width b (m)	d (cm)	As (cm^2)
S1	1	top	10 - #8 @ 200	1.350	1.800	71.190	50.671
	1	botom	10 - #8 @ 200	1.550	1.800	71.190	50.671

Sec.Name	L.Comb.		Mu (tonf-m)	Rn	ρ.Req
S1	1	top	-	-	-
	1	bottom	49.739	6.415	0.0016

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Sec.Name	L.Comb.		$As_1(cm^2)$	$As_2(cm^2)$	$As_3(cm^2)$	$As_4(cm^2)$	$As_5(cm^2)$	$As_{max}(cm^2)$
S1	1	top	12.960	-	-	45.046	42.641	293.941
	1	bottom	12.960	20.834	27.772	45.046	42.641	293.941

Sec.Name	L.Comb.		Using $As(cm^2)$	Select $As(cm^2)$	Result
S1	1	top	50.671	12.960	OK
	1	bottom	50.671	27.772	OK

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Title

Bending Moment Diagram

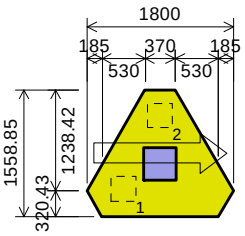
Foundation name	Section name	Direction	L/C ID
F-3	S1	X	1

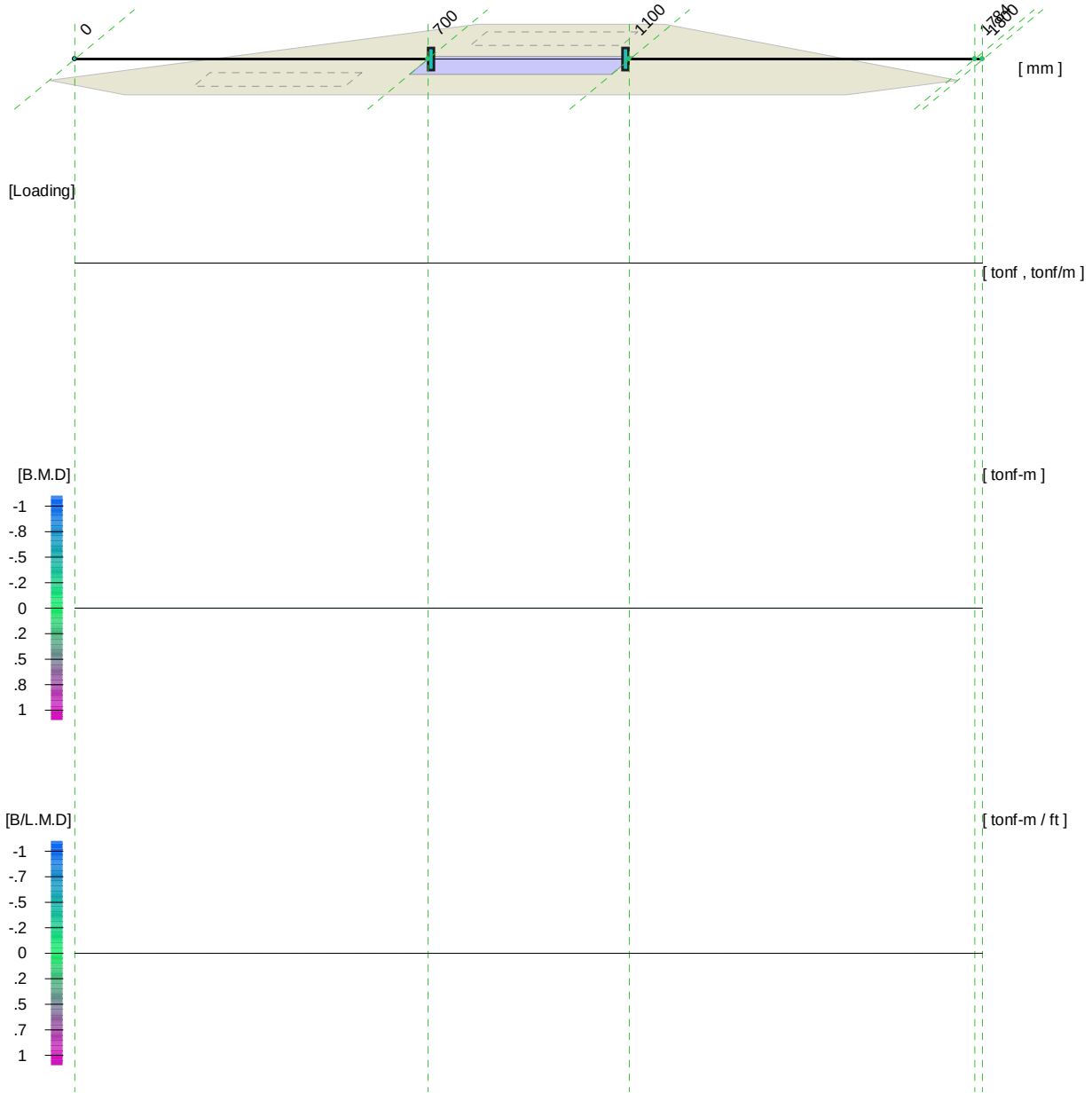
Analysis Method		
Conventional Rigid Method with reaction (Method 1)		

ΣFz	ΣMy	Moment intia
-119.540 tonf	26.897 tonf-m	0.3030 m^4

Area	Contact Area	Critical Point Method
1.861 m^2		Maximum Point

Critical Value: Mu_{bottom} = 0 tonf-m , Mu_{top} = 0 tonf-m





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AFES	Calculation Sheet of Foundation	Project Na. : 7.5 MW. Power Plant Stream..
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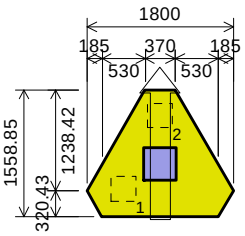
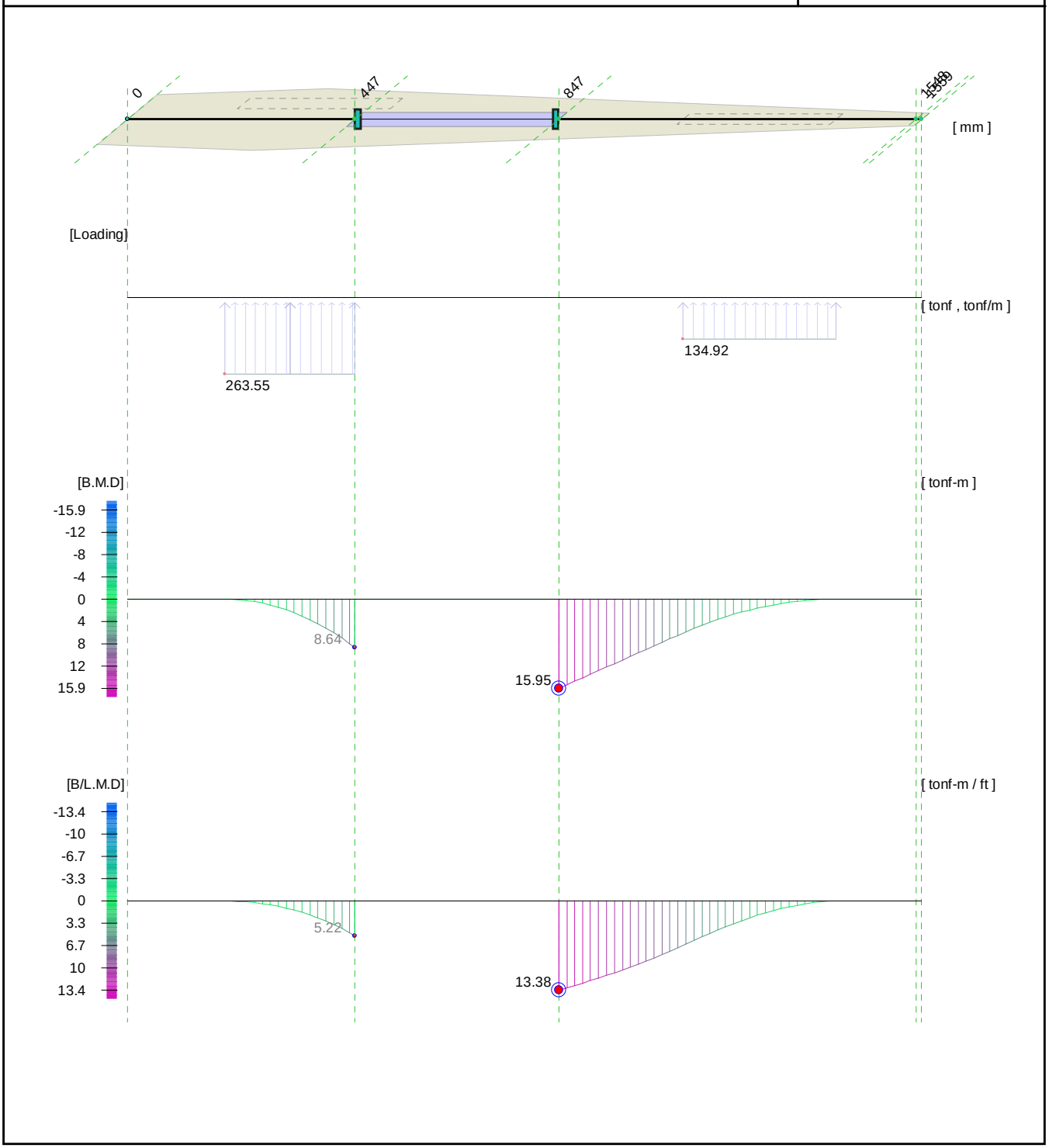
Bending Moment Diagram

Foundation name	Section name	Direction	L/C ID
F-3	S1	Y	1

Analysis Method		
Conventional Rigid Method with reaction (Method 1)		
ΣFz: -119.540 tonf	ΣMx: 17.365 tonf-m	Moment intia: 0.3030 m^4
Area: 1.861 m^2	Contact Area	Critical Point Method: Maximum Point
Critical Value: Mu_{bottom} = 15.947 tonf-m , Mu_{top} = 0 tonf-m		





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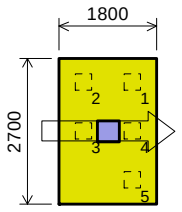
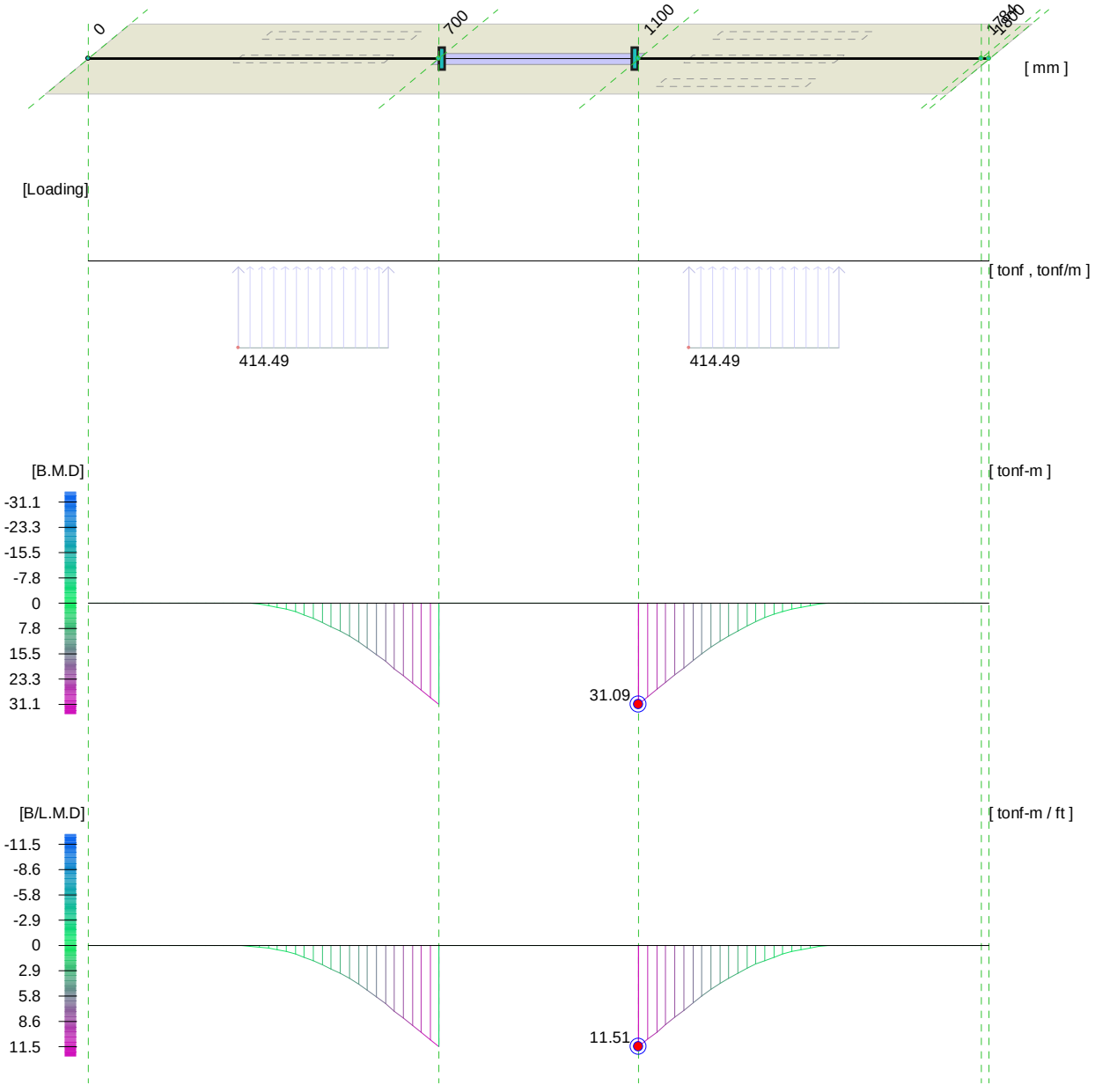
Title

Bending Moment Diagram

Foundation name	Section name	Direction	L/C ID
F-2	S1	X	1

Analysis Method		
Conventional Rigid Method with reaction (Method 1)		
ΣFz: -248.696 tonf	ΣMy: -22.383 tonf-m	Moment intia: 1.3122 m^4
Area: 4.860 m^2	Contact Area	Critical Point Method: Maximum Point
Critical Value: Mu_{bottom} = 31.087 tonf-m , Mu_{top} = 0 tonf-m		





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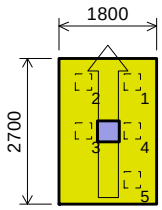
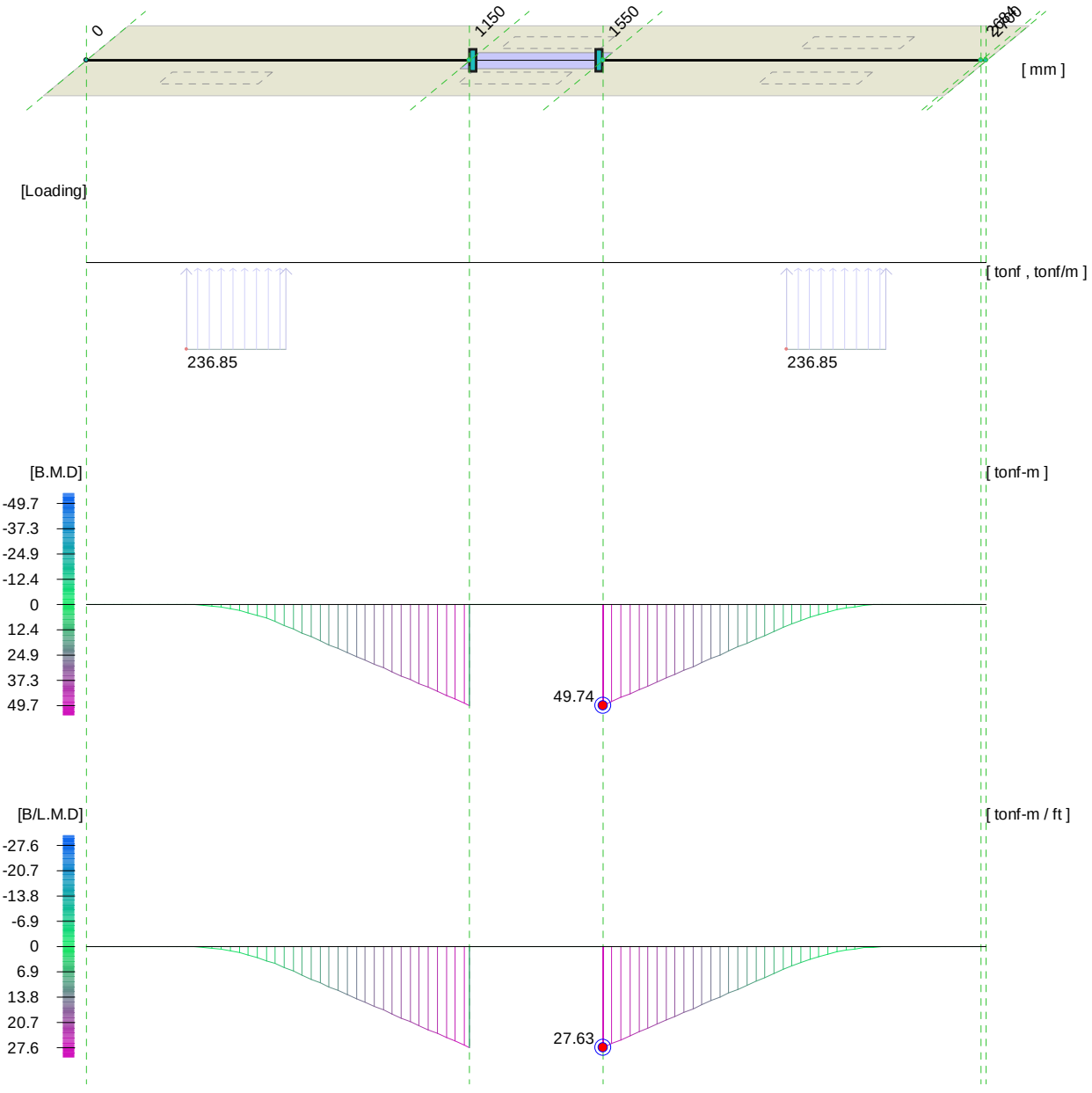
Title

Bending Moment Diagram

Foundation name	Section name	Direction	L/C ID
F-2	S1	Y	1

Analysis Method		
Conventional Rigid Method with reaction (Method 1)		
ΣFz: -248.696 tonf	ΣMx: 44.765 tonf-m	Moment intia: 2.9525 m^4
Area: 4.860 m^2	Contact Area	Critical Point Method: Maximum Point
Critical Value: Mu_{bottom} = 49.739 tonf-m , Mu_{top} = 0 tonf-m		





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6.3 ONE WAY SHEAR FORCE

6.3.1 One-Way Shear Formula

ACI 318-05 CODE 11.3.1.1

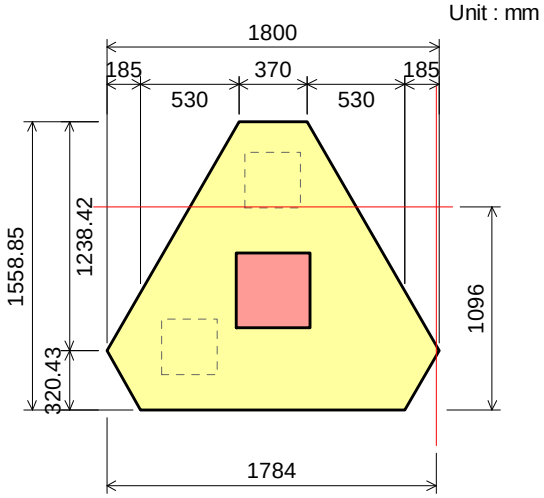
- For members subject to shear and flexure only.
- $\phi V_c = .8 \cdot 2 \sqrt{f_{ck}}\ B'w\ d$ (eq 11-3)
- **Vu <= ϕV_c , then OK!!**

6.3.2 Check of One-Way Shear

Group 1 - F-3

◉ Footing Name : F-3 GroupType : Irregular PileType : True

Unit : mm



- X direction One-Way Shear (All Width)

Sec.Name	L.Comb.	Loc. (mm)	d (mm)	Bw (mm)	ϕVc (tonf)	Vu (tonf)	Result
S1	1	1784	737.3	55.4	2.901	0	OK

- Y direction One-Way Shear (All Width)

Sec.Name	L.Comb.	Loc. (mm)	d (mm)	Bw (mm)	ϕVc (tonf)	Vu (tonf)	Result
S1	1	1096	711.9	904.4	45.708	39.726	OK

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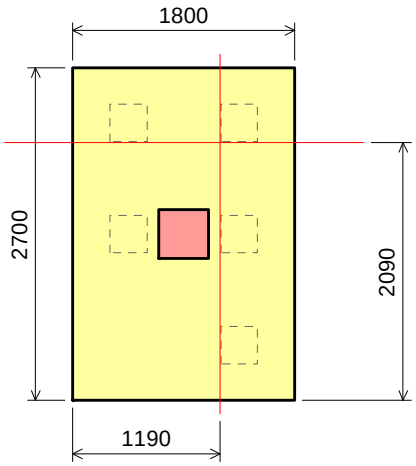
Group 2 - F-2

◉ Footing Name : F-2 GroupType : Isolated PileType : True

Unit : mm



- X direction One-Way Shear (All Width)

Sec.Name	L.Comb.	Loc. (mm)	d (mm)	Bw (mm)	ϕVc (tonf)	Vu (tonf)	Result
S1	1	1190	737.3	2700	141.319	124.349	OK

- Y direction One-Way Shear (All Width)

Sec.Name	L.Comb.	Loc. (mm)	d (mm)	Bw (mm)	ϕVc (tonf)	Vu (tonf)	Result
S1	1	2090	711.9	1800	90.967	71.056	OK

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Title

Shear Force Diagram

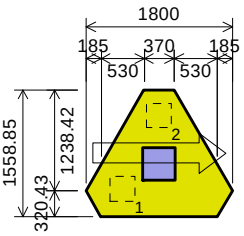
Foundation name	Section name	Direction	L/C ID
F-3	S1	X	1

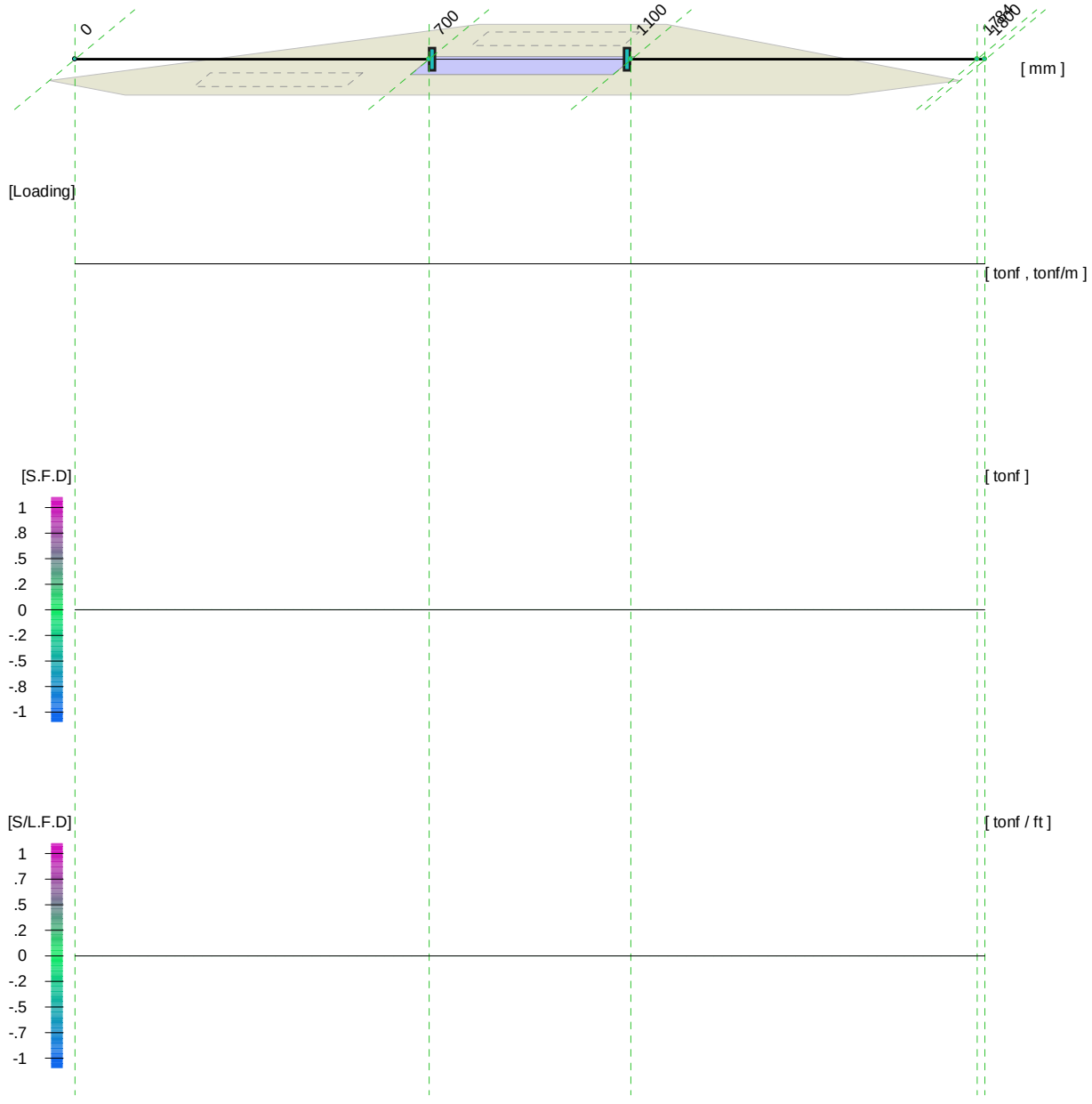
Analysis Method		
Conventional Rigid Method with reaction (Method 1)		

ΣFz	ΣMy	Moment intia
-119.540 tonf	26.897 tonf-m	0.3030 m^4

Area	Contact Area	Critical Point Method
1.861 m^2		Maximum Point

Critical Value	
Vu = 0 tonf	





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Title

Shear Force Diagram

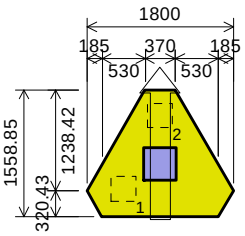
Foundation name	Section name	Direction	L/C ID
F-3	S1	Y	1

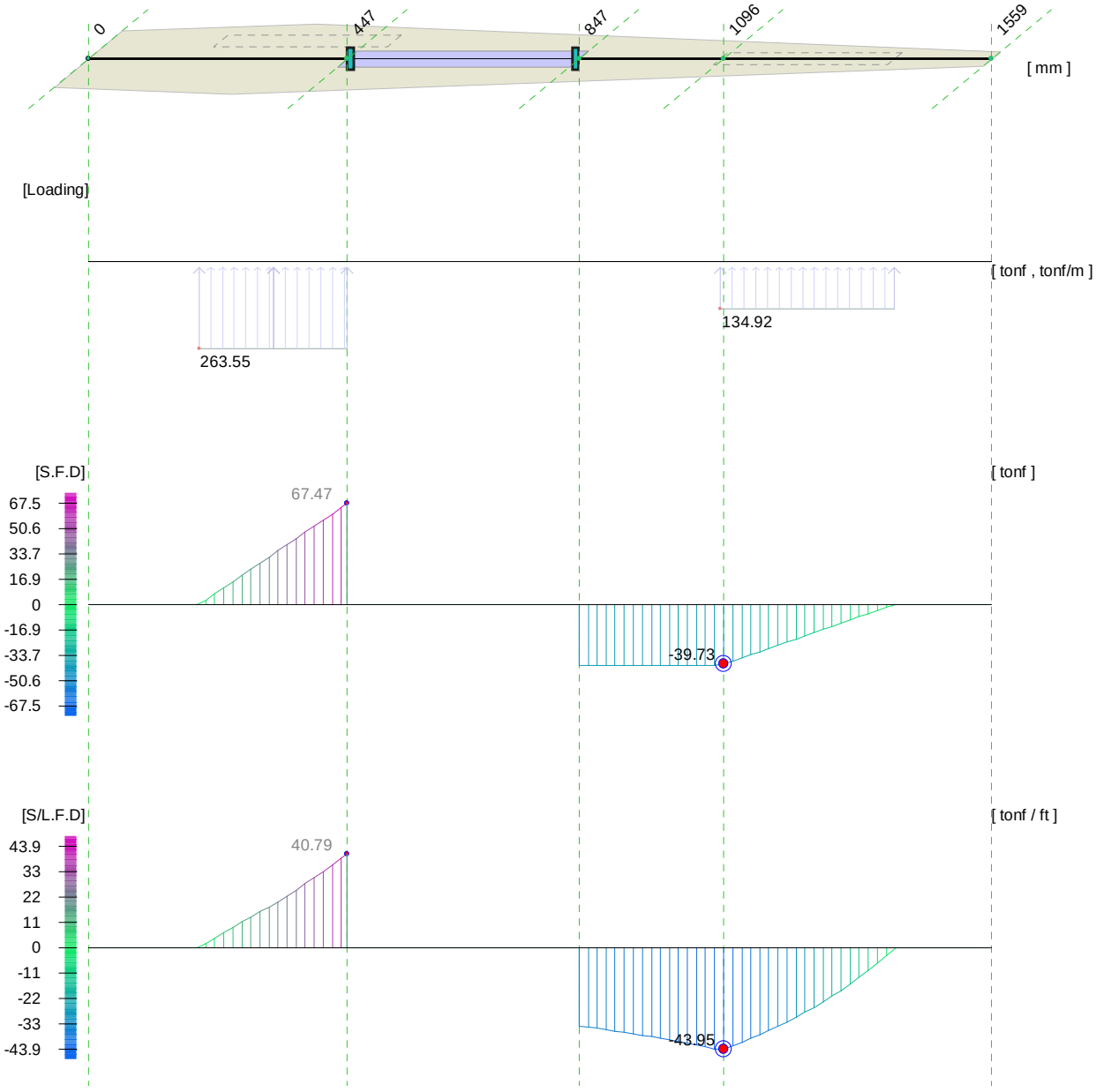
Analysis Method		
Conventional Rigid Method with reaction (Method 1)		

ΣFz	ΣMx	Moment intia
-119.540 tonf	17.365 tonf-m	0.3030 m^4

Area	Contact Area	Critical Point Method
1.861 m^2		Maximum Point

Critical Value: Vu = -39.726 tonf





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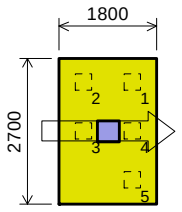
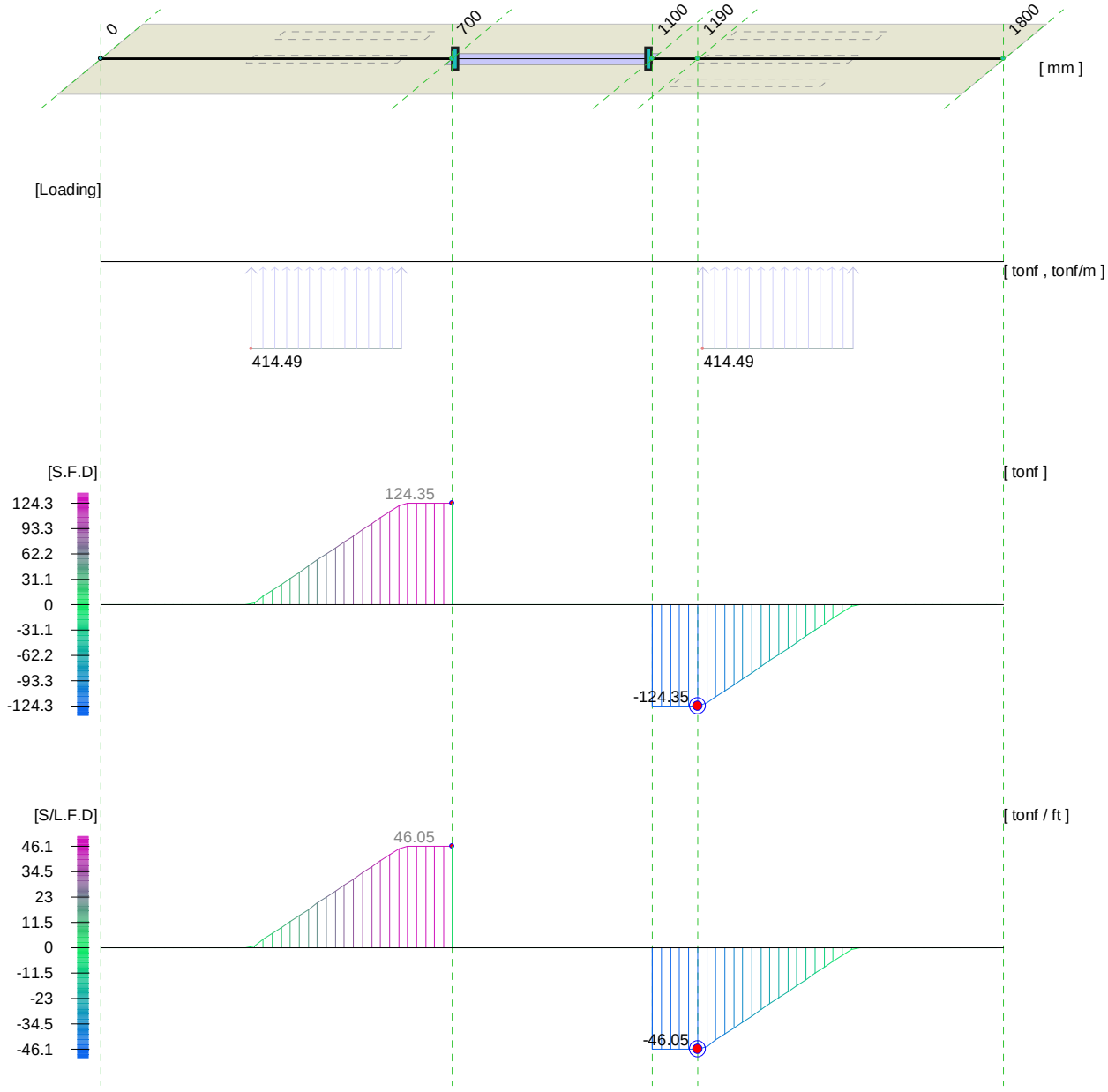
Title

Shear Force Diagram

Foundation name	Section name	Direction	L/C ID
F-2	S1	X	1

Analysis Method		
Conventional Rigid Method with reaction (Method 1)		
ΣFz: -248.696 tonf	ΣMy: -22.383 tonf-m	Moment intia: 1.3122 m^4
Area: 4.860 m^2	Contact Area	Critical Point Method: Maximum Point
Critical Value: Vu = -124.349 tonf		





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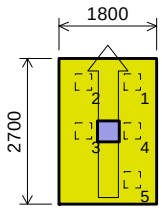
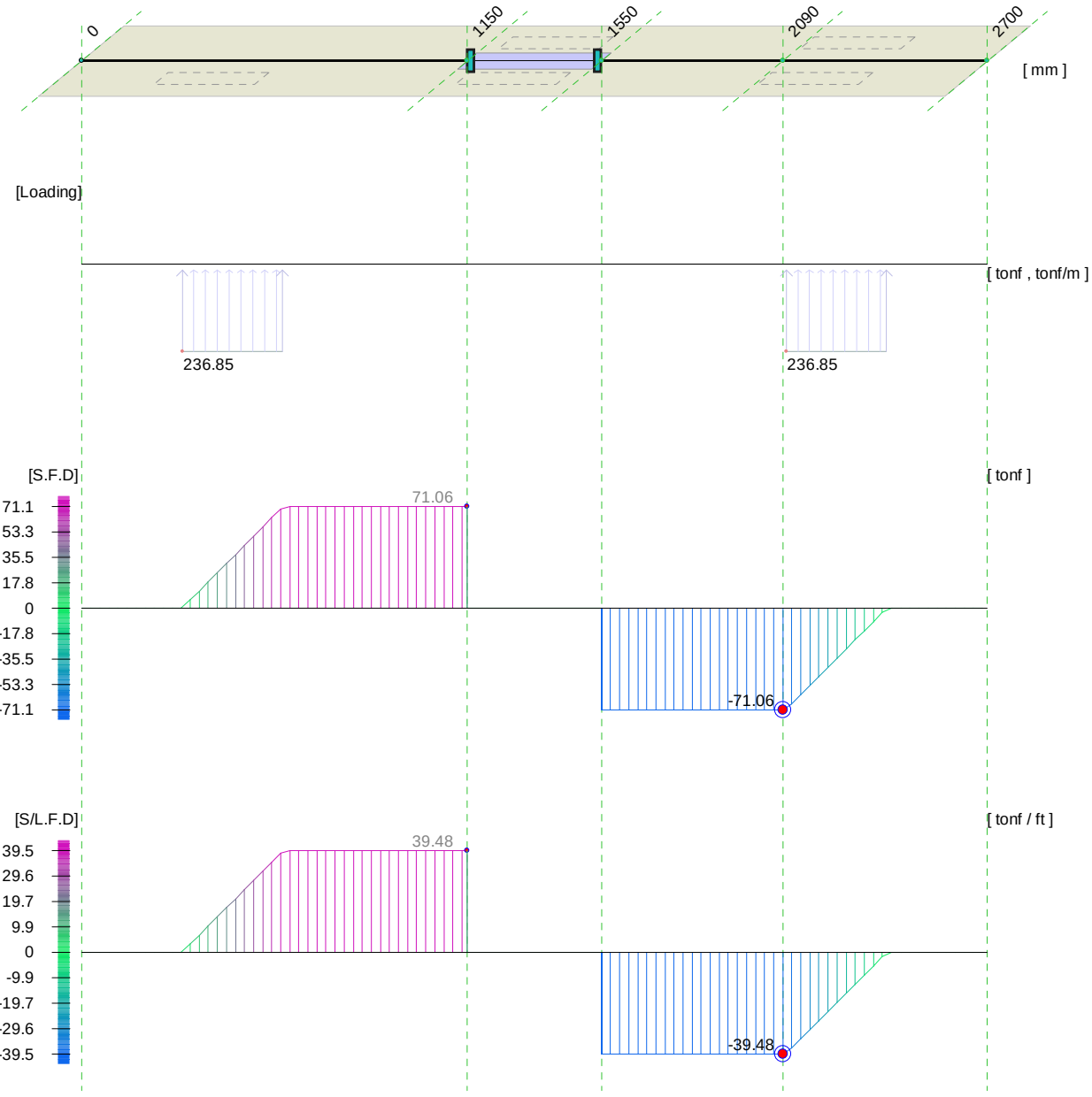
Title

Shear Force Diagram

Foundation name	Section name	Direction	L/C ID
F-2	S1	Y	1

Analysis Method		
Conventional Rigid Method with reaction (Method 1)		
ΣFz: -248.696 tonf	ΣMx: 44.765 tonf-m	Moment intia: 2.9525 m^4
Area: 4.860 m^2	Contact Area	Critical Point Method: Maximum Point
Critical Value: Vu = -71.056 tonf		





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6.4 TWO WAY SHEAR FORCE

6.4.1 Two-Way Shear Formula

Vu = ∑Fz · Shade Ratio

(a) $\phi V_{c1} = .8 \cdot 2 \cdot (1 + 2/\beta_c) \sqrt{f_{ck}}\ b_o \cdot d$ (eq 11-33) <- Vc1

(b) $\phi V_{c2} = .8 \cdot 2 \cdot (1 + \alpha_s\ d / 2\ b_o) \sqrt{f_{ck}}\ b_o \cdot d$ (eq 11-34) <- Vc2

(c) $\phi V_{c3} = .8 \cdot 4 \sqrt{f_{ck}}\ b_o \cdot d$ (eq 11-35) <- Vc3

$\phi Vc = Min(\phi V_{c1}, \phi V_{c2}, \phi V_{c3})$ ACI 318-05 CODE 11.12.2.1

Vu ≤ ϕ V_c , then OK

where

β = ratio of long side to short side of the column, concentrated load or reaction area

α_s = 40 for interior colimns

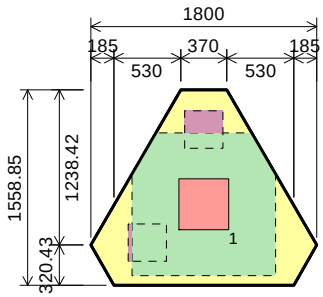
= 30 for edge columns

= 20 for corner columns

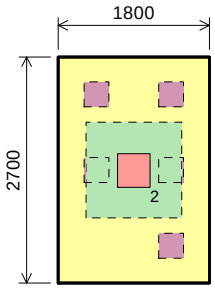
b_o = perimeter of critical section

$$\text{Shade Ratio} = \frac{\text{Footing Area - Punching Area}}{\text{Footing Area}}$$

6.4.2 Check of Two-WayShear



Ft.Name	F-3	**Punching Area**	12338.470 cm^2
Pr.Name	1	**Pile effect**	.69 / 2
Shape	Rectangle	**ϕ Vc1**	555.159 tonf
L.Comb.	1	**ϕ Vc2**	570.957 tonf
Pl	400 mm	**ϕ Vc3**	370.106 tonf
Pw	400 mm	**ϕ Vc**	370.106 tonf
bo / d	3535.58 / 737.3 mm	**Vu**	39.533 tonf
βc / αs	1 / 20	**Result**	**OK**



Ft.Name	F-2	**Punching Area**	12934.510 cm^2
Pr.Name	2	**Pile effect**	3.209 / 5
Shape	Rectangle	**ϕ Vc1**	714.318 tonf
L.Comb.	1	**ϕ Vc2**	1009.915 tonf
Pl	400 mm	**ϕ Vc3**	476.212 tonf
Pw	400 mm	**ϕ Vc**	476.212 tonf
bo / d	4549.2 / 737.3 mm	**Vu**	151.060 tonf
βc / αs	1 / 40	**Result**	**OK**

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6.5 PILE PUNCHING SHEAR FORCE

6.5.1 Pile Punching Shear Formula

$Vu = \Sigma Fz \cdot \text{Shade Ratio}$

(a) $\phi V_{c1} = .8 \cdot 2 \cdot (1 + 2/\beta_c) \sqrt{f_{ck}}\ b_o \cdot d$ (eq 11-33) <- Vc1

(b) $\phi V_{c2} = .8 \cdot 2 \cdot (1 + \alpha_s\, d / 2\, b_o) \sqrt{f_{ck}}\ b_o \cdot d$ (eq 11-34) <- Vc2

(c) $\phi V_{c3} = .8 \cdot 4 \sqrt{f_{ck}}\ b_o \cdot d$ (eq 11-35) <- Vc3

$\phi Vc = \text{Min}(\phi V_{c1}, \phi V_{c2}, \phi V_{c3})$ ACI 318-05 CODE 11.12.2.1

$Vu \le \phi V_c$, then OK

where

β = ratio of long side to short side of the column, concentrated load or reaction area

α_s = 40 for interior colimns

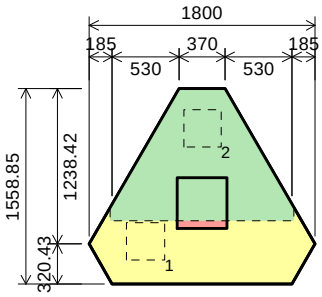
= 30 for edge columns

= 20 for corner columns

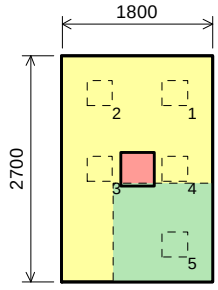
b_o = perimeter of critical section

$$\text{Shade Ratio} = \frac{\text{Footing Area - Punching Area}}{\text{Footing Area}}$$

6.5.2 Check of Pile Punching Shear



Ft.Name	F-3	**Punching Area**	10205.790 cm^2
Pile No.	2	**$\beta c / \alpha s$**	1 / 20
Shape	Square	**ϕ Vc1**	262.032 tonf
L.Comb.	1	**ϕ Vc2**	473.248 tonf
PileName	PHC-12	**ϕ Vc3**	174.688 tonf
Diameter	300mm	**ϕ Vc**	174.688 tonf
bo	1668.77mm	**Vu**	100.246 tonf
d	737.3mm	**Result**	**OK**



Ft.Name	F-2	**Punching Area**	14006.290 cm^2
Pile No.	5	**$\beta c / \alpha s$**	1 / 20
Shape	Square	**ϕ Vc1**	371.662 tonf
L.Comb.	1	**ϕ Vc2**	509.792 tonf
PileName	PHC-12	**ϕ Vc3**	247.775 tonf
Diameter	300mm	**ϕ Vc**	247.775 tonf
bo	2366.96mm	**Vu**	62.766 tonf
d	737.3mm	**Result**	**OK**

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7. DESIGN OF TIE-GIRDER

7.1 FORMULA

- Moment and Shear
- Reinforcement
  - Shrinkage and temperature reinforcement ---- ACI CODE 7.12.2

    $As \geq = fac \cdot b \cdot h$, fac = following

    Area of shrinkage and temperature reinforcement shall provide at least the following ratio of reinforcement area to gross concrete area, but not less than 0.0014

    (a) Slabs where Grade 40 or 50 deformed bars are used 0.0020

    (b) Slabs where Grade 60 deformed bars or welded wire reinforcement are used..... 0.0018

    (c) Slabs where reinforcement with yield stress exeeding 60,000 psi measured at a yield strain of 0.35 percent is used ..... $\frac{0.0018 \times 60{,}000}{f_y}$
  - Required Reinforcement by Analysis

    $As \geq As_2$
  - At every section of flexural members where tensile reinforcement is required

    $As \geq As_5 \geq As_4$ ---- ACI Eq (10-3)
  - The requirements of Eq (10-3) need not be applied, if every section As provided is at least one -third greater then that required by analysis ---- ACI CODE 10.5.3

    $As_2 = \rho_{req} \cdot b \cdot d$

    $As_3 = 1.333\ \rho_{req} \cdot b \cdot d$

    $As_4 = \frac{200}{f_y} \cdot b \cdot d$

    $As_5 = \frac{3\sqrt{f_{ck}}}{f_y} \cdot b \cdot d$

    $As_{max} = 0.75\ \rho_b \cdot b \cdot d$

    $\rho_b = 0.85 \times \beta_1 \times \frac{f_{ck}}{f_y} \times \frac{0.003 \times E_s}{0.003 \times E_s + f_y}$

    Selected As = Max (As_1 , As_2 , Min (As_3 , Max (As_4 , As_5)))

    If Selected As < Using As < As_{max} , then OK!!

Note : The reinforcement is calculated bases on the maximum moment under the foundation in each direction.
But, the 'ISO' , 'OCT' , 'HEX' , 'COMB' , 'TANK1' foundations are calaulated as face pier
Where,

$Rn = \frac{Mu}{\phi bd^2}$, $\phi = .85$, $\rho.req = \frac{0.85 \cdot fck}{fy} \times \left(1 - \sqrt{1 - \frac{2Rn}{0.85fck}} \right)$

- Shear

$\phi V_c = \phi\ 2\sqrt{f_{ck}}\ B_w\ d$ [ACI CODE 11.3.1.1 (11-3)]

$\phi V_s = \phi \frac{A_s\ f_y\ d}{s}$ [ACI CODE 11.5.7.2 (11-15)]

$\phi V_{smax} = \phi\ 8\sqrt{f_{ck}}\ B_w d$ [ACI CODE 11.5.7.9]

if $V_u < 0.5 \cdot \phi V_c$ then , $Asv_{req} = 0$

if $V_u \geq 0.5 \cdot \phi V_c$ then , $Asv_{req} = \frac{(V_u - \phi V_c)s}{\phi f_y d} \geq 0.75\sqrt{f_{ck}} \frac{b_w s}{f_y} \geq \frac{50 b_w s}{f_y}$ [ACI CODE 11.5.6.3 (11-13)]

$\phi V_n = \phi V_c + \phi V_s$ [ACI CODE 11.1.1.1 (11-2)]

$V_u \leq \phi V_n$ -> OK [ACI CODE 11.1.1.1 (11-1)]

7.2 GEOMETRY AND MATERIALS

7.2.1 General

Unit(kgf/cm^2,mm)

ϕ(Flexure)	ϕ(Shear)	f'c	fy1	fy2
.85	.8	280.00	4000.00	4000.00

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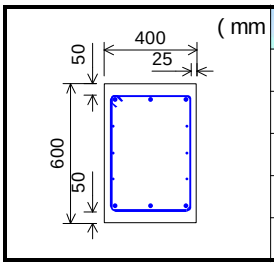
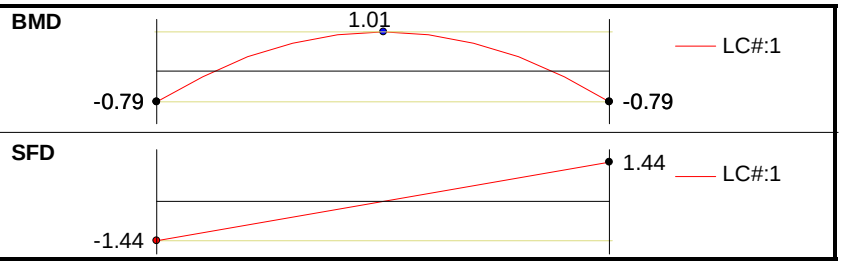
7.2.2 MATERIAL

Unit (mm , tonf , tonf-m)



ST-Beam
Length : 5000
Top : 3 - #8
Bottom : 3 - #8
Side : 2 x 3 - #5
Stirrup : #3 @ 200



7.3 MEMBER FORCE

Sturcture 1

- ST-Beam

Unit (tonf , tonf-m)

L.Comb.	Ra	Rb	Ma	Mb	V_{max}	$M_{max(-)}$	$M_{max(+)}$
1	-1.44	1.44	-.785	-.785	-1.44	-.785	1.015

7.4 REQUIRED REINFORCEMENT

Sturcture 1

- ST-Beam

(cm^2)

L.Comb.		As_1	As_2	As_3	As_4	As_5	As_{select}	As_{used}	As_{max}	Result
1	Top	2.2	.4	.6	7.4	7	2.2	15.2	48.4	OK
	Bottom	2.2	.6	.8	7.4	7	2.2	15.2	48.4	OK

7.5 ONE WAY SHEAR

Sturcture 1

- ST-Beam

(tonf , cm^2)

L.Comb.	Vu	ϕVc	ϕVs	ϕVn	$ϕVs_{max}$	Asv_{use}	Asv_{req}	Result
1	1.44	15.482	12.432	27.915	61.929	1.425	0	OK

- Shear Reinforcement Space Check

Sturcture 1

(mm)

Name	Using Space	Max Space	Result
ST-Beam	200	272.6	OK

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