KELLER



Retention Pile Design

Waterford Student Accommodation

Client	Project No.	Project Address
Firm Construction	08426	Lots 21-23 McKay Street, Waterford

Date	Document Number	Rev	Remarks	Design	Review	Approve
5/4/22	08426-RPD-0	0	Initial Review	MW	MW	MW

Mr Michael Wulff MIEAust CPEng NER	ENGINEERS ENGINEERS Register
Signature	Date 5/4/22
Registered on the NER in the area(s) of Braetice of Civil Engineering	

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APPENDICES

APPENDIX A	Pile Design Schedule
APPENDIX B	Marked-Up Layout Drawings
APPENDIX C	CPT Information
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1.0 INTRODUCTION/SCOPE

This package details the design of Keller Pty Ltd self-certified retention piling solution for the proposed Waterford Student Accommodation development located at McKay Street, Keaney Place, and Garvey Street in Waterford, WA. The work will be performed for Firm Construction.

The project comprises the installation of 450mm diameter CFA retention piles spaced at 0.55m centres.

2.0 INFORMATION

2.1 Reference Documentation

The design is carried out with reference to the following standards codes:

- AS 2159 2009 Piling Design and Installation;
- AS/NZS 1170.0 2002 Structural Design Actions Part 0 General Principles;
- AS 3600 2018 Concrete Structures;

The design has considered the following documentation:

Document Title	Document Reference	Rev	Ву	Dated
Forward Works – Building 1 – Ground Floor Slab and Foundations Layout	SF-11.01	В	Peritas	10/03/22
Forward Works – Building 2 – Ground Floor Slab and Foundations Layout	SF-21.01	В	Peritas	10/03/22
Forward Works – Pile Elevations	SF-41.01	В	Peritas	10/03/22
Forward Works – Pile and Basement Details	SF-41.11	В	Peritas	10/03/22
Building 1 – CSP Ground Floor	A2100_B1	02	DKO Architecture	17/03/22
Building 2 – CSP Ground Floor	A2100_B2	02	DKO Architecture	17/03/22
Retention Wall Elevations	A0307	01	DKO Architecture	17/03/22
Retention Wall Elevations and Sections	A0308	01	DKO Architecture	17/03/22
Preliminary Geotechnical Study	J2101291 001 R	0	Galt Geotechnics	24/11/21

Table 1: Document List

Copies of these documents and/or key extracts can be found in the Appendices.

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3.0 DESIGN CONDITIONS / BUILDABILITY

3.1 Retention Piles

The retention design has been carried out using the WALLAP software package.

We have considered 7# different section types to cater for the different bulk excavation levels and ground conditions. The extents of these sections are labelled on the layout drawing provided in Appendix B. The retaining wall has been designed using 450mm diameter piles spaced up to a maximum of 0.55m centre-to-centre. Our proposed pile locations are shown on the marked-up layout drawing included in Appendix B and is detailed in the design summary included as Appendix A.

The design is typically based on the maximum bulk excavation level indicated on the drawings (with an additional 200mm over-excavation allowance). Where there are excavations for pile caps or strip footings close to the retention wall, these have also been considered. The bulk excavation contractor should ensure that no additional over-excavation occurs during the works.

The retention system will comprise cantilevered piles only. No ground anchors are required. Floor slabs have been taken as providing permanent support to the retention structure in the final condition.

We have allowed for 10kPa surcharge (unless otherwise outlined), applied directly behind the wall, along all boundaries. The estimated maximum lateral movement of the wall is typically up to 50mm at the top of the wall.

The retention design allows for a minimum factor of safety of 1.5 (Burland-Potts method) for the temporary condition (strip footing / pile cap excavations).

Should any of the above conditions not be correct, please notify us prior to the start of the pile installation. Refer to Appendix D for the WALLAP analysis output.

3.2 Axial Loads

No axial line loads are to be applied to the retention piles.

3.3 Durability

In the absence of more detailed information for durability requirements, a minimum concrete strength (f'c) of 40MPa and a minimum cover of 100mm has been adopted to coincide with Keller construction practices for CFA piles. This corresponds with an exposure classification for concrete piles of moderate or better. The design is based on this allowance being adequate.

3.4 Installation Tolerances

Piles will be installed to the tolerances outlined in AS2159-2009 only. More stringent criteria are considered impractical to achieve.

3.5 Design Software

Programs used in the design of the piles for this project include RAPT (developed by PCDC Pty Ltd) and WALLAP (distributed by Geosolve).

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4.0 GEOTECHNICAL DESIGN

4.1 Ground Conditions

The geotechnical investigation, carried out on site, indicates a profile of loose to medium dense sand overlying dense to very dense sand. The groundwater level is noted to be at approximately RL5m, which is well below the proposed basement excavation levels.

Table 2 details the ground profile considered in the design. Appendix C contains relevant CPT plots used in this design.

Depths (m)	Material	Consistency / Weathering
0 - 2	Sand	Loose (L)
2 – 7	Sand	Medium Dense (MD)
7 – 13.5	Sand	Dense (D)
13.5+	Sand	Very Dense (VD)

Table 2: Design Profile

4.2 Design Parameters

As a specialist design and construct piling contractor Keller Pty Ltd has adopted suitable parameters interpreted from available site investigation information with consideration of pile type, installation techniques, and experience in installing piles in similar ground conditions.

The ground conditions will be assessed on site and pile lengths may be adjusted accordingly should conditions on site vary from the adopted design profiles.

Table 3 details the parameters adopted in our retention design.

Material	¥ (kN/m³)	φ' (°)	c' (kPa)	E' (MPa)
L Sand	17	33	0	15
MD Sand	18	35	0	45
D Sand	18	37	0	80
VD Sand	19	38	0	125

Table 3: Adopted Design Parameters

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5.0 STRUCTURAL DESIGN

5.1 Bending Moments

All retention piles have been designed for the bending moments induced due to the soil pressures (as determined by WALLAP).

5.2 Longitudinal Reinforcement

The structural design of the reinforced piles has been designed in accordance to AS2159-2009, to cater for the design bending movements. A minimum Asteel of 0.5% of Ag (with fsy=500MPa) has been adopted in the retention pile design.

Interaction charts of the pile sections produced from the computer program RAPT, as detailed in Appendix E, were used to assess the longitudinal steel requirements for the piles, in accordance with the requirements of AS2159-2009 and AS3600-2018.

5.3 Lateral Loads

To cater for the applied lateral loadings from the soil pressures, the ligature diameter and spacing has been proportioned to conform to AS2159-2009 and AS3600-2018. See Appendix E for detailed shear calculations.

5.4 Reinforcement Development

Pile reinforcement will be fully developed into the capping beam using straight bar development, where applicable, in accordance with the requirements of a refined development length outlined in Section 13 of AS3600-2018.

The top of all pile reinforcement cages will be installed to the piling platform level, assumed to be at top of capping beam level. The projection length of the main reinforcement bars will be covered in debonding foam, to assist with pile cropping operations on site. Pile cropping is to be carried out by others.

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6.0 DESIGN VERIFICATION

6.1 Retaining Wall Monitoring

The retaining wall analyses predict wall deflections of up to 50mm. The suitability of the deflections nominated in this report should be assessed by others.

Wall deflections can be further minimised by:

- Controlling the excavation to minimise any unplanned over-excavation;
- Minimising active surcharges during the excavation stage.

Wall monitoring is a requirement of this design and should be carried out by others during the construction of the basement. Wall monitoring typically consists of:

- Strategically-placed survey points typically at capping beam level;
- Taking a base reading prior to excavation;
- Regularly measuring wall movements particularly after each excavation drop.

Results of the monitoring should be forwarded to Keller immediately after survey for review and assessment. Failure to do so will void this design.

6.2 Construction Certification

At the completion of the project Keller Pty Ltd will provide certification of the retention piles. The certification will certify that the piles have been installed in accordance with our design and conforming to the requirements and performance criteria of Australian Standard 2159-2009 and within this report.

6.3 Summary

The pile design comprises 450mm diameter retention piles spaced at 0.55m centres.

A summary of the proposed retention pile design is given in the Design Summary provided in Appendix A.

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Appendix A

Pile Design Schedule & WALLAP Summary

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 Date:
 28/03/2022

 By:
 MW

Section	Section	No. of	Pile	Top of	Max.	Pile	Pile	Retained	Embedded	Factor	Anticipated	Max	Max	Max	Max	Max	Concrete	No. of	Bar	Projection	Main Cage	Ligs
Ref	Length	Piles	Dia.	Wall	Exc. L	Toe	L	Height	Length	of	Deflection	Spacing	BM	BM	SF	SF		Bars	Diam	Length	Length	
	(m)		(m)	(mRL)	(mRL)	(mRL)	(m)	(m)	(m)	Safety	(mm)	(m)	(kNm/m)	(kNm)	(kN/m)	(kN)	MPa		mm	m	m	
Α	16.5	30	0.45	12.4	9.6	6.4	6	2.8	3.2	1.88	7	0.55	31.7	26.2	23.2	19.1	40	4	20	0.5	5.4	N10@300
В	39.5	72	0.45	13.1	9.7	6.1	7	3.4	3.6	1.77	16	0.55	57.8	47.7	39.2	32.3	40	4	20	0.5	6.4	<u>N10@300</u>
С	24.5	45	0.45	14.4	9.7	5.4	9	4.7	4.3	1.75	46	0.55	147.9	122.0	90.6	74.7	40	5	24	0.5	8.4	<u>N10@300</u>
D	24.5	45	0.45	14.4	10.7	6.9	7.5	3.7	3.8	1.91	18	0.55	72.6	59.9	44.0	36.3	40	4	20	0.5	6.9	N10@300
E	9	17	0.45	14.4	10.2	6.9	7.5	4.2	3.3	1.95	23	0.55	89.3	73.7	55.0	45.4	40	4	20	0.5	6.9	<u>N10@300</u>
F	9.5	18	0.45	14.4	9.2	5.4	9	5.2	3.8	1.82	50	0.55	167.5	138.2	99.4	82.0	40	6	24	0.5	8.4	<u>N10@300</u>
G	5.5	10	0.45	13.9	9.2	5.9	8	4.7	3.3	1.61	39	0.55	120.1	99.1	83.3	68.7	40	5	20	0.5	7.4	N10@300
	129	237																				

Additional Design Notes

Section A - Batters down from RL9.6m to RL8.5m over 2.5m Section B - Batters down from RL9.7m to RL8.6m over 2.5m Section C - Batters down from RL9.7m to RL8.7m over 2.6m Section D - Batters down from RL10.7m to RL9.7m over 2.6m



Appendix B

Marked-Up Layout Drawings

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