DHC
STRUCTURAL | CIVIL

STRUCTURAL CALCULATIONS

PROJECT
IN SLAB 220D TANK DESIGN IN RESIDENTIAL WAFFLE SLABS
SINGLE STOREY, CLASS H1 EXPANSIVITY SOILS

CLIENT
APD LTD

ADDRESS
APD LTD

DATE
1/05/2024

PROJECT NUMBER
7527-H1(1)-220D

DOCUMENT CONTROL RECORD

Project	IN SLAB 220D TANK DESIGN IN RESIDENTIAL WAFFLE SLABS		
Client	APD LTD	**Project Number**	7527-H1(1)-220D

Rev	Date	Revision Details	Author	Reviewed By	Approved By
A	1 May 2024	Building Consent	P**S**	A**H**	A**H**
Current Revision		**A**			

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a) Using the documents or data in electronic form without requesting and checking them for accuracy against the original hard copy version.
b) Using the documents or data for any purpose not agreed to in writing by DHC Consulting Group Ltd

Author

P**hilip Seto**

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Approved By

Alyx Hodgson

Alyx@dhc.nz

Project:	IN SLAB 220D TANK DESIGN IN RESIDENTIAL WAFFLE SLABS	**Project No:**	7527-H1(1)-220D
Subject:	Structural Calculations	**Author:**	Philip Seto

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1. COUNCIL DOCUMENTATION

PRODUCER STATEMENT – PS1
DESIGN

BUILDING CODE CLAUSE(S): B1 **JOB NUMBER:** 7527-H1(1)-22
ISSUED BY: DHC Consulting Group Ltd
(Engineering Design Firm)
TO: APD Ltd
(Owner/Developer)
TO BE SUPPLIED TO: Building Consent Authority
(Building Consent Authority)
IN RESPECT OF: Structural Design of concrete Waffle slabs for In slab tanks in class H1 soils - single storey.
(Description of Building Work)
AT: APD Ltd
(Address, Town/City)
LEGAL DESCRIPTION: **N/A** ☑

We have been engaged by the owner/developer referred to above to provide *(Extent of Engagement)*:
Structural engineering design as per the calculations attached
in respect of the requirements of the Clause(s) of the Building Code specified above for Part only , as specified in the Schedule, of the proposed building work.

The design carried out by us has been prepared in accordance with:

- ☑ Compliance documents issued by the Ministry of Business, Innovation & Employment *(Verification method/acceptable solution)* B1/VM1, B1/VM4 and/or;
- ☑ Alternative solution as per the attached Schedule.

The proposed building work covered by this producer statement is described on the drawings specified in the Schedule, together with the specification, and other documents set out in the Schedule.

On behalf of the Engineering Design Firm, and subject to:

- Site verification of the following design assumptions: Soils to 300kPa UBC, expansitivity class H1, AS2870:2011 .
- All proprietary products meeting their performance specification requirements;

I believe on reasonable grounds that:

- the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the Schedule, will comply with the relevant provisions of the Building Code and that;
- the persons who have undertaken the design have the necessary competency to do so.

I recommend the CM 2 level of **construction monitoring**.

I, *(Name of Engineering Design Professional)* Alyx Hodgson , am:

- ☑ CPEng number 1019377

and hold the following qualifications BE(Hons), CMEngNZ, CPEng

The Engineering Design Firm holds a current policy of Professional Indemnity Insurance no less than $200,000
The Engineering Design Firm is a member of ACE New Zealand.

SIGNED BY *(Name of Engineering Design Professional)*: Alyx Hodgson
(Signature below):

ON BEHALF OF *(Engineering Design Firm)*: DHC Consulting Group Ltd Date: 01/05/2024

Note: This statement has been prepared solely for the Building Consent Authority named above and shall not be relied upon by any other person or entity. Any liability in relation to this statement accrues to the Engineering Design Firm only. As a condition of reliance on this statement, the Building Consent Authority accepts that the total maximum amount of liability of any kind arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in tort or otherwise, is limited to the sum of $200,000.

This form is to accompany **Form 2 of the Building (Forms) Regulations 2004** for the application of a Building Consent.

SCHEDULE to PS1

Please include an itemised list of all referenced documents, drawings, or other supporting materials in relation to this producer statement below:

DHC Drawings REF NO. 7527-H1(1)-220D - SHEETS: S002, S301-3

DHC Calculations REF NO. 7527-H1(1)-220D - DATED: 2024.05.01

Maximum design load assumptions to slab edges:

Roof loads G/Q: 0.45kpa/0.25kpa x 3.0m (LD) x 1 Roof level
Brick veneer wall loads G/Q: 1.54kpa/0kpa x 2.7 x 1 (1 storeys)
Weather board wall loads G/Q: 0.4kpa/0kpa x 2.7 x 1 (1 Storeys)

MAX UDL AND POINT LOADS AT PERIMETER FOOTING

WALL: G = 4.43KN/M (BRICK VENEER)
G = 1.08KN/M (WEATHER BOARD)

ROOF: G = 1.35KN/M
Q = 0.75KN/M

GARAGE & DRIVEWAY:
G_{SDL} = 0.25KPA
Q = 2.5KPA
Q_{PL} = 12KN

Soil expansivity class assumptions: Class H1, Ys ≤ 60mm

The attached PS1 is subject to:

1. This statement is based on generic design of the concrete waffle slab only, without specific knowledge of the location or intended use of the product at the site referred to. The Owner/Developer and Building Consent Authority must be satisfied the specified product and the corresponding Producer Statement and manufacturer's specifications are applicable to the situation in which the product is to be used,
2. Any ground at the site directly supporting the slab providing an allowable working bearing capacity of 100kPa minimum
3. Any structure supporting the balustrade to be in accordance with the Building Code Acceptable Solutions or subject to specific design,
4. The work covered by this statement being carried out in accordance with the manufacturer's installation specifications,
5. all reinforced concrete work being carried out in accordance with NZS 3109 and NZS 3114, and
6. all structural steelwork work being carried out in accordance with NZS 3404, and
7. the engineering work covered by this statement being inspected at appropriate times during construction by the Building Consent Authority, geotechnical engineers % structural engineers as required by the building consent conditions

Referenced documents: Drawings Ref: 7527 – Dated 01/05/2024
Alternative Solutions: AS2870

Part only Schedule:

This PS1 covers part only of the building work for the following reason(s):

- This statement only covers the elements designed by DHC Consulting Group Ltd.

PS1 Expiry Date

This PS1 is valid for Building Consents lodged **until the end of May 2025**.

GUIDANCE ON USE OF PRODUCER STATEMENTS

Information on the use of Producer Statements and Construction Monitoring Guidelines can be found on the Engineering New Zealand website
https://www.engineeringnz.org/engineer-tools/engineering-documents/producer-statements/

Producer statements were first introduced with the Building Act 1991. The producer statements were developed by a combined task committee consisting of members of the New Zealand Institute of Architects (NZIA), Institution of Professional Engineers New Zealand (now Engineering New Zealand), Association of Consulting and Engineering New Zealand (ACE NZ) in consultation with the Building Officials Institute of New Zealand (BOINZ). The original suite of producer statements has been revised at the date of this form to ensure standard use within the industry.

The producer statement system is intended to provide Building Consent Authorities (BCAs) with part of the reasonable grounds necessary for the issue of a Building Consent or a Code Compliance Certificate, without necessarily having to duplicate review of design or construction monitoring undertaken by others.

PS1 DESIGN Intended for use by a suitably qualified independent engineering design professional in circumstances where the BCA accepts a producer statement for establishing reasonable grounds to issue a Building Consent;

PS2 DESIGN REVIEW Intended for use by a suitably qualified independent engineering design review professional where the BCA accepts an independent design professional's review as the basis for establishing reasonable grounds to issue a Building Consent;

PS3 CONSTRUCTION Forms commonly used as a certificate of completion of building work are Schedule 6 of NZS 3910:2013 or Schedules E1/E2 of NZIA's SCC 2011[2]

PS4 CONSTRUCTION REVIEW Intended for use by a suitably qualified independent engineering construction monitoring professional who either undertakes or supervises construction monitoring of the building works where the BCA requests a producer statement prior to issuing a Code Compliance Certificate.

This must be accompanied by a statement of completion of building work (Schedule 6).

The following guidelines are provided by ACE New Zealand and Engineering New Zealand to interpret the Producer Statement.

Competence of Engineering Professional
This statement is made by an engineering firm that has undertaken a contract of services for the services named, and is signed by a person authorised by that firm to verify the processes within the firm and competence of its personnel.

The person signing the Producer Statement on behalf of the engineering firm will have a professional qualification and proven current competence through registration on a national competence-based register such as a Chartered Professional Engineer (CPEng).

Membership of a professional body, such as Engineering New Zealand provides additional assurance of the designer's standing within the profession. If the engineering firm is a member of ACE New Zealand, this provides additional assurance about the standing of the firm.

Persons or firms meeting these criteria satisfy the term "suitably qualified independent engineering professional".

Professional Indemnity Insurance
As part of membership requirements, ACE New Zealand requires all member firms to hold Professional Indemnity Insurance to a minimum level.

The PI Insurance minimum stated on the front of this form reflects standard practice for the relationship between the BCA and the engineering firm.

Professional Services during Construction Phase
There are several levels of service that an engineering firm may provide during the construction phase of a project (CM1-CM5 for engineers[3]). The building Consent Authority is encouraged to require that the service to be provided by the engineering firm is appropriate for the project concerned.

Requirement to provide Producer Statement PS4
Building Consent Authorities should ensure that the applicant is aware of any requirement for producer statements for the construction phase of building work at the time the building consent is issued as no design professional should be expected to provide a producer statement unless such a requirement forms part of the Design Firm's engagement.

Refer Also:

1. Conditions of Contract for Building & Civil Engineering Construction NZS 3910: 2013
2. NZIA Standard Conditions of Contract SCC 2011
3. Guideline on the Briefing & Engagement for Consulting Engineering Services (ACE New Zealand/Engineering New Zealand 2004)
4. PN01 Guidelines on Producer Statements

www.acenz.org.nz
www.engineeringnz.org

To the Building Official,

Building Consent Authority

APD Ltd

Compliance with Building Code Clause B2 – Durability

The purpose of this letter is to demonstrate how compliance with Clause B2 (Durability) of the Building Code will be achieved for the above project. We can confirm that for specifically designed structural elements that are included within our design documentation:

Material	Means of compliance	Details
Reinforced concrete	B2/AS1	Concrete cover to reinforcing has been selected in accordance with NZS3101, Part 1, Section 3
Structural timber	B2/AS1	Timber treatment has been selected in accordance with Table 1A of B2/AS1
Mild steel structure	Alternative Solution	Protection for mild steel has been specified in accordance with SNZ TS 3404 – Durability requirements for steel structures and components and AS/NZS2312 – Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings. This guide works on a time to first maintenance basis and assumes on-going maintenance. Refer to the attached maintenance plan (optional but recommended).
Other		

Yours faithfully,

Alyx Hodgson

For and on behalf of

DHC Consulting Group Ltd

APD Ltd

Structural maintenance schedule

This schedule of ongoing inspection and maintenance of structural elements shall be included with the Operations and Maintenance manuals and provided to the Owner/Body Corporate and building managers.

Inspection/maintenance timeframe and item	
Half-yearly	Wash down all exposed steelwork that is not in a fully interior environment including: • Veranda steelwork • Steel Carpark structure (beams, columns, braces etc) • Deck and balcony steelwork • Exposed façade steelwork, both primary and secondary structure • Plantrooms and plenums with fresh-air intakes • External structural components such as Buckling Restrained Braces, Viscous Dampers, Eccentrically Braced Frames and the like • Sub-ground floor mild-steel structures such as beams, isolation bearings etc.
(b) 5 yearly	Inspect and repair sealant that encloses structural mild-steel components and/or timber with mild-steel fixings
(c) 10 yearly	Check exposed timber fixings for corrosion, repair as required.
	Inspect/replace sealant that encloses structural mild-steel components and/or timber with mild-steel fixings. This will typically include sealants around the perimeter of precast panels. Note that 10 years is the expected useful life for many sealants
	Check exposed structural steel within plantrooms and plenums for corrosion. Repair protective coatings as required.
	Check all exposed steelwork that is not in a fully interior environment for signs of corrosion. Repair protective coatings as required.
	Audit of damage to exposed intumescent coatings. Repair as required.
(d) 25 yearly	Inspect samples of structural steel that is hidden from view but not enclosed within a vapour barrier, and repair protective coatings as necessary. A typical example is a veranda with built-in steelwork. (Such steelwork should typically have duplex protective coatings). Inspection may typically require removal of claddings and/or the drilling of holes for borescope access. Repair as required.
	Inspect all exposed, external timber. Repair as required.
	Inspect all exposed, external reinforced concrete for signs of spalling or cracking. Repair as required.
	Audit of damage to enclosed intumescent coatings. Repair as required.
Following fit-out or alterations	Audit of damage to intumescent coatings. Repair as required.
Following seismic shaking > SLS1 event	Inspections and repair as per b), c) and d) above

CERTIFICATE OF DESIGN WORK
MEMORANDUM FROM LICENSED BUILDING PRACTITIONER

Section 30C and Section 45, Building Act 2004

The Building

Street address	APD Ltd		
Suburb		**Town/city**	Auckland
Postcode		**Building consent no.**	

The Owner

Name(s)	APD Ltd		
Email	darien@apd.co.nz	**Phone**	027 585 9088
Address			

Basis for providing this memorandum

I am providing this memorandum in my role as the **specialist** designer who carried out or supervised specific Primary structure elements of restricted building work (RBW) design work as described in this memorandum. Other designers will provide memoranda covering the remaining RBW design work. Refer also to the attached PS1.

Identification of restricted building work (RBW) design work

I, Alyx Hodgson carried out or supervised the following RBW design work:

Primary structure: B1

Design work that is RBW		Description (as required) and reference to plans and specifications	Carried out or supervised
Foundations and subfloor framing	✓	Waffle slab with in-slab tank As per PS1 and calculations attached	Supervised
Retaining walls	✗		
Beams	✗		
Portal	✗		
Bracing	✗		
Other (primary)	✗		

Note: SED = Elements subject to Specific Engineering Design outside of the scope of NZS3604:2011, unless otherwise noted.

Initial AH **Date** 01/05/2024

Waivers and modifications

Are waivers or modifications of the Building Code required? No

If yes, please provide details of the waivers or modifications:

Building Code clause	Waiver/modification required

Issued by

Name	Alyx Hodgson	**Design entity/company**	DHC Consulting Group Ltd
Chartered status	CPEng	**Chartered no.**	1019377
Email	alyx@dhc.nz	**Website**	DHC.NZ
Phone (daytime)	0211120973	**Phone (after hours)**	0211120973
Mobile			
Postal address	PO BOX 9079, Newmarket, Auckland		
Physical address	26 Patey St Epsom		

Declaration

I, Alyx Hodgson, LBP state that I have applied the skills and care reasonably required of a competent design professional in carrying out or supervising the RBW described in this memorandum and that based on this, I certify that the RBW described in this memorandum:

- complies with the Building Code; or
- complies with the Building Code subject to any waiver or modification of the Building Code described in this memorandum.

Signature  **Date** 01/05/2024

Agreement to provide a producer statement during construction

Producer statement construction (PS3) or producer statement construction review (PS4)

I, being the owner / agent confirm that I have engaged the following producer statement author(s) **listed on the reverse side** of this document to be responsible for carrying out construction (PS3) or observing and supervising construction (PS4)

Name:	APD Ltd		☐ Owner ☐ Agent
Signature:		Date:	
Building consent number (if known)			
Address of project:	APD Ltd		

Important notes:

In order to approve a building consent, Council must be satisfied on reasonable grounds that the provisions of the Building Code will be met. Council must also be satisfied that the building work is constructed in accordance with the building consent and Building Code before it can issue a code compliance certificate. Producer statements are a mechanism used for establishing compliance with the Building Code and are a cost-effective alternative to Council undertaking design reviews and inspections itself.

In some instances, building work that is specifically designed may require specialist installation / supervision. Where these elements are identified, the owner / agent may enter into an agreement with Council, to provide a producer statement to support compliance.

This form serves as acknowledgement by the owner/agent that a producer statement will be provided on completion of the building work to which it relates. If at the time of application, the design professional or contractor details are unknown, please complete all other fields of this form noting the words ***"to be advised"*** *in the author's name field.*

Producer statement construction (PS3) *If an owner / agent intends to provide a PS3 for internal waterproofing or installation of a heating appliance in lieu of an inspection the author must be on Councils Producer Statement Register and the author* ***must*** *phone the Call Centre on (09) 301 0101 to advise they will be performing the work. At this time Council staff will check and confirm the author is on the Register and if so, record the contractor's details against the building consent. An inspection is not required for this work. All other work performed by a contractor must be inspected and supported by a producer statement.*

Producer statement construction review (PS4) *Producer statements must be supported by way of site observation records and instructions, diary notes, testing and commissioning certificates, warranties, or such documents applicable to the construction, which has been undertaken / observed / supervised.*

On completion of the building work, Council will rely on the producer statement and supporting documentation when making its decision on whether to issue a code compliance certificate. All producer statement authors must be listed on the Auckland Council Producer Statement Register; the register can be found on the Councils website @ **www.aucklandcouncil.govt.nz** **.**

Please note *that whilst every effort is made to identify producer statement requirements at consent stage; it may be possible that further information is required during construction and prior to the issue of the Code Compliance Certificate.*

Tick if applies	Description of work *(delete items not applicable)*	Producer Statement Authors name *(If unknown, write TBA)*	Approved author #	Type
☐	Geotechnical - soil conditions, soil compaction, earthworks, excavations on boundary, etc			PS4
☑	Foundations, piling, masonry (Type A, B or C), compaction of hard-fill, drain bridging, raft slab	Alyx Hodgson	CPEng - 1019377	PS4
☐	Pile driving			~~PS3~~ PS4
☐	Internal waterproofing membranes			PS3
☐	External waterproofing membranes			PS3
☐	Heating appliance			PS3
☐	Stormwater management devices			PS4
☐	Waste water systems			PS4
☐	Swimming pool			PS4
☐	Precast and pre-stressed concrete			~~PS3~~ PS4
☑	Structural steel / portal frames			*
☐	Facade systems			PS4
☐	Installation, testing & commissioning certificates for fire safety systems			*
☐	Inspection & test plan (ITP) structural steel welding			*
☐	Fire safety systems			PS3
☐	Fire protection – interior surface finishes, floor coverings & suspended flexible fabrics			PS3
☐	Fire protection – intumescent coatings to structural steel			PS3
☐	Passive fire protection - stopping of fire rated walls, floors, ceilings & penetrations			PS3
☐	Heating ventilation & air-conditioning (HVAC)			PS4
☐	Proprietary product installation			PS3
☐	Racking			PS4
☐	Seismic performance			PS4
☐				
☐				

* *Refer to conditions of consent for type of producer statement and certification requirements*

CONSTRUCTION MONITORING SCHEDULE
RESIDENTIAL

Schedule of inspections for

Address APD Ltd

DHC Consulting Group Ltd confirm the below inspections at a minimum are required to be undertaken to achieve a construction monitoring of specific engineering items to an Engineering New Zealand/ACENZ CM 2 level.

No.	Item of inspection	Timeframe
(Delete any that do not apply)		
1	Foundation beams, pads and slabs	Pre-pour

Notes:

a) The above items of inspection are the minimum required to enable DHC Consulting Group Ltd to issue a PS4 – Producer Statement Construction Review for the specific engineering design items.

b) The above items of inspection do not cover work constructed in accordance with NZS 3604:2011, for which inspections are to be undertaken by the Building Consent Authority.

c) The Contractor/Builder is to provide DHC Consulting Group Ltd at least 24 hours' notice of the requirement for an inspection. The above timeframes are indicative, the Engineer and Contractor are to agree the timing of inspection prior to work commencing on site.

d) A copy of this inspection schedule is to be held on site during the works, and the Contractor/Builder is to provide reasonable and safe access to enable works to be inspected according to the schedule.

e) The above schedule does not necessarily represent the actual number of inspections to be undertaken. The number of inspections will depend on the construction method, sequence of the works and whether or not unforeseen conditions or difficulties are encountered on site.

2. FOUNDATIONS

TYPICAL RESIDENTIAL WAFFLE SLAB WITH APD TANKS

Loadings:	Tib Width
Roof	3.0m
Floor	2.5m
STANDARD RESI.	Tib Width
Roof	3.0m
Floor	2.5m

Class M - 1 Storey - Ys = 40mm

	Slab	APD Pods	Mesh	Add. Top bar	Rib Bar
Weatherboard	85mm	220mm	SE62	Not Req.	HD12
Brick Veneer	85mm	220mm	SE72	Not Req.	HD12

Class M - 2 Storey - Ys = 40mm

	Slab	APD Pods	Mesh	Addition. Top bar	Rib Bar
Weatherboard	85mm	220mm	SE72	Not Req.	HD12
Brick Veneer	85mm	220mm	SE62	HD12 @ 1200crs	HD12

Class H - 1 Storey - Ys = 60mm

	Slab	APD Pods	Mesh	Add. Top bar	Rib Bar
Weatherboard	85mm	220mm	SE62	HD12 @ 1200crs	HD16
Brick Veneer	85mm	220mm	SE62	HD16 @ 1200CRS	HD12 (Maintain moisture to ground during constrution)

Class H - 2 Storey - Ys = 60mm

	Slab	APD Pods	Mesh	Addition. Top bar	Rib Bar
Weatherboard	85mm	220mm	SE62	HD12 @ 1200crs	HD12
Brick Veneer	85mm	220mm	SE72	HD16 @ 1200crs	HD12

SE72 mesh can be substituted with SE62 + HD12 Hockey Bars
SE62 + HD12 Hockey Bars > SE72 Mesh

TYPICAL RESIDENTIAL GARAGE WAFFLE SLAB WITH APD TANKS

Loadings: Tib Width
Roof 3.0m
Floor 2.5m
Garge RESI.

Class M - 1 Storey - Ys = 40mm

	Slab	APD Pods	Mesh	Add. Top bar	Rib Bar
Weatherboard	105mm	220mm	SE82		HD12
Brick Veneer	105mm	220mm	SE82		HD12

Class M - 2 Storey - Ys = 40mm

	Slab	APD Pods	Mesh	Addition. Top bar	Rib Bar
Weatherboard	105mm	220mm	SE82	Not Req.	HD12
Brick Veneer	105mm	220mm	SE82	Not Req.	HD12

Class H - 1 Storey - Ys = 60mm

	Slab	APD Pods	Mesh	Add. Top bar	Rib Bar
Weatherboard	105mm	220mm	SE82	Not Req.	HD16
Brick Veneer	105mm	220mm	SE82	Not Req.	HD12 (Maintain moisture to ground during construction)

Class H - 2 Storey - Ys = 60mm

	Slab	APD Pods	Mesh	Addition. Top bar	Rib Bar
Weatherboard	105mm	220mm	SE82	Not Req.	HD12
Brick Veneer	105mm	220mm	SE82	HD16 @ 1200crs	HD12

SE72 mesh can be substituted with SE62 + HD12 Hockey Bars
SE62 + HD12 Hockey Bars > SE72 Mesh

WAFFLE SLAB: CLASS H1 SOILS - SINGLE STOREY

WAFFLE SLAB DESIGN

EDGE LABEL: Single storey - Class H

DHC STRUCTURAL | CIVIL

Project # :	7527
DESIGN BY :	PS
DATE :	

Slab details

Edge Beam Width = 300 mm
Pod Depth = 220 mm
Top slab Depth = 85 mm
Total slab Depth = 305 mm
Rib width = 100 mm @ 1.2 m
Concrete Strength = 25 MPa
Stress block parameters:
α= 0.85
β= 0.85

Design loads (calculated per 1m of foundation)

Load for centre heave/bearing (heaviest load case)

Element	Type	G	Q	LD (m)
Slab	Edge Beam	7.32 kPa	1.50 kPa	0.3 m
Slab	Waffle slab	2.48 kPa	1.50 kPa	0.53 m
Roof	LIGHT ROOF	0.45 kPa	0.25 kPa	3.0 m
Wall	LIGHT CLAD	0.40 kPa	0.00 kPa	3.0 m
Floor	TIMBER FLOOR	0.60 kPa	1.50 kPa	0.0 m
Additional load		0.0 kN/m	0.0 kN/m	-

Load case		Load factors G	Load factors Q	Load factors Scale	Design load
LC1	Centre heave	1.0	0.5	1.1	7.8 kN/m
LC2	ULS bearing pressure	1.2	1.5	1.0	10.2 kN/m
LC3	Edge heave	0.9	0.0	1.0	4.5 kN/m

Load for Edge Heave (lightest load case)

Element	Type	G	Q	LD (m)
Slab	Edge Beam	7.32 kPa	0.00 kPa	0.3 m
Slab	Waffle slab	2.48 kPa	0.00 kPa	0.45 m
Roof	LIGHT ROOF	0.45 kPa	0.25 kPa	1.0 m
Wall	LIGHT CLAD	0.40 kPa	0.00 kPa	3.0 m
Floor	TIMBER FLOOR	0.60 kPa	1.50 kPa	0.0 m
Additional load		0.0 kN/m	0.0 kN/m	-

Soil parameter

Ultimate bearing capacity : 300.0 kPa
$\Phi_{bc\ (CENTRE\ HEAVE)}$ = 0.33 *geotechnical reduction factor*
$\Phi_{bc\ (ULS)}$ = 0.50 *ULS geotechnical reduction factor*
Soil Ultimate Pressure (LC1): 26.08 kPa **OK**
Soil Ultimate Pressure (LC2): 34.17 kPa **OK**
Soil class to AS2870 H1 *40< Ys <60*
Ys= 60 mm *Design Soil Movement*
Hs= 1.5 m *Depth of design suction change*
300 year *Drought return period*

Design parameters for stiffened raft - Walsh Method

Ym= 42 mm *Centre Heave Differential Mound Movement*
e= 1.35 m *Edge Distance (centre heave)*
30% *Edge heave movement reduction for wet soil profile*
Ym= 21 mm *Edge Heave Differential Mound Movement*
e= 1.44 m *Edge Distance (edge heave)*
Keep soil profile wet during construction
k= 1000 kPa *Mound Stiffeness*
Wf= 0.67 *Assume Normal Profile Of Soil*

Moment check (Centre Heave)

W_{ULS}= 7.82 kN/m *Edge ULS Load*
M*= 10.6 kNm/m *Slab Bending Moment*
Mesh SE72 *Slab mesh*
31 mm *Mesh top cover*
Amesh= 192 mm²/m
f_{ym}= 500 MPa *Reo Yeild Strength*
No Additional Reinforcement
A_{bar}= 0 mm²/m *Hockey bars area*
f_{yb}= 500 MPa
a= 45.2 mm *Compression block depth*
d= 267 mm *Effective depth*
ΦMn= 19.9 kNm/m *Slab Moment Capacity* **OK**

Moment check (Edge Heave)

W_{st}= 4.47 kN/m *Design load (stabilising)*
F_{EH1}= 10.0 kN *Uplift force from edge heave acting at* 1.20 m *from e*
F_{EH2}= 10.1 kN *Uplift force from edge heave acting at* 0.64 m *from e*
M*= 12.1 kNm/m *Slab Bending Moment*
HD16 @ 1200crs *Rib Bottom reinfocement*
50 mm *Bottom cover*
Abar= 168 mm²/m *Reinfocement area*
fyb= 500 MPa *Bar Steel Yeild Strengt*
a= 39.4 mm *Compression block depth*
d= 247 mm *Effective depth*
ΦMn= 16.2 kNm/m *Slab Moment Capacity* **OK**

Shear check (Centre Heave)

W_{ULS}= 7.82 kN/m *Edge ULS Load*
A_{cv}= 26700 mm² *Effective shear area*
19.0 mm *Maximum conc. aggregate size*
k_a= 1.00 *Aggregate size factor*
p_w= 0.0072
k_d= 1.00 *Member depth factor*
v_c= 0.763 MPa *Shear resisted by concrete*
ΦV_c= 15.3 kN *Design shear strength provided by concrete*
OK **Shear reinforcement is not required**

Balance strain check (Centre Heave)

ε_c= 0.003 *Max concrete compression strain*
ε_y= 0.0025 *Steel yield strain*
c_d= 146 mm *Position of natural axis*
$0.75\rho_b$= 1.5% *Max. reinforcement ratio*
ρ_{min}= 0.3% *Min. reinforcement ratio*
ρ_b= 0.9% *Design reinforcement ratio* **OK**

OUTPUT - Steel requirements

Mesh : Mesh SE72
Hockey bars:
Rib bottom Steel: HD16 @ 1200crs
Shear Steel:

WAFFLE SLAB DESIGN

EDGE LABEL: Single storey - Class H

DHC STRUCTURAL | CIVIL

Project # :	7527
DESIGN BY :	PS
DATE :	27/06/2023

Slab details

Edge Beam Width = 300 mm
Pod Depth = 220 mm
Top slab Depth = 85 mm
Total slab Depth = 305 mm
Rib width = 100 mm @ 1.2 m
Concrete Strength = 25 MPa

Stress block parameters:
α= 0.85
β= 0.85

Design loads (calculated per 1m of foundation)

Load for centre heave/bearing (heaviest load case)

Element	Type	G	Q	LD (m)
Slab	Edge Beam	7.32 kPa	1.50 kPa	0.3 m
Slab	Waffle slab	2.48 kPa	1.50 kPa	0.53 m
Roof	LIGHT ROOF	0.45 kPa	0.25 kPa	3.0 m
Wall	BRICK CLAD (70)	1.65 kPa	0.00 kPa	3.0 m
Floor	TIMBER FLOOR	0.60 kPa	1.50 kPa	0.0 m
Additional load		0.0 kN/m	10.5 kN/m	-

Load case		Load factors G	Load factors Q	Load factors Scale	Design load
LC1	Centre heave	1.0	0.5	1.1	17.8 kN/m
LC2	ULS bearing pressure	1.2	1.5	1.0	30.5 kN/m
LC3	Edge heave	0.9	0.0	1.0	8.4 kN/m

Load for Edge Heave (lightest load case)

Element	Type	G	Q	LD (m)
Slab	Edge Beam	7.32 kPa	0.00 kPa	0.3 m
Slab	Waffle slab	2.48 kPa	0.00 kPa	0.45 m
Roof	LIGHT ROOF	0.45 kPa	0.25 kPa	1.0 m
Wall	BRICK CLAD (70)	1.65 kPa	0.00 kPa	3.0 m
Floor	TIMBER FLOOR	0.60 kPa	1.50 kPa	1.0 m
Additional load		0.0 kN/m	0.0 kN/m	-

Soil parameter

Ultimate bearing capacity : 300.0 kPa
$\Phi_{bc\ (CENTRE\ HEAVE)}$ = 0.33 *geotechnical reduction factor*
$\Phi_{bc\ (ULS)}$ = 0.50 *ULS geotechnical reduction factor*
Soil Ultimate Pressure (LC1): 59.38 kPa **OK**
Soil Ultimate Pressure (LC2): 101.67 kPa **OK**
Soil class to AS2870 H1 *40< Ys <60*
Ys= 60 mm *Design Soil Movement*
Hs= 1.5 m *Depth of design suction change*
300 year *Drought return period*

Design parameters for stiffened raft - Walsh Method

Ym= 42 mm *Centre Heave Differential Mound Movement*
e= 1.35 m *Edge Distance (centre heave)*
30% *Edge heave movement reduction for wet soil profile*
Ym= 21 mm *Edge Heave Differential Mound Movement*
e= 1.44 m *Edge Distance (edge heave)*
Keep soil profile wet during construction
k= 1000 kPa *Mound Stiffeness*
Wf= 0.67 *Assume Normal Profile Of Soil*

Moment check (Centre Heave)

W_{ULS}= 17.81 kN/m *Edge ULS Load*
M*= 24.1 kNm/m *Slab Bending Moment*
Mesh SE72 *Slab mesh*
31 mm *Mesh top cover*
Amesh= 192 mm²/m
f_{ym}= 500 MPa *Reo Yeild Strength*
Additional Reinforcement Required, try: **HD12 @ 1200crs**
A_{bar}= 94 mm²/m *Hockey bars area*
f_{yb}= 500 MPa
a= 67.4 mm *Compression block depth*
d= 261 mm *Effective depth*
ΦMn= 27.7 kNm/m *Slab Moment Capacity* **OK** OK

Moment check (Edge Heave)

W_{st}= 8.38 kN/m *Design load (stabilising)*
F_{EH1}= 10.0 kN *Uplift force from edge heave acting at* 1.20 m *from e*
F_{EH2}= 10.1 kN *Uplift force from edge heave acting at* 0.64 m *from e*
M*= 6.4 kNm/m *Slab Bending Moment*
HD12 @ 1200crs *Rib Bottom reinfocement*
50 mm *Bottom cover*
Abar= 94 mm²/m *Reinfocement area*
fyb= 500 MPa *Bar Steel Yeild Strengt*
a= 22.2 mm *Compression block depth*
d= 249 mm *Effective depth*
ΦMn= 9.5 kNm/m *Slab Moment Capacity* **OK**

Shear check (Centre Heave)

W_{ULS}= 17.81 kN/m *Edge ULS Load*
A_{cv}= 26100 mm² *Effective shear area*
19.0 mm *Maximum conc. aggregate size*
k_a= 1.00 *Aggregate size factor*
p_w= 0.0110
k_d= 1.00 *Member depth factor*
v_c= 0.911 MPa *Shear resisted by concrete*
ΦV_c= 17.8 kN *Design shear strength provided by concrete*
OK **Shear reinforcement is not required**

Balance strain check (Centre Heave)

ε_c= 0.003 *Max concrete compression strain*
ε_y= 0.0025 *Steel yield strain*
c_d= 142 mm *Position of natural axis*
$0.75\rho_b$= 1.5% *Max. reinforcement ratio*
ρ_{min}= 0.3% *Min. reinforcement ratio*
ρ_b= 1.3% *Design reinforcement ratio* **OK**
OK

OUTPUT - Steel requirements

Mesh : Mesh SE72
Hockey bars: HD12 @ 1200crs
Rib bottom Steel: HD12 @ 1200crs
Shear Steel:

BEAM DESIGN

BEAM LABEL : Suspended edge beam - threestorey

JOB # :	7527
DESIGN BY :	PS
DATE :	27/06/2023
PAGE :	

SPAN TYPE:	Simple		TOP RESTRAINT SPACING	0.1	m	ψ_C	0.4	Ws/Wu	0.68
SPAN LENGTH (L)	1.05	m	BOT RESTRAINT SPACING	1.05	m	ψ_S	0.7	Es/Eu	0.5
			STUD HEIGHT	2.7	m	ψ_L	0.4	DEFLECTION UPPER LIMIT	12 mm
			ROOF PITCH	20	°	ψ_E	0.3		

DISTRIBUTED LOAD

LOAD TYPE	TRIBUTARY WIDTH 1 (m)	TRIBUTARY WIDTH 2 (m)	DEAD LOAD G (kPa)	LIVE LOAD Q	WIND DOWN W_{DOWN} (kPa)	WIND UP W_{UP} (kPa)	EQ Eu (kPa)	LOAD START a (m)	LOAD END b (m)
LIGHT ROOF	3.00	3.00	0.45	0.25	0.00		0.00	0.00	1.05
TIMBER FLOOR	5.00	5.00	0.60	1.50			0.00	0.00	1.05
							0.00	0.00	1.05
							0.00	0.00	1.05
							0.00	0.00	1.05
							0.00	0.00	1.05
							0.00	0.00	1.05
							0.00	0.00	1.05
							0.00	0.00	1.05
							0.00	0.00	1.05

WALL LOAD

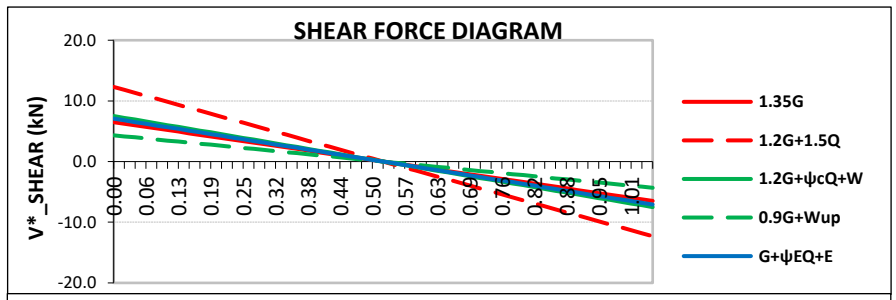
WALL TYPE	HEIGHT 1 (m)	HEIGHT 2 (m)	G (kPa)	LOAD START (m)	LOAD END (m)
LIGHT CLAD	8.10	8.10	0.40	0.00	1.05
				0.00	1.05
				0.00	1.05
				0.00	1.05

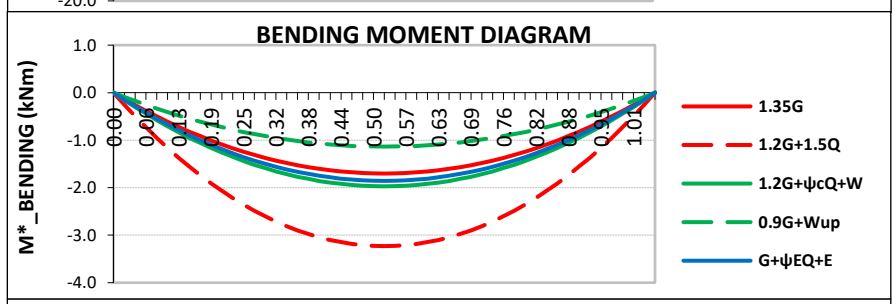
CONCENTRATED LOADS

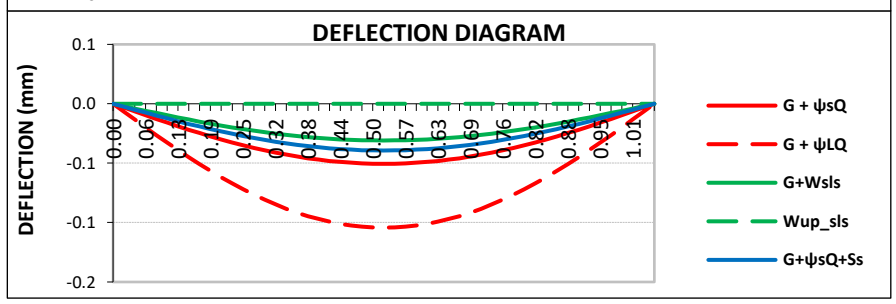
NOTE	G (kN)	Q (kN)	W_{DOWN} (kN)	W_{UP} (kN)	Eu (kN)	POSITION (m)
						0.53
						0.53
						0.53
						0.53
						0.53
						0.53
						0.53
						0.53
						0.53

APPLIED MOMENT (POSITIVE IN ANTICLOCKWISE)

NOTE	G (kNm)	Q (kNm)	W_{DOWN} (kNm)	W_{UP} (kNm)	Eu (kNm)	POSITION (m)
	0.00	0.00	0.00	0.00	0.00	0.53
					0.00	0.53
					0.00	0.53
					0.00	0.53







BEAM DESIGN

BEAM TYPE	CONCRETE		DEPTH (mm)	205	ϕb	0.85	
fc (MPa)	20		WIDTH (mm)	300	ϕs	0.75	
nTOP REO	1	HD12	TOP COVER	50	fy_top	500	MPa
nBOT REO	2	HD12	BOT COVER	50	fy_bot	500	MPa
STIRRUP	0	R6	SPACING	100	fyt	300	MPa
Avt_min	B S/(16 fyt) sqr(fc) =		8.4mm2	>	Avt =	0mm2	NG
As_min	B d sqr(fc) / (4 fy) =		95.9mm2	<	As =	113.1mm2	OK
a_max =	0.75 β (εc/(εc + εy)) d		49.7mm	>	a	22.2mm	OK
ϕMn =	ϕb As fy (d - a/2)				s_min =	250mm	OK
ϕVn =	ϕs (Av fyt d/s + vb Ac)						
vb =	(0.07+10pl) sqr(fc)		0.08sqr(fc)≤vb≤0.2sqr(fc)				

	POSITIVE BENDING M*+ (kNm)	POSITIVE BENDING ϕ k1 Mn	NEGATIVE BENDING M*- (kNm)	NEGATIVE BENDING ϕ k1 Mn	SHEAR V* (kN)	SHEAR ϕ k1 Vn	
1.35G	1.70	12.68	0.00	6.61	6.49	17.66	OK
1.2G+1.5Q	3.23	12.68	0.00	6.61	12.30	17.66	OK
1.2G+ψcQ+W_DN	1.97	12.68	0.00	6.61	7.51	17.66	OK
0.9G+W_UP	1.14	12.68	0.00	6.61	4.32	17.66	OK
G+ψEQ+E	1.86	12.68	0.00	6.61	7.07	17.66	OK

REACTION	G (kN)	Q (kN)	W_{DOWN} (kN)	W_{UP} (kN)	S_U (kN)	R_U (kN)
Ra	4.81	4.36	0.00	0.00	0.00	12.30
Rb	4.81	4.36	0.00	0.00	0.00	12.30
Ma	N.A.	N.A.	N.A.	N.A.	N.A.	0.00
Mb	N.A.	N.A.	N.A.	N.A.	N.A.	0.00

LOAD CASE	L to δ RATIO	DEFLECTION δ (mm)		L to δ LIMIT	DEF. LIMIT δ (mm)	
G+ψsQ	L/20770	-0.05	<	360	2.92	OK
G+ψLQ	L/10075	-0.10	<	360	2.92	OK
G+W_SLS	L/33951	-0.03	<	240	4.38	OK
W_UP_SLS	FLAT	0.00	<	240	4.38	OK
G+ψEQ+Es	L/26692	-0.04	<	360	2.92	OK
1kN Vib.		0.01	<		1	OK

SUMMARY

205Dx300B_fc=20MPa_1HD12 TOP & 2HD12 BOT + 0LEGGED R6-100

MOISTURE CONTENT : 18% OR LESS (12 MONTHS OR LONGER DURATION OF LOAD)

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