Calculation Sheet

Project Title	IPL Steam Boiler Study FEL1	**Project No.**	24177
Client	IPL Phosphate Hill	**Calculation No.**	24177-ST-CAL-0001
Calculation Title	Donkey Boiler	**Revision**	B
Project Phase	Concept Design	**Date**	25/01/25

Calculation Objective / Scope

- Assumption 1
- Assumption 2
- ...

Calculation Assumptions

- assumption 1
- assumption 2

Software Used

- Space Gass
- RFEM
- ...

Holds

- n/a

Calculation Sheet

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1 Introduction

1.1 Calculation Objective / Scope

The existing boiler is to be removed by lifting it and inserting a skate so it can be rolled out.

This calculation presents the FEA of the jacking plates added to the boiler frame, and design of piping supports

1.2 Exclusions

This calculation excludes the following: - design of rollers and supporting mechanisms

1.3 Basis of Design

In general, design is in accordance with AS 4100 for steel.

1.4 Design Standards and Codes

Unless specifically noted, the design complies with Australian Standards and selected international standards as listed in the Design Criteria. The following summarizes the key standards used in producing this calculation:

- AS 1170.0 - 2002 Structural design actions - Part 0: General principles
- AS 1170.1 - 2002 Structural design actions - Part 1: Permanent, imposed and other actions
- AS 1170.2 - 2021 Structural design actions - Part 2: Wind actions
- AS 3600 - 2018 Concrete structures
- AS 4100 - 1998 Steel structures

1.5 Other Reference Documents

Other reference documents used in this design include:

- 3D laser scan data

2 Assumptions

2.1 Holds

- n/a

2.2 Assumptions

- Jacking cylinder dimension, refer Appendix A, Section 5
- Differential displacement between adjacent jacking point is must be $< L/600$
- centerline of jack is no more than 195mm from edge of bottom frame

2.3 Relied on Information

- 3D scan, site photos

3 Methodology

- Perform member check using Space Gass model, to get sanity check of the member capacity, design load ratio must be less than 1.0
- Perform FEA of the jacking point and check for limiting stresses and strains, where applicable. Acceptance criteria as follows
  - design stress < 0.9Fy, for regions away from geometric discontinuities.
  - plastic equivalent strain (VM strains) $< 5\%$

4 RFEM MODEL OF JACKING PLATES

4.1 Load - Self weight

4.2 Chem anchor/base plate design

Project:
Project no:
Author:

Project data

Project name	
Project number	
Author	
Description	
Date	2/6/2025
Code	AS

Material

Steel	STEEL_1_440_320, STEEL_1_320_250, 3678-250
Concrete	N25

Project:
Project no:
Author:

Project item Node 1

Design

Name	Node 1
Description	4-m20/125 hilti re500
Analysis	Stress, strain/ loads in equilibrium

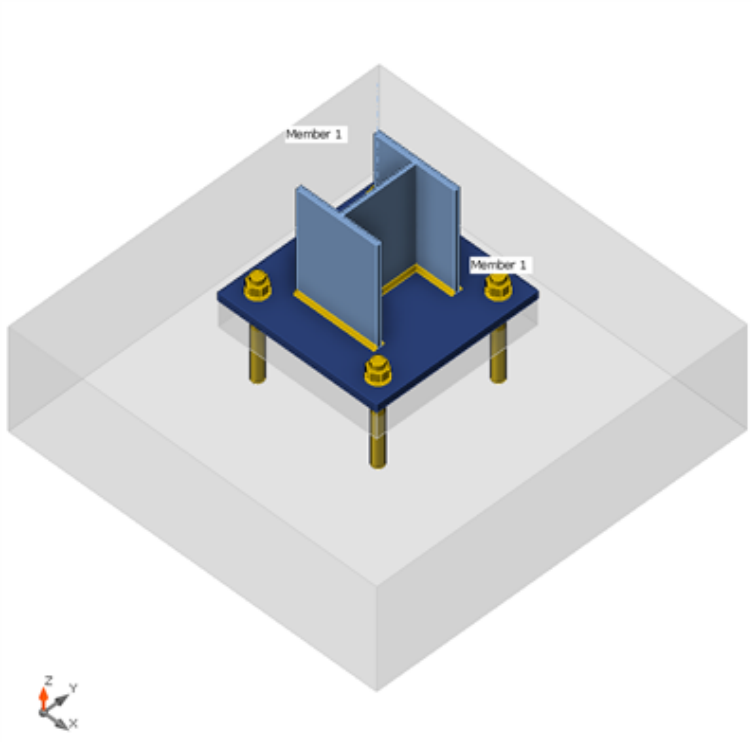
Members

Geometry

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]
Member 1	6 - 150 UC 30.0	0.0	90.0	-90.0	0.0	0.0	0.0

Supports and forces

Name	Support	Forces in	X [mm]
Member 1 / end		Position	0.0



Cross-sections

Name	Material
6 - 150 UC 30.0	STEEL_1_440_320

Anchors

Name	Diameter [mm]	f_y [MPa]	f_u [MPa]	Gross area [mm^2]
M20 4.6	20.0	240.0	400.0	314.0

Load effects (forces in equilibrium)

Name	Member	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
Ult Services Extreme(1)	Member 1 / End	-12.0	14.8	2.2	-0.1	0.0	0.0
Service - No Crane + Wsx+(2)	Member 1 / End	-4.7	5.9	0.9	0.0	0.0	0.0

Unbalanced forces

Name	X [kN]	Y [kN]	Z [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
Ult Services Extreme(1)	14.8	2.2	-12.0	0.0	0.0	-0.1
Service - No Crane + Wsx+(2)	5.9	0.9	-4.7	0.0	0.0	0.0

Foundation block

Item	Value	Unit
CB 1		
Dimensions	703.0 x 708.0	mm
Depth	200.0	mm
Anchor	M20 4.6	
Anchoring length	100.0	mm
Shear force transfer	Anchors	
Mortar joint	50.0	mm

Check

Summary

Name	Value	Check status
Analysis	100.0%	OK
Plates	0.0 < 5.0%	OK
Anchors	83.2 < 100%	OK
Welds	7.5 < 100%	OK
Concrete block	0.6 < 100%	OK
Buckling	Not calculated	

Plates

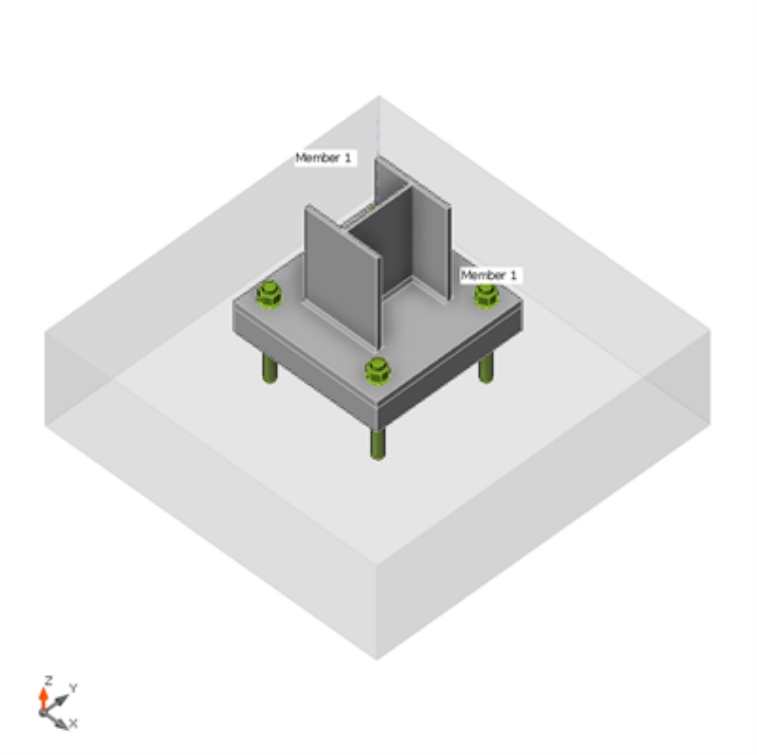
Name	Material	F_y [MPa]	t_p [mm]	Loads	σ_{Ed} [MPa]	ε_{Pl} [%]	$\sigma_{c,Ed}$ [MPa]	Status
Member 1-bfl 1	STEEL_1_440_320	320.0	9.40	Ult Services Extreme(1)	43.7	0.0	0.0	OK
Member 1-tfl 1	STEEL_1_440_320	320.0	9.40	Ult Services Extreme(1)	37.2	0.0	0.0	OK
Member 1-w 1	STEEL_1_440_320	320.0	6.60	Ult Services Extreme(1)	8.0	0.0	0.0	OK
BP1	3678-250	250.0	15.00	Ult Services Extreme(1)	12.5	0.0	0.0	OK

Design data

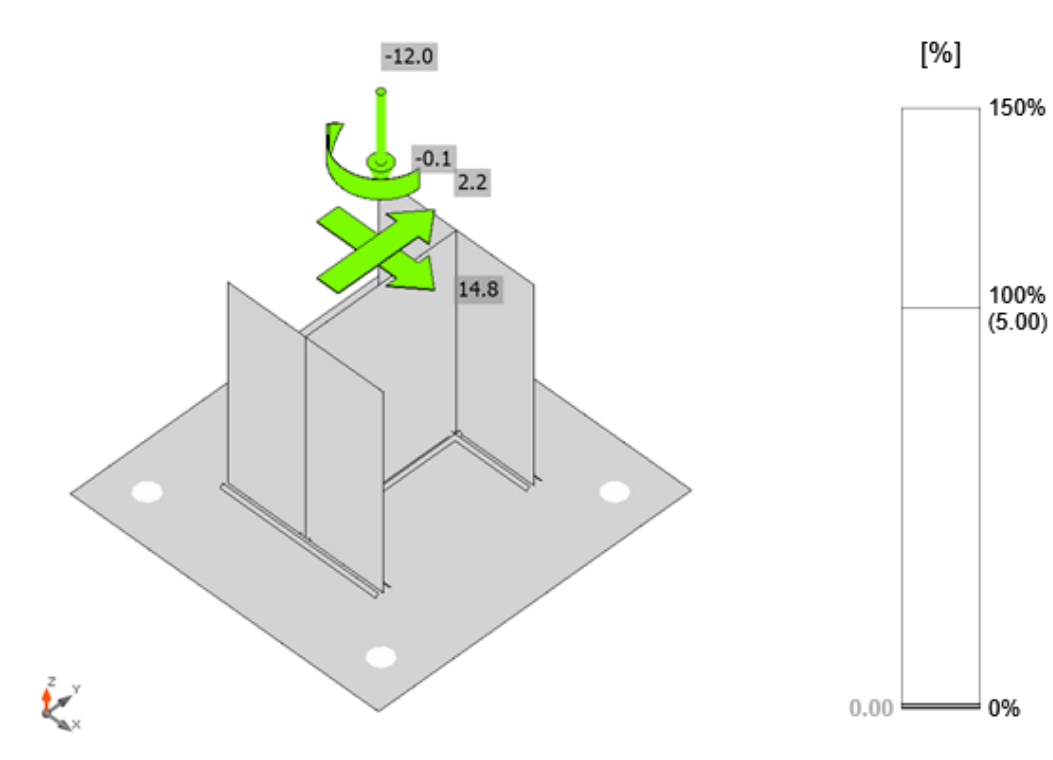
Material	F_y [MPa]	ε_{lim} [%]
STEEL_1_440_320	320.0	5.0
3678-250	250.0	5.0

Symbol explanation

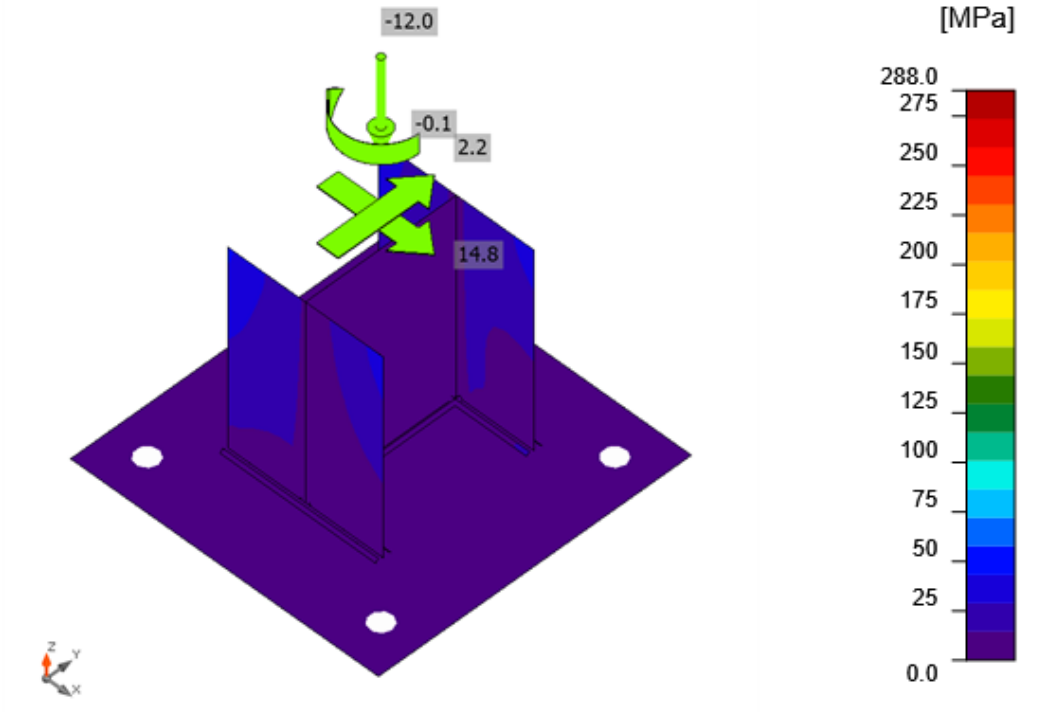
F_y	Yield strength
t_p	Plate thickness
σ_{Ed}	Equivalent stress
ε_{Pl}	Plastic strain
$\sigma_{c,Ed}$	Contact stress
ε_{lim}	Limit of plastic strain



Overall check, Ult Services Extreme(1)



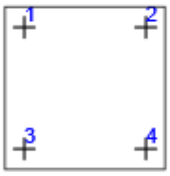
Strain check, Ult Services Extreme(1)



Equivalent stress, Ult Services Extreme(1)

Project:
Project no:
Author:

Anchors

Shape	Item	Loads	N^*_{tf} [kN]	V^* [kN]	$\phi N_{Rk,c}$ [kN]	$\phi V_{Rk,s,M}$ [kN]	$\phi V_{Rk,c}$ [kN]	$\phi V_{Rk,cp}$ [kN]	Ut_t [%]	Ut_s [%]	Ut_{ts} [%]	Detailing	Status
	A1	Ult Services Extreme(1)	0.1	3.8	39.7	4.6	25.2	161.0	0.4	82.3	17.0	OK	OK
	A2	Ult Services Extreme(1)	0.0	3.8	0.0	4.6	26.5	161.0	0.0	83.2	42.2	OK	OK
	A3	Ult Services Extreme(1)	0.0	3.7	0.0	4.6	0.0	161.0	0.1	80.0	2.8	OK	OK
	A4	Ult Services Extreme(1)	0.0	3.7	0.0	4.6	26.5	161.0	0.0	80.1	42.2	OK	OK

Design data

Grade	ϕN_{tf} [kN]
M20 4.6 - 1	49.0

Symbol explanation

N^*_{tf}	Tension force
V^*	Resultant of bolt shear forces Vy and Vz in shear planes
$\phi N_{Rk,c}$	Concrete cone resistance - AS 5216:2018 – 6.2.3
$\phi V_{Rk,s,M}$	Anchor shear resistance - AS 5216:2018 – 7.2.2.3
$\phi V_{Rk,c}$	Concrete edge resistance - AS 5216:2018 – 7.2.3
$\phi V_{Rk,cp}$	Concrete pry-out resistance - AS 5216:2018 – 7.2.4
Ut_t	Utilization in tension
Ut_s	Utilization in shear
Ut_{ts}	Utilization in tension and shear
ϕN_{tf}	Anchor tensile resistance - AS 5216:2018 – 6.2.2

Welds

Item	Edge	Loads	f_{uw} [MPa]	t_t [mm]	t_w [mm]	v^*_w [kN/m]	ϕv_w [kN/m]	U_t [%]	Detailing	Status
BP1	Member 1-bfl 1	Ult Services Extreme(1)	490.0	◢ 4.00 ◣	◢ 5.66 ◣	59.0	940.8	6.3	OK	OK
		Ult Services Extreme(1)	490.0	◢ 4.00 ◣	◢ 5.66 ◣	54.5	940.8	5.8	OK	OK
BP1	Member 1-tfl 1	Ult Services Extreme(1)	490.0	◢ 4.00 ◣	◢ 5.66 ◣	68.3	940.8	7.3	OK	OK
		Ult Services Extreme(1)	490.0	◢ 4.00 ◣	◢ 5.66 ◣	70.9	940.8	7.5	OK	OK
BP1	Member 1-w 1	Ult Services Extreme(1)	490.0	◢ 4.00 ◣	◢ 5.66 ◣	16.2	940.8	1.7	OK	OK
		Ult Services Extreme(1)	490.0	◢ 4.00 ◣	◢ 5.66 ◣	16.9	940.8	1.8	OK	OK

Symbol explanation

f_{uw}	Nominal tensile strength of weld metal
t_t	Throat thickness of weld
t_w	Leg size
v^*_w	Design force per unit length of weld
ϕv_w	Nominal capacity of a fillet weld per unit length
U_t	Utilization
◢	Fillet weld

Concrete block

Item	Loads	A_1 [mm^2]	A_2 [mm^2]	σ [MPa]	ϕf_b [MPa]	Ut [%]	Status
CB 1	Ult Services Extreme(1)	71711.7	418351.0	0.2	27.0	0.6	OK

Symbol explanation

A_1	Loaded area
A_2	Supporting area
σ	Average stress in concrete
ϕf_b	Concrete block bearing resistance – AS 3600, Cl.12.6
Ut	Utilization

Buckling

Buckling analysis was not calculated.

Code settings

Item	Value	Unit	Reference
Coefficient of friction between steel and concrete	0.55	-	
Slip factor in friction-type connections	0.35	-	AS 4100:2020 – 9.2.3.2
Limit plastic strain	0.05	-	
Detailing	Yes		
Minimum bolt pitch [d]	2.50	-	AS 4100:2020 – 9.5.1
Minimum edge distance to a bolt [d]	1.25	-	AS 4100:2020 – 9.5.2
Concrete breakout resistance check	Both		
Cracked concrete	Yes		
Local deformation check	Yes		
Local deformation limit	0.03	-	CIDECT DG 1, 3 – 1.1
Geometrical nonlinearity (GMNA)	Yes		Analysis with large deformations for hollow section joints

5 Appendix A