IPENZ ENGINEERS NEW ZEALAND | NEW ZEALAND INSTITUTE OF ARCHITECTS INCORPORATED | ACENZ

HCL Job No: 20145

Building Code Clause(s) : B1, B2**

PRODUCER STATEMENT – PS1 – DESIGN

(guidance notes on the use of this form are printed on page 2)

Auckland Council
16/02/2018
BCO10260425
BUILDING CONSENT

ISSUED BY: Ian Hutchinson Consultants Ltd
(Design Firm)

TO: Three Blokes Ltd
(Owner / Developer)

TO BE SUPPLIED TO: Auckland Council
(Building Consent Authority)

IN RESPECT OF: Proposed Planning Shed
(Description of Building Work)

AT: 362 Matakana Valley Road, Matakana
(Address)

SEC 1 **DP** **SO** 400726

We have been engaged by the owner/developer referred to above to provide:
Specific Structural Design Computation services in respect of the requirements of
(Extent of Engagement)

Clause(s) B1 (VM1) (VM4) (AS1) of the Building Code for
☐ All ☑ Part only (as included in the Design Calculations, ref 20145, dated 04/10/2017),
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 B1 (VM1) B1 (AS1) B1 (VM4)
or (verification method / acceptable solution)
☑ Alternative solution as per the attached schedule B2** (Refer to attached correspondence ref: L 20145PS1 dated: 7 December 2017

The proposed building work covered by this producer statement is described on the drawings titled Drawing By and Titled and numbered Drawing Numbers together with the specification, and other documents set out in the schedule attached to this statement.

On behalf of the Design Firm, and subject to:
(i) Site verification of the following design assumptions Ground conditions in accordance with Geotechnical Investigation Report L20145 dated 04 October 2017
(ii) All proprietary products meeting their performance specification requirements;

I **believe on reasonable grounds** that a) the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the attached schedule, will comply with the relevant provisions of the Building Code and that b), the persons who have undertaken the design have the necessary competency to do so. I also recommend the following level of construction monitoring/observation:
☐CM1 ☑CM2 ☐CM3 ☐CM4 ☐CM5 (Engineering Categories) or ☐ as per agreement with owner/developer (Architectural)

I, Ian Thomas Hutchinson am: ☑ CPEng # 63973

I am a Member of: ☑ IPENZ ☐ NZIA
and hold the following qualifications: BE ME MIPENZ (Civil Structural) CPEng IntPE(NZ)
The Design Firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than $200,000*.
The Design Firm is a member of ACENZ ☑

SIGNED BY: Ian Thomas Hutchinson **ON BEHALF OF:** Ian Hutchinson Consultants Ltd
(Design Firm)

DATE: 7 December 2017 **SIGNATURE:**

Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total maximum amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), 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.

** Refer to attached correspondence ref: L 20145PS1 dated: 7 December 2017 to be read in conjunction with this Producer Statement (PS1) – Design. Please note that this PS1 is not valid without attached correspondence.

GUIDANCE ON USE OF PRODUCER STATEMENTS

Producer statements were first introduced with the Building Act 1992. The producer statements were developed by a combined task committee consisting of members of the New Zealand Institute of Architects, Institution of Professional Engineers New Zealand, Association of Consulting Engineers New Zealand in consultation with the Building Officials Institute of New Zealand. The original suite of producer statements has been revised at the date of this form as a result of enactment of the Building Act (2004) by these organisations to ensure standard use within the industry.

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

PS1 Design	Intended for use by a suitably qualified independent 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 design 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 3910:2003 [1] or Schedules E1/E2 of NZIA's SCC 2007[2]
PS4 Construction	Intended for use by a suitably qualified independent design professional who undertakes 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 ACENZ, IPENZ and NZIA to interpret the Producer Statement.

Competence of Design Professional

This statement is made by a Design 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 designers.

A competent design professional will have a professional qualification and proven current competence through registration on a national competence based register, either as a Chartered Professional Engineer (CPEng) or a Registered Architect.

Membership of a professional body, such as the Institution of Professional Engineers New Zealand (IPENZ)or the New Zealand Institute of Architects (NZIA), provides additional assurance of the designer's standing within the profession. If the design firm is a member of the Association of Consulting Engineers New Zealand (ACENZ), this provides additional assurance about the standing of the firm.

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

*** Professional Indemnity Insurance**

As part of membership requirements, ACENZ 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, small projects. If the parties deem this inappropriate for large projects the minimum may be up to $500,000.

Professional Services during Construction Phase

There are several levels of service which a Design Firm may provide during the construction phase of a project (CM1CM5)[3] (OL1-OL4)[2]. The Building Consent Authority is encouraged to require that the service to be provided by the Design 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.

Attached Particulars

Attached particulars referred to in this producer statement refer to supplementary information appended to the producer statement.

Refer Also:

1 *Conditions of Contract for Building & Civil Engineering Construction NZS 3910: 2003*

2 *NZIA Standard Conditions of Contract SCC 2007 (1st edition)*

3 *Guideline on the Briefing & Engagement for Consulting Engineering Services (ACENZ/IPENZ 2004)*

www.acenz.org.nz
www.ipenz.org.nz
www.nzia.co.nz

Hutchinson
CONSULTING ENGINEERS

PO Box 150, Orewa 0946
154 Centreway Road, Orewa
+64 9 426 5702
www.hc.co.nz

Our Ref: L 20145PS1

7 December 2017

Auckland Council
Private Bag 92300
AUCKLAND 1142

Attn: Team Leader (Building Control)

Dear Sir/Madam,

RE: PRODUCER STATEMENT – DESIGN (PS1) B2 DURABILITY COMPLIANCE

As a result of Auckland Council recently indicating that Chartered Professional Engineers could be removed from the Producer Statement Authors Register for non-compliance with the Producer Statement Policy requirements surrounding B2 Durability, we confirm the following.

This office has carried out specific engineering design of various structural elements associated with the accompanied Producer Statement Design (PS1) in accordance with the compliance documents issued by the Department of Building and Housing B1 (VM1), B1 (AS1) and B1 (VM4).

We further confirm that the material components within our design have generally been selected and specified for material durability in accordance with the following material code clauses and/or New Zealand Building Code Acceptable Solutions:

Structural Steel
Steel protections and coatings shall be in accordance with the "Guide to the Protection of Structural Steel against Atmospheric Corrosion by the Use of Protective Coatings" AS/NZS 2312:2014.

Timber
Timber treatment shall be in accordance with the approved building consent specifications provided by the architectural designer, the requirements of NZBC B2/AS1 – Table 1A, and requirements of NZS 3604:2011 / NZS 3602:2003.

Reinforced Concrete
Reinforced concrete cover shall be in accordance with NZS 3101:2006 Part 1, Section 3.

Reinforced Concrete Masonry
Reinforced consent Masonry shall be in accordance with NZS 4230:2004, Section 4 and read in conjunction with NZS 3101:2006.

Please note that this office has not carried out any specific engineering design for material durability of any individual structural component and/or for the structure as a whole.

Our certification of the selection of material components within the design is limited to the clauses of the relevant documentation as listed above.

We trust this meets your approval.

Yours faithfully
IAN HUTCHINSON CONSULTANTS LTD

Prepared by Paul Jarvie
STRUCTURAL MANAGER

Reviewed by Ian Hutchinson
MANAGING DIRECTOR

Hutchinson
CONSULTING ENGINEERS

PO Box 150, Orewa 0946
154 Centreway Road, Orewa
+64 9 426 5702
www.hc.co.nz

SPECIFIC ENGINEERING DESIGN CALCULATIONS

PROJECT DETAILS:

PROJECT:	Proposed Planning Shed
CLIENT:	Three Blokes Ltd
SITE:	362 Matakana Valley Road Matakana
ARCHITECT:	Campbell Registered Architects Ltd
JOB REF:	20145
DATE:	4 October 2017
BY:	Paul Wilson

DESIGN SUMMARY:

- Foundation design in accordance with geotechnical report by Hutchinson referenced 20145 dated 4 October 2017.
- Masonry Retaining Wall Design
- Intertenancy fire wall & parapet wall design
- Timber Portal Frame Superstructure by others




GENERAL SPECIFICATION

BRIEF OUTLINE OF STRUCTURAL REQUIREMENTS / SPECIFICATIONS

1.0 GENERAL

Engineering details are to be read in conjunction with all other relevant documentation.

Do not scale any drawings. For setting out information refer to Architect's documentation.

The contractor is to ensure temporary stability of the building and ground at all times. Any temporary loading conditions imposed by the construction techniques are to be checked by the contractor.

All workmanship and construction practice is to be to the latest editions of NZ Standards (and other relevant standards).

All work is to be carried out to the NZ Building Code and any Territorial Authority requirements.

Any engineering discrepancies should be immediately referred to the Engineer for resolution.

For any nominated products, acceptable alternative products may be submitted by the Contractor for approval.

Contractor and fabricators shall confirm all dimensions prior to commencement of work. Discrepancies, if found, shall be brought to the immediate attention of the Architect.

ABBREVIATIONS

UB	Universal Beam e.g. a 250UB 31.4 is a 252x146 'I' beam and weighs 31.4kg per metre
TFB	Tapered Flange Beam e.g. 125TFB 13.1
UC	Universal Column e.g. a 200UC 46.2 is a 203x203 'I' beam and weighs 46.2kg per metre
EA	Equal Angle e.g. 50x50x6 EA has 6mm thick sides
UA	Unequal Angle e.g. 125x75x10 UA
CHS	Circular Hollow Section e.g. 102x8.6 CHS has an 8.6mm wall thickness
SHS	Square Hollow Section e.g. 89x89x3.6 SHS has 3.6mm wall thickness
RHS	Rectangular Hollow Section e.g. 89x38x4.0 RHS
PFC	Parallel Flange Channel e.g. 200PFC is a 200x75 channel
P/C	Pre-camber
PL	Steel Plate
SG	Stress Graded timber, available in grade 6, 8, 10, and 12
G	Only available in G8, verified green timber, typically used in wet service situations
GL	Glulam Timber
c/c	Centre to centre distance (also CTRS)

2.0 DESIGN LOADS

2.1 All imposed loads have been calculated in accordance with AS / NZS 1170.1, and structural elements designed for the following loads.

2.2 Permanent Loads

ELEMENTS	LOADINGS kPa (Plan area)
Timber Floors	0.5
Timber Decks	0.5
Heavy/Light Roof	0.85/0.45

ELEMENTS	LOADINGS kPa (Face area)
Timber Framed walls	0.5
Timber Framed walls + brick veneer	2.1
20/25 Series Masonry	4.1/5.1

2.3 Imposed Loads

	LOADINGS	
Residential Elements	**Udl Q_b kPa**	**Pt Loads Q_b kN**
Decks	2.0	1.8
Roofs	0.25	1.1
Garages	2.5	13*
All Other floors	1.5	1.8

*For garages with timber floors, this can be reduced to 9kN acting over 300mm x 300mm.

2.4 Specific Loads

The following specific loads have been allowed for: Nil.

3.0 SITE WORKS – GENERAL

3.1 Origin of levels is the LINZ datum – refer to Survey drawings.

3.2 All drawings to be read in conjunction with the specification.

3.3 Existing services are shown indicatively only. Before construction commences, it is the contractor's responsibility to locate the position and depth of all services that could be adversely affected by their operations. Inform Architect of any variations.

3.4 All work to be in accordance with the Territorial Authority standards.

3.5 Concrete for site works only to be 10MPa unless noted otherwise.

3.6 Catchpit positions and grate levels are approximate. Final positions are to suit kerb levels.

3.7 All work on public drains is to be carried out by an approved licensed drain layer, to the relevant Territorial Authorities' standards.

4.0 SITE WORKS – EARTHWORKS

4.1 Temporary batters to have a 1V:1H maximum slope, but also refer to any specific requirements in the geotechnical report.

4.2 Work to include the stripping of vegetation, topsoil, and any surface deleterious matter. This includes the breaking out of substructures and hard paving where required.

4.3 Care is to be exercised adjacent to existing trees that are to be retained. Any excavations shall be performed by hand in the vicinity of existing trees.

4.4 The subgrade shall be inspected by the Engineer and proof rolled as necessary. Any soft spots shall be over-excavated and compacted back to level with imported GAP65 material.

5.0 FOUNDATIONS

5.1 Unless noted otherwise, foundations have been designed in accordance with the 'good ground' assumption as defined by NZS 3604 2011 for:

100kPa safe bearing capacity (under unfactored loads).
150kPa dependable bearing capacity (under factored loads).

5.2 All founding material is to be approved by the Engineer before any concrete, including blinding concrete, is placed. Note that all footings are to be founded in original ground or certified engineered earth fill as approved by the Engineer. Refer also to the requirements of any specific Geotechnical Report.

5.3 No services excavations shall be formed within a 1:1 line of the underside of any foundation unless specifically instructed by the Engineer.

5.4 Slabs on grade are to be constructed onto prepared basecourse.

5.5 All backfill behind retaining walls, if any, is to be of approved free-draining material. Drain coils are to be fitted to drain, to approved silt traps.

5.0 REINFORCED CONCRETE

6.1 Minimum 28 day compressive concrete strengths to be as follows:

Exposure Zone (as defined in NZS 3604: 2011)	GRADE (MPa)
B	17.5
C	20
D	25

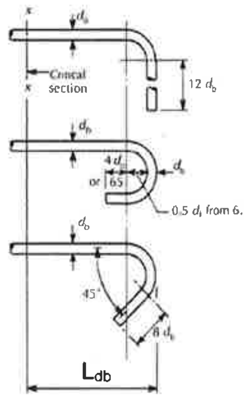
6.2 Concrete sizes indicated on the drawings do not include the thickness of applied finishes.

6.3 Chamfers to be formed on all exposed corners, generally 15mm x 15mm.

6.4 Sizes indicated show depth x width for beams. Depth excludes depth of slab unless noted otherwise.

6.5 If construction joints are not shown, their location shall be the contractor's responsibility to suit the conditions of the design. The Contractor is to allow for all construction joints necessary to complete the work, without causing distress to the structure. Location to be agreed with Engineer. In general, for slabs on grade, saw cuts (25mm deep x 5mm wide) are to be formed to produce a grid of 5.0m x 5.0m maximum, after the initial cure (approximately 24 – 48 hours after concrete pour).

6.6 All penetrations are to be located to the written approval of the Engineer and as shown on the drawings. Services to be cast in where shown.



6.7 Ensure adequate gaps maintained between suspended concrete work and all non-structural elements.

6.8 Finish to concrete to be as follows (if not specified elsewhere):

ELEMENT	TYPE OF FINISH (to NZS 3411)
Walls and all exposed concrete faces	F5 with special features – see Architects drawings
Floor slab	U3 for application of floor finish – see drawings

6.9 For all proprietary concrete materials, full calculations and shop drawings are to be submitted to the Engineer in adequate time by the Contractor for approval. These are to show full compliance with the design intent. Where necessary this documentation is to be submitted to the Territorial Authority for the necessary Building Consents.

7.0 REINFORCEMENT

Hook definitions;

a. A 90° turn plus an extension of at least 12 bar diameters at the free end of the bar
b. A semi-circular turn plus an extension of at least 4 bar diameters but not less than 65mm at the free end of the bar
c. A stirrup hook, which is defined as a 135° turn around a longitudinal bar plus an extension of at least 8 stirrup bar diameters for plain bars and 6 stirrup bar diameters for deformed bars at the free end of the bar embedded in the core concrete of the member

Minimum lap length as follows:

a. Masonry lap lengths;
   Grade 300 reinforcing = 40 x bar diameter
   Grade 500 reinforcing = 70 x bar diameter
b. Concrete lap lengths;

$$L_{db}=\frac{(0.5\alpha_a f_y)\, d_b}{\sqrt{f'_c}}$$

Where α_a = 1.3 for top reinforcement where more than 300mm of fresh concrete is cast in the member below the bar, or 1.0 for all other cases.

For example; (α_a = 1.0)

Concrete Strength	*Steel Strength*	*Lap length required*
20MPa	*300MPa*	*34 x d_b*
20MPa	*500MPa*	*56 x d_b*
25MPa	*300MPa*	*30 x d_b*
25MPa	*500MPa*	*50 x d_b*
30MPa	*300MPa*	*28 x d_b*
30MPa	*500MPa*	*46 x d_b*

Minimum bend diameters of Class E steel bars, with yield strength 300MPa or 500MPa

a. Normal
   i. Bar diameter (d_b) 6-20mm = $5d_b$
   ii. Bar diameter (d_b) 24-32mm = $6d_b$

b. Stirrups or ties
   i. For **deformed** bars:
      1. Bar diameter (d_b) 6-20mm = $4d_b$
      2. Bar diameter (d_b) 24-32mm = $6d_b$
   ii. For **plain** bars:
      1. Bar diameter (d_b) 6-20mm = $2d_b$
      2. Bar diameter (d_b) 24-32mm = $3d_b$

For example;

Bar Diameter	***Type***	***Required Bend Diameter (d_i)***
R6	*Stirrup or tie*	*12mm*
R10	*Stirrup or tie*	*20mm*
D10	*Stirrup or tie*	*40mm*
D10/H10	*Normal*	*50mm*
D12	*Stirrup or tie*	*48mm*
D12/H12	*Normal*	*60mm*
D16/H16	*Normal*	*80mm*
D20/H20	*Normal*	*100mm*
D24/H24	*Normal*	*144mm*
D32/H32	*Normal*	*192mm*

Minimum cover to reinforcement:

a. Masonry:

Exposure Classification	**Minimum cover (mm)**
Coastal Frontage*	60
Coastal Perimeter	50
External (inland)	45
Closed interior	35

b. Concrete:

Exposure Classification	**Concrete Strength (MPa)**				
	17.5	20	25	30	40
	Minimum cover (mm)				
Closed Interior	30	25	25	20	20
External (Inland)	50	40	35	30	25
Coastal Perimeter	65	50	40	35	30
Coastal Frontage*	-	-	50	45	40
Cast against Ground	75	75	75	75	75
Cast against Ground with DPC	50	50	50	50	50

* Within 100m of high tide mark or within 500mm of high tide mark to the direction of the prevailing wind

7.1 All reinforcement shall comply with the following:

SYMBOL	TYPE
R	Structural grade plain bars to NZS 3402 (300MPa)
D	Structural grade deformed bars to NZS 3402 (300MPa)
HD/H	Deformed bars grade 500 to NZS 3402 (500MPa)
HR	Plain bars grade 500 to NZS 3402 (500MPa)

7.2 Minimum distribution steel shall be D12 at 300 centres.

7.3 Reinforcement laps to be to NZS 3109. Mesh lap to be one mesh + 25mm.

7.4 Adequate support to all reinforcement to be made by the use of spacers, stools and the like.

7.5 All bending of reinforcement to be to NZS 3109.

7.6 Notation used for reinforcement fixing:

B/W	Both ways
B/F	Both faces
E/F	Earth face
V	Vertical
H	Horizontal
N/F	Near face
BOT	Bottom
ABR	Alternative bars reversed

8.0 STRUCTURAL TIMBER

8.1 Timber beams shall be propped until dry to prevent premature creep.

8.2 All normal timber sizes given are nominal dimensions unless otherwise stated.

8.3 All glue laminated timber sizes are actual dimensions.

8.4 Timber treatment shall be specified and shall comply with the recommendations of the Timber Preservation Authority. Generally all timber to be treated to the requirements of the Building Code. Refer to Architects drawings / specifications.

Hazard	*Hazard Class*	*Examples*
Low	*H1.1*	*Interior linings, internal wall*
	H1.2	*Wall framing, skillion roof framing*
Moderate	*H3.1*	*Claddings, fascia, wall framing*
	H3.2	*Deck bearers, joists, boards*
High	*H4*	*Fence posts, landscaping timber*
Severe	*H5*	*House piles, retaining walls*
Marine	*H6*	*Marinas, wharf piles*

8.5 All structural timber to be stress graded SG8 Pinus Radiata unless noted otherwise.

8.6 Where timber connections are exposed to the weather, all steel connection shall be galvanised (unless in the sea spray zone in which case they are to be stainless steel). Faces and edges of steel elements which rest against tanalised timber shall be painted before positioning. Minimum connections are 5mm plate and 2/M16 bolts unless noted otherwise.

8.7 All bolts and nuts to have washers as the following table:

	ROUND (mm)	SQUARE (mm)
M6	30 x 1.6	25 x 25 x 1.6
M8	36 x 2.0	32 x 32 x 2.0
M10	45 x 2.5	40 x 40 x 2.5
M12	55 x 3.0	50 x 50 x 3.0
M16	65 x 4.0	57 x 57 x 4.0
M20	75 x 5.0	65 x 65 x 5.0
>M20	85 x 6.0	75 x 75 x 6.0

9.0 STRUCTURAL STEELWORK

9.1 Steelwork drawings show the design intent. The Contractor is to prepare shop drawings for review. No fabrication is to commence until shop drawings are reviewed by the Engineer and written notification issued.

9.2 All reactions are shown in kN.

9.3 All protective coatings to steelwork to be in accordance with the architectural specifications. Generally, all exposed structural steel is to be galvanised, unless noted otherwise. All external flitch beams are to have plates galvanised and top, bottom and side edges full sealed.

9.4 All steelwork beams, girders, trusses and the like are to be precambered to compensate for the effects of dead load deflection as noted on the drawings.

9.5 Where the weight of a steel section is omitted the heaviest commonly available steel section shall be utilized.

9.6 All bolts to a minimum of M12 and all welds to be a minimum of 6mm continuous fillet (SP).

9.7 All beam connection plates to be a minimum thickness of 10mm. All other plates to be a minimum thickness of 6mm. All cap plates to be a minimum thickness of 3mm. All hollow sections to be sealed with cap plates.

9.8 M12 bolts where specified to the grade 4.6/S. All other bolts to be grade 8.8/S, unless noted otherwise.

9.9 All HD bolts to be fabricated from material with a minimum yield stress of 250MPa, set to template, checked for level and position before casting. All grout under base plates to have a compressive strength of at least 25MPa.

9.10 All nuts and turning bolts are to have approved washers. All exposed nuts, bolts and washers to be galvanised and to have protective coatings to match general steelwork, unless noted otherwise.

9.11 All cold formed sections, including cold rolled purlins to be to AS 1538. To be formed from zinc coated high strength steel strip with a minimum yield stress of 450MPa. All to be galvanised with a minimum coating of 300g/m². All purlin connections to be to manufacturer's recommendations.

9.12 All rod bracing to be a minimum of grade 300 plain reinforcing bar, unless noted otherwise.

9.13 Steel members shall be to the following grades, unless noted otherwise.

Member	Grade
UB, UC, TFC, PFC, TFB, Angles	300+
RHS, SHS, CHS	350
WB, WC	300+
Stainless steel	250+ (grade 315L)

9.14 All sealed sections to be galvanized shall have vent holes. To be shown on shop drawings.

9.15 Purlin cleats are to be in accordance with the manufacturer's standard details except where the top flange of the purlin is more than 300mm above supporting steelwork 75 x 75 x 8 angle cleats shall be used. Purlins shall be fixed using approved flanged bolts and washers.

9.16 Ceiling systems, ductwork, etc. to be suspended from purlins should be fixed with hook bolts through purlin web. The flanges of the purlins or girts shall not be holed.

10.0 REINFORCED MASONRY

10.1 Generally all concrete block masonry construction to be in accordance with NZS 4229:2013, and NZS 4210:2001.

10.2 Refer to figure 8.1, NZS 4229:2013 for D16 Trimmers around openings.

10.3 The top of all the concrete block walls to be continuous Bond Beam B1 or B2, as per figure 10.1 and 10.2, NZS 4229:2013. Continuous Bond Beam type B3 (figure 10.2, NZS 4229:2013) to be provided at mid-floor level of 2 storey walls.

10.4 Minimum reinforcing to be as follow unless shown otherwise:

Bond	15 Series		20 Series	
	Vertical	Horizontal	Vertical	Horizontal
Running	D12@800crs	D12@800crs	D12@600crs	D12@600crs
Stack	D10@400crs	D10@400crs	D12@400crs	D12@400crs

10.5 In general only load bearing masonry is shown on the structural drawings. All non-load bearing masonry is to be separated from structure by a 12mm compressible joint. All load bearing masonry, including retaining walls, shall be a minimum of Grade B.

10.6 Concrete blocks shall have a minimum compressive strength of 12.5MPa, to NZS 4210. Density to be greater than 1750kg/m³.

10.7 Mortar shall comply with the requirements of NZS 4210 to a nominal mix of:

1 part cement / 3 parts sand / ½ part lime.

10.8 All cores with reinforcement to be grout filled as a minimum. Additional covers filled as noted on the drawings. Grout shall have a slump of 230mm and a compressive strength in accordance with NZS 3604:2011 clause 4.5.3.

10.9 In general, walls to be full height before grouting cores. Washout ports to be provided at bottom course where vertical bars are located for all walls where poured height exceeds 1.2m. Mortar joints to be 10mm thick with blocks fully bedded and perpends filled. Joints to be tooled at exposed or rendered surfaces.

Cores are to be cleaned of all mortar fins and droppings through washout ports which are not to be closed until inspected by Engineer.

Grout to be added to ensure fill of cores with a maximum continuous pour height of 3600mm.

10.10 No construction of masonry on suspended floors is to take place until floor is fully depropped.

10.11 All Grade A masonry to be supervised by a registered mason, including grouting. All masonry to be inspected by Engineer prior to grouting.

10.12 Chasing of load bearing masonry only permitted as shown on Engineer's drawings.

TIMBER FRAMING DESIGN

Hutchinson CONSULTING ENGINEERS	JOB: Three Blokes Ltd			
	SUBJECT: Inter tennancy fire wall design (Wind check)			
	BY: Paul W	WALL: 1	DATE: Nov 2017	JOB NO: 20145

UNIFORMLY DISTRIBUTED LOADS (SIMPLY SUPPORTED):

Dead Loads, G:

roof:	0.15 kPa x	3.0 m =	0.5 kN/m
floor:	0.50 kPa x	0.0 m =	0.0 kN/m
internal walls:	0.35 kPa x	0.0 m =	0.0 kN/m
external walls:	2.30 kPa x	0.0 m =	0.0 kN/m

G = 0.5 kN/m

Live Loads, Q:

roof:	0.25 kPa x	3.0 m =	0.8 kN/m
external floor:	2.00 kPa x	0.0 m =	0.0 kN/m
internal floor:	1.50 kPa x	0.0 m =	0.0 kN/m

Q = 0.8 kN/m

WIND PRESSURE:

p_z = 1.00 kPa

$C_{pe} \times C_{pi}$ = 0.3

W_u = 0.30 KPa

W_s = 0.20 KPa

LOAD COMBINATIONS:

SLS = Serviceability Limit State
ULS = Ulitmate Limit State

ULS Distributed Loads:

1.35G = 0.6 kN/m
1.2G + 1.5Q = 1.7 kN/m
$1.2G + W_u + \Psi_c Q$ = 0.8 kN/m

Ψ_c = 0.4

DESIGN ACTIONS:

design **moment (ULS):** $M^* = \frac{w h^2}{8}$

M* = 1.63 kNm/m

design **axial load (ULS):** N* = 1.7 kN/m

MATERIAL PROPERTIES:

Try = 140 x 90 MSG8 at 450mm centres

h = Stud Height
h = **6600 mm**

Axial load timber properties:

Member Type: Multiple
Timber Grade = MSG8
Strength reduction factor, ϕ = 0.8
Load duration factor, k_1 = 0.8
Parallel support factor, k_4 = 1.20
Compressive strength, f_c = 18 MPa
Area, A = 12600 mm2

Depth, d = 140 mm
Width, b = 90 mm
Spacing, s = 450 mm

Slenderness coefficient, S = 50
Stability factor, k_8 = 0.12

$\Phi N_c = \Phi k_1 k_4 k_8 f_c A$
ΦN_c = 20.9 kN

N* = 0.7 kN OK!

Moment timber properties:

Member Type: Multiple
Timber Grade = MSG8
Strength reduction factor, ϕ = 0.8
Load duration factor, k_1 = 1.0
Parallel support factor, k_4 = 1.20
Stability factor, k_8 = 1.00
Bending strength, f_b = 14 MPa
Effective section moduli, Z = 294 mm3

$\Phi M_b = \Phi k_1 k_4 k_8 f_b Z$
ΦM_b = 3.95 kNm   M* = 0.74 kN   OK!

Combined check:

ΦM_b = 3.95 kNm   M* = 0.74 kN
ΦN_c = 20.9 kN   N* = 0.4 kN

$$\frac{M^*}{\Phi M_b} + \frac{N^*}{\Phi N_c} = 0.20 < 1.00 \quad \text{OK!}$$

SERVICABILITY LIMIT STATE DESIGN:

limit **deflection** to $\frac{\text{span}}{180}$ = 15.0 mm $\Delta = \frac{5 w \ell^4}{384 EI}$

MATERIAL PROPERTIES:

Timber member properties:

Distributed wind load, w = 0.09 kN/m
Modulus of elasticity, E = 9130 MPa
Second moment of inertia, I = 20.58 mm4

Theoretical wind load deflection, Δ = 11.9 mm   OK!

Use 2/140 x 45 MSG8 @ 450 mm

UNIFORMLY DISTRIBUTED LOADS (SIMPLY SUPPORTED):

Dead Loads, G:

roof:	0.15 kPa x	3.0 m =	0.5 kN/m
floor:	0.50 kPa x	0.0 m =	0.0 kN/m
internal walls:	0.35 kPa x	0.0 m =	0.0 kN/m
external walls:	2.30 kPa x	0.0 m =	0.0 kN/m

G = 0.5 kN/m

Live Loads, Q:

roof:	0.25 kPa x	3.0 m =	0.8 kN/m
external floor:	2.00 kPa x	0.0 m =	0.0 kN/m
internal floor:	1.50 kPa x	0.0 m =	0.0 kN/m

Q = 0.8 kN/m

WIND PRESSURE:

$p_z =$ 1.00 kPa

$C_{pe} \times C_{pi} = 0.5$

$W_u = 0.50$ KPa

$W_s = 0.34$ KPa

LOAD COMBINATIONS:

SLS = Serviceability Limit State
ULS = Ulitmate Limit State

ULS Distributed Loads:

$1.35G = 0.6$ kN/m

$1.2G + 1.5Q = 1.7$ kN/m

$1.2G + W_u + \Psi_c Q = 0.8$ kN/m

$\Psi_c = 0.4$

DESIGN ACTIONS:

design **moment (ULS):** $M^* = \frac{w h^2}{8}$

$M^* = 2.72$ kNm/m

design **axial load (ULS):** $N^* = 1.7$ kN/m

MATERIAL PROPERTIES: Try = 140 x 90 MSG8 at 450mm centres

h = Stud Height
h = **6600 mm**

Axial load timber properties:

Member Type: Multiple
Timber Grade = MSG8
Strength reduction factor, $\phi = 0.8$
Load duration factor, $k_1 = 0.8$
Parallel support factor, $k_4 = 1.20$
Compressive strength, $f_c = 18$ MPa
Area, A = 12600 mm2

Depth, d = 140 mm
Width, b = 90 mm
Spacing, s = 450 mm

Slenderness coefficient, S = 50
Stability factor, $k_8 = 0.12$

$\Phi N_c = \Phi k_1 k_4 k_8 f_c A$

$\Phi N_c = 20.9$ kN

$N^* = 0.7$ kN OK!

Moment timber properties:

Member Type: Multiple
Timber Grade = MSG8
Strength reduction factor, ϕ = 0.8
Load duration factor, k_1 = 1.0
Parallel support factor, k_4 = 1.20
Stability factor, k_8 = 1.00
Bending strength, f_b = 14 MPa
Effective section moduli, Z = 294 mm3

$\Phi M_b = \Phi k_1 k_4 k_8 f_b Z$
ΦM_b = 3.95 kNm   M* = 1.23 kN   OK!

Combined check:

ΦM_b = 3.95 kNm   M* = 1.23 kN
ΦN_c = 20.9 kN   N* = 0.4 kN

$$\frac{M^*}{\Phi M_b} + \frac{N^*}{\Phi N_c} = 0.33 < 1.00$$ OK!

Use 2/140 x 45 MSG8 @ 450 mm

CANTILEVER UNIFORMLY DISTRIBUTED LOADS:

Dead Loads, G:

roof:	0.45 kPa x	0.0 m =	0.0 kN/m
floor:	0.50 kPa x	0.0 m =	0.0 kN/m
internal walls:	0.35 kPa x	0.0 m =	0.0 kN/m
external walls:	0.50 kPa x	0.4 m =	0.0 kN/m
	self weight (member) =		0.00 kN/m

G = 0.0 kN/m

ρ_u = 1.00 kPa
C_{fig} = 1.20
W_u = ρ_u x C_{fig} x 0.0 m

W_u = -0.5 kN/m

Live Loads, Q:

roof:	0.25 kPa x	0.0 m =	0.0 kN/m
external floor:	2.00 kPa x	0.0 m =	0.0 kN/m
Internal floor:	1.50 kPa x	0.0 m =	0.0 kN/m

Q = 0.0 kN/m

ρ_s = 0.67 kPa
W_s = W_u x ρ_s / ρ_u

W_s = -0.3 kN/m

CANTILEVER POINT LOADS:

G = 0.0 kN

Q = 0.0 kN

W_u = 0.0 kN

W_s = 0.0 kN

BACKSPAN UNIFORMLY DISTRIBUTED LOADS:

Dead Loads, G:

roof:	0.45 kPa x	0.0 m =	0.0 kN/m
floor:	0.50 kPa x	0.0 m =	0.0 kN/m
internal walls:	0.35 kPa x	0.0 m =	0.0 kN/m
external walls:	0.50 kPa x	0.4 m =	0.0 kN/m
	self weight (member) =		0.00 kN/m

G = 0.0 kN/m

ρ_u = 1.00 kPa
uplift C_{fig} = 1.20
W_u = ρ_u x C_{fig} x 0.0 m

W_u = -0.5 kN/m

Live Loads, Q:

roof:	0.25 kPa x	0.0 m =	0.0 kN/m
external floor:	2.00 kPa x	0.0 m =	0.0 kN/m
internal floor:	1.50 kPa x	0.0 m =	0.0 kN/m

Q = 0.0 kN/m

ρ_s = 0.67 kPa
W_s = W_u x ρ_s / ρ_u

W_s = -0.3 kN/m

CANTILEVER LOAD COMBINATIONS:

SLS = Serviceability Limit State
ULS = Ulitmate Limit State

ULS Distributed Loads:		**Point Loads:**
1.35G = 0.0 kN/m		0.0 kN
1.2G + 1.5Q = 0.0 kN/m		0.0 kN
0.9G + W_u = -0.5 kN/m		0.0 kN

Maximum ULS Distributed Load
w = 0.0 kN/m

SLS Distributed Loads:

G + ψ_sQ = 0.0 kN/m	(Steel)	0.0 kN
k_2G + ψ_sQ = 0.0 kN/m	(Timber)	0.0 kN
G + Q + W_s = -0.3 kN/m		0.0 kN
	(where Q = 0.0 kN/m)	

Load duration factor (short term), ψ_s = 1.0
Duration of Load factor, k_2 = 1.0
(moisture content < 18%)

Working Stress Loads:

G + Q = 0.0 kN/m	0.0 kN
G + W_s = -0.3 kN/m	0.0 kN

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CONSULTING ENGINEERS

JOB:	Three Blokes Ltd		
SUBJECT:	Grid line M parapet wall design		
BY: Paul W	WALL: 2	DATE: Nov 2017	JOB NO: 20145

ULTIMATE LIMIT STATE DESIGN:

design **moment (ULS):** $M_{cant}^* = \dfrac{w\,l^2}{2} + P l_p$

$M_{back}^* = \dfrac{w\,l_b^{\,2}}{8} - \dfrac{M_{cant}^*}{2}$

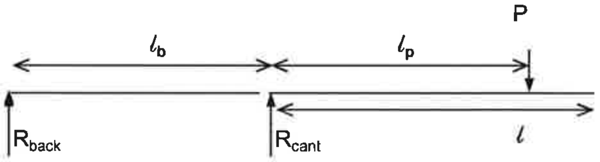
l = Cantilever

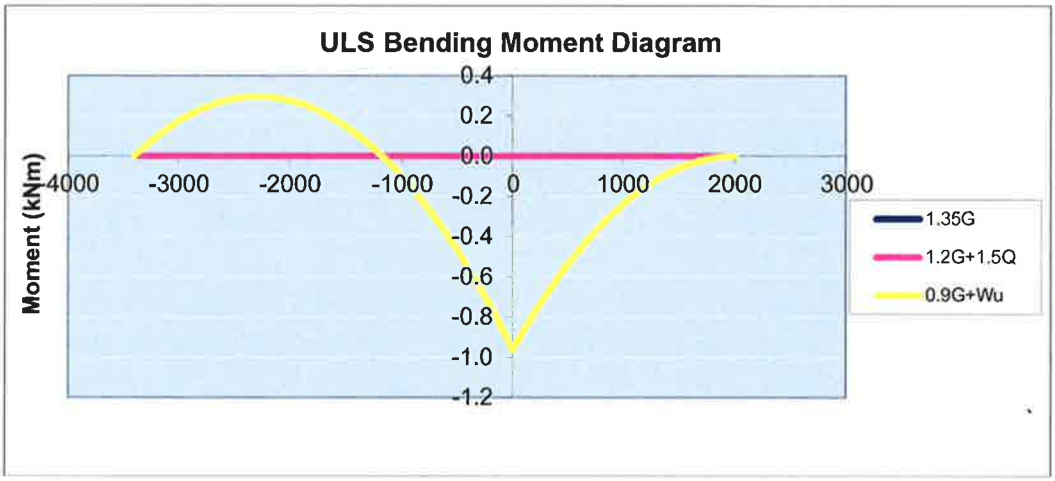
l = **2000 mm**

l_p = **2000 mm**

$M^* =$ 1.0 kNm $< \Phi M_n$

backspan, l_b = **3400 mm**





MATERIAL PROPERTIES:

Timber member properties:

Member Type: Multiple
Timber Grade = SG8
Strength reduction factor, ϕ = 0.8
Load duration factor, k_1 = 0.6
Parallel support factor, k_4 = 1.20
Stability factor, k_8 = 1.00
Bending strength, f_b = 14 MPa

Strength reduction factor, ϕ = 0.9
Yield strength, f_y = 300 MPa

For Timber:

$F_b = \Phi k_1 k_4 k_8 f_b$

F_b = 8.1 MPa

For Steel:

$F_b = \Phi f_y$

F_b = 270 MPa

effective section moduli:

$M^* = \Phi M_n$

$\Phi M_n = F_b Z$

$Z_{req} \geq \dfrac{M^*}{F_b}$

$Z_{req} \geq$ **119.0** $\times 10^3\ mm^3$

$Z_{req} \geq$ **3.6** $\times 10^3\ mm^3$

Try:	140x45 SG8 @ 400mm CRS

$Z_{(Actual)} =$ 147.0 $\times 10^3\ mm^3$

Hutchinson CONSULTING ENGINEERS	JOB: Three Blokes Ltd		
	SUBJECT: Grid line M parapet wall design		
BY: Paul W	WALL: 2	DATE: Nov 2017	JOB NO: 20145

SERVICABILITY LIMIT STATE DESIGN:

$$\Delta = \frac{w\,\ell^4}{8\,EI} + \frac{P\,\ell_p^{\,3}}{3\,EI} + \text{rotation}$$

limit **cantilever deflection** to $\frac{\text{span}}{150}$ = 13 mm & **cantilever wind deflection** to $\frac{\text{span}}{150}$ = 13 mm

limit **backspan deflection** to $\frac{\text{span}}{300}$ = 11 mm

MATERIAL PROPERTIES:

Timber member properties:

Distributed dead load, w = 0.0 kN/m
Distributed dead and live load, w = 0.0 kN/m
Distributed dead and wind load, w = -0.3 kN/m
Point load dead load, P = 0.0 kN
Point load dead and live load, P = 0.0 kN
Point load dead and wind load, P = 0.0 kN

Modulus of elasticity, E = 8000 MPa

total timber $I_{req} \geq$ 9.8 x 10^6 mm^4
(WIND GOVERNS)
cantilever $I_{req} \geq$ 6.0 x 10^6 mm^4
rotation $I_{req} \geq$ 3.8 x 10^6 mm^4

Steel member properties:

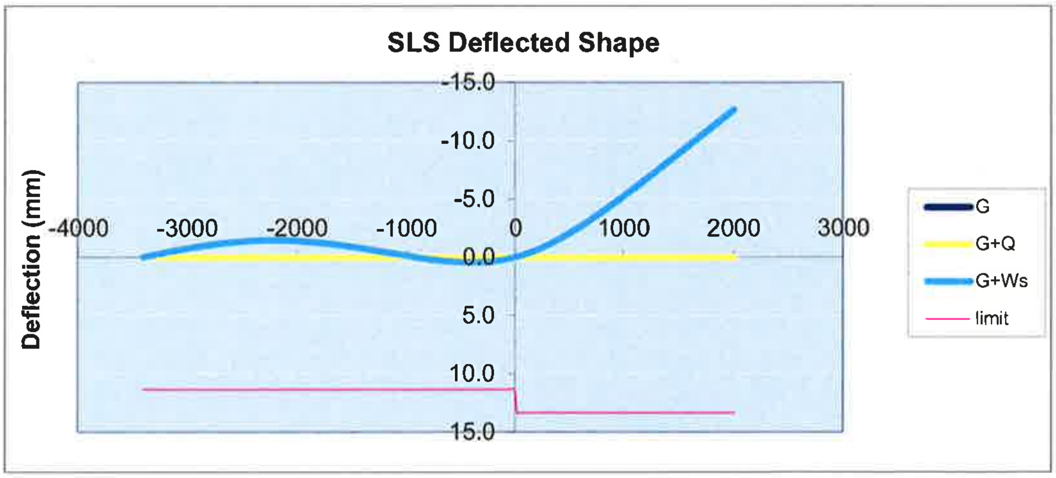
Distributed dead load, w = 0.0 kN/m
Distributed dead and live load, w = 0.0 kN/m
Distributed dead and wind load, w = -0.3 kN/m
Point load dead load, P = 0.0 kN
Point load dead and live load, P = 0.0 kN
Point load dead and wind load, P = 0.0 kN

Modulus of Elasticity, E = 200 GPa

total steel $I_{req} \geq$ 0.0 x 10^6 mm^4
(WIND GOVERNS)
cantilever $I_{req} \geq$ 0.2 x 10^6 mm^4
rotation $I_{req} \geq$ 0.2 x 10^6 mm^4

Try:	140x45 SG8 @ 400mm CRS

$I_{(Actual)}$ = 10.3 x 10^6 mm^4



2 DESIGN SUMMARY:

Moment capacity, ϕM = 1.2 kNm	OK!	
Theoretical dead load deflection, Δ = 0.0 mm	OK!	
Theoretical dead and live load deflection, Δ = 0.0 mm	OK!	
Theoretical dead and wind load deflection, Δ = -12.7 mm	OK!	-0.006 mm ℓ
Backspan dead load deflection, Δ = 0.0 mm	<SPAN/300 - OK!	
Backspan dead and live load deflection, Δ = 0.0 mm	<SPAN/300 - OK!	
Backspan dead and wind load deflection, Δ = -1.1 mm	<SPAN/150 - OK!	

Use 140x45 SG8 @ 400mm CRS

SUPPORT REACTIONS:

Cantilever Support	***Backspan Support***
1.35G = 0.0 kN	1.35G = 0.0 kN
1.2G + 1.5Q = 0.0 kN	1.2G + 1.5Q = 0.0 kN
0.9G + W_u = -2.1 kN	0.9G + W_u = -0.5 kN
G + ψ_sQ = 0.0 kN	G + ψ_sQ = 0.0 kN
k_2G + ψ_sQ = 0.0 kN	k_2G + ψ_sQ = 0.0 kN
G + Q + W_s = -1.4 kN	G + Q + W_s = -0.4 kN
G + Q = 0.0 kN	G + Q = 0.0 kN

CANTILEVER UNIFORMLY DISTRIBUTED LOADS:

Dead Loads, G:

roof: 0.45 kPa x 0.0 m = 0.0 kN/m
floor: 0.50 kPa x 0.0 m = 0.0 kN/m
internal walls: 0.35 kPa x 0.0 m = 0.0 kN/m
external walls: 0.50 kPa x 0.4 m = 0.0 kN/m
self weight (member) = 0.00 kN/m

G = 0.0 kN/m

ρ_u = 1.00 kPa
C_{fig} = 1.20
W_u = ρ_u x C_{fig} x 0.0 m

W_u = -0.5 kN/m

Live Loads, Q:

roof: 0.25 kPa x 0.0 m = 0.0 kN/m
external floor: 2.00 kPa x 0.0 m = 0.0 kN/m
Internal floor: 1.50 kPa x 0.0 m = 0.0 kN/m

Q = 0.0 kN/m

ρ_s = 0.67 kPa
W_s = W_u x ρ_s / ρ_u

W_s = -0.3 kN/m

CANTILEVER POINT LOADS:

G = 0.0 kN **Q = 0.0 kN**

W_u = 0.0 kN **W_s = 0.0 kN**

BACKSPAN UNIFORMLY DISTRIBUTED LOADS:

Dead Loads, G:

roof: 0.45 kPa x 0.0 m = 0.0 kN/m
floor: 0.50 kPa x 0.0 m = 0.0 kN/m
internal walls: 0.35 kPa x 0.0 m = 0.0 kN/m
external walls: 0.50 kPa x 0.4 m = 0.0 kN/m
self weight (member) = 0.00 kN/m

G = 0.0 kN/m

ρ_u = 1.00 kPa
uplift C_{fig} = 1.20
W_u = ρ_u x C_{fig} x 0.0 m

W_u = -0.5 kN/m

Live Loads, Q:

roof: 0.25 kPa x 0.0 m = 0.0 kN/m
external floor: 2.00 kPa x 0.0 m = 0.0 kN/m
internal floor: 1.50 kPa x 0.0 m = 0.0 kN/m

Q = 0.0 kN/m

ρ_s = 0.67 kPa
W_s = W_u x ρ_s / ρ_u

W_s = -0.3 kN/m

CANTILEVER LOAD COMBINATIONS:

SLS = Serviceability Limit State
ULS = Ulitmate Limit State

ULS Distributed Loads:	**Point Loads:**
1.35G = 0.0 kN/m	0.0 kN
1.2G + 1.5Q = 0.0 kN/m	0.0 kN
0.9G + W_u = -0.5 kN/m	0.0 kN

Maximum ULS Distributed Load
w = 0.0 kN/m

SLS Distributed Loads:

G + ψ_sQ = 0.0 kN/m	(Steel)	0.0 kN
k_2G + ψ_sQ = 0.0 kN/m	(Timber)	0.0 kN
G + Q + W_s = -0.3 kN/m		0.0 kN
	(where Q = 0.0 kN/m)	

Load duration factor (short term), ψ_s = 1.0
Duration of Load factor, k_2 = 1.0
(moisture content < 18%)

Working Stress Loads:

G + Q = 0.0 kN/m	0.0 kN
G + W_s = -0.3 kN/m	0.0 kN

ULTIMATE LIMIT STATE DESIGN:

design **moment (ULS):**

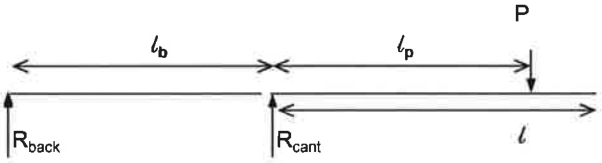
$$M_{cant}^* = \frac{w\ell^2}{2} + P\ell_p$$

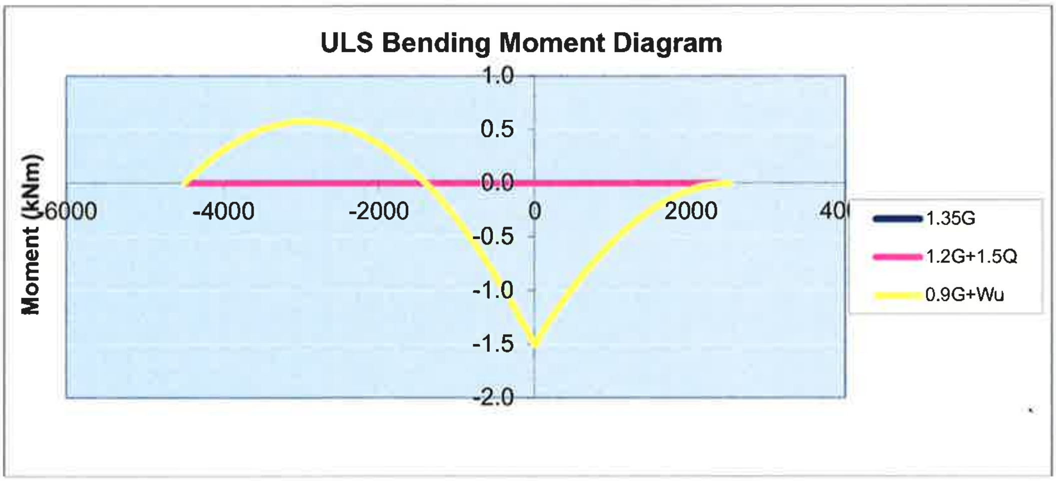
$$M_{back}^* = \frac{w\ell_b^2}{8} - \frac{M_{cant}^*}{2}$$

ℓ = Cantilever
ℓ = **2500 mm**
ℓ_p = **2500 mm**

M^* = 1.5 kNm < ΦM_n

backspan, ℓ_b = **4500 mm**





MATERIAL PROPERTIES:

Timber member properties:

Member Type: Single
Timber Grade = Hyspan
Strength reduction factor, ϕ = 0.8
Load duration factor, k_1 = 0.6
Parallel support factor, k_4 = 1.00
Stability factor, k_8 = 1.00
Bending strength, f_b = 48 MPa

Strength reduction factor, ϕ = 0.9
Yield strength, f_y = 300 MPa

For Timber:

$F_b = \Phi k_1 k_4 k_8 f_b$

F_b = 23.0 MPa

For Steel:

$F_b = \Phi f_y$

F_b = 270 MPa

effective section moduli:

$M^* = \Phi M_n$

$\Phi M_n = F_b Z$

$$Z_{req} \geq \frac{M^*}{F_b}$$

$Z_{req} \geq$ **65.1** x 10^3 mm^3

$Z_{req} \geq$ **5.6** x 10^3 mm^3

Try:	140x45 HYSPAN @ 400mm CRS

$Z_{(Actual)}$ = 147.0 x 10^3 mm^3

Hutchinson CONSULTING ENGINEERS	JOB: Three Blokes Ltd			
	SUBJECT: Grid line A parapet wall design			
	BY: Paul W	WALL: 3	DATE: Nov 2017	JOB NO: 20145

SERVICABILITY LIMIT STATE DESIGN:

$$\Delta = \frac{w \ell^4}{8EI} + \frac{P \ell_p^3}{3EI} + \text{rotation}$$

limit **cantilever deflection** to $\frac{\text{span}}{150}$ = 17 mm & **cantilever wind deflection** to $\frac{\text{span}}{150}$ = 17 mm

limit **backspan deflection** to $\frac{\text{span}}{300}$ = 15 mm

MATERIAL PROPERTIES:

Timber member properties:

Distributed dead load, w = 0.0 kN/m
Distributed dead and live load, w = 0.0 kN/m
Distributed dead and wind load, w = -0.3 kN/m
Point load dead load, P = 0.0 kN
Point load dead and live load, P = 0.0 kN
Point load dead and wind load, P = 0.0 kN

Modulus of elasticity, E = 13200 MPa

total timber $I_{req} \geq$ 10.3 $\times 10^6$ mm^4
(WIND GOVERNS)
cantilever $I_{req} \geq$ 7.1 $\times 10^6$ mm^4
rotation $I_{req} \geq$ 3.2 $\times 10^6$ mm^4

Steel member properties:

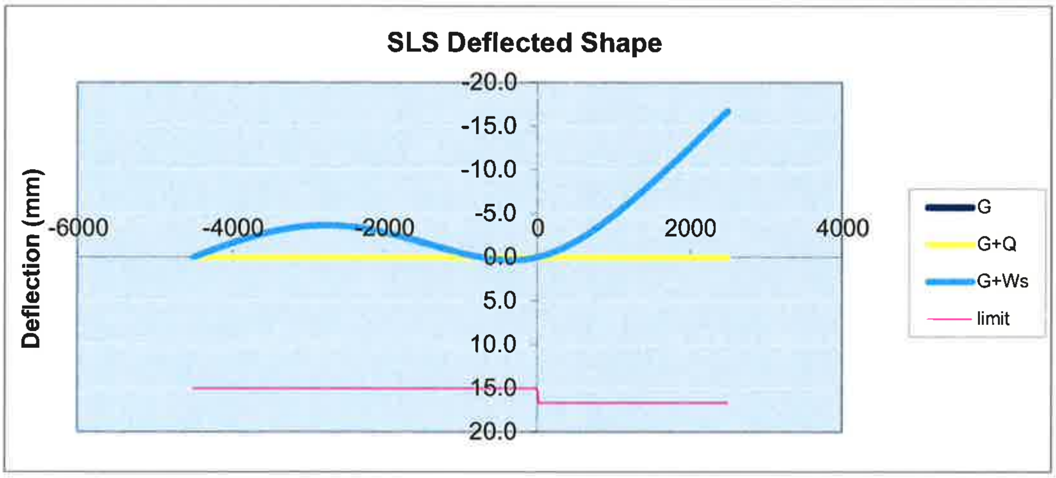
Distributed dead load, w = 0.0 kN/m
Distributed dead and live load, w = 0.0 kN/m
Distributed dead and wind load, w = -0.3 kN/m
Point load dead load, P = 0.0 kN
Point load dead and live load, P = 0.0 kN
Point load dead and wind load, P = 0.0 kN

Modulus of Elasticity, E = 200 GPa

total steel $I_{req} \geq$ 0.0 $\times 10^6$ mm^4
(WIND GOVERNS)
cantilever $I_{req} \geq$ 0.5 $\times 10^6$ mm^4
rotation $I_{req} \geq$ 0.2 $\times 10^6$ mm^4

Try: 140x45 HYSPAN @ 400mm CRS

$I_{(Actual)}$ = 10.3 $\times 10^6$ mm^4



Hutchinson CONSULTING ENGINEERS	JOB: Three Blokes Ltd			
	SUBJECT: Grid line A parapet wall design			
	BY: Paul W	WALL: 3	DATE: Nov 2017	JOB NO: 20145

3 DESIGN SUMMARY:

Moment capacity, ϕM = 3.4 kNm	OK!	
Theoretical dead load deflection, Δ = 0.0 mm	OK!	
Theoretical dead and live load deflection, Δ = 0.0 mm	OK!	
Theoretical dead and wind load deflection, Δ = -16.7 mm	FAIL!	-0.007 mm *l*
Backspan dead load deflection, Δ = 0.0 mm	<SPAN/300 - OK!	
Backspan dead and live load deflection, Δ = 0.0 mm	<SPAN/300 - OK!	
Backspan dead and wind load deflection, Δ = -3.3 mm	<SPAN/150 - OK!	

Use 140x45 HYSPAN @ 400mm CRS

SUPPORT REACTIONS:

Cantilever Support	***Backspan Support***
$1.35G$ = 0.0 kN	$1.35G$ = 0.0 kN
$1.2G + 1.5Q$ = 0.0 kN	$1.2G + 1.5Q$ = 0.0 kN
$0.9G + W_u$ = -2.6 kN	$0.9G + W_u$ = -0.7 kN
$G + \psi_s Q$ = 0.0 kN	$G + \psi_s Q$ = 0.0 kN
$k_2 G + \psi_s Q$ = 0.0 kN	$k_2 G + \psi_s Q$ = 0.0 kN
$G + Q + W_s$ = -1.7 kN	$G + Q + W_s$ = -0.5 kN
$G + Q$ = 0.0 kN	$G + Q$ = 0.0 kN

CANTILEVER UNIFORMLY DISTRIBUTED LOADS:

Dead Loads, G:

roof: 0.45 kPa x 0.0 m = 0.0 kN/m
floor: 0.50 kPa x 0.0 m = 0.0 kN/m
internal walls: 0.35 kPa x 0.0 m = 0.0 kN/m
external walls: 0.50 kPa x 0.7 m = 0.0 kN/m
self weight (member) = 0.00 kN/m

G = 0.0 kN/m

ρ_u = 1.00 kPa
C_{fig} = 1.20
$W_u = \rho_u \times C_{fig} \times$ 0.0 m

W_u = -0.8 kN/m

Live Loads, Q:

roof: 0.25 kPa x 0.0 m = 0.0 kN/m
external floor: 2.00 kPa x 0.0 m = 0.0 kN/m
Internal floor: 1.50 kPa x 0.0 m = 0.0 kN/m

Q = 0.0 kN/m

ρ_s = 0.67 kPa
$W_s = W_u \times \rho_s / \rho_u$

W_s = -0.5 kN/m

CANTILEVER POINT LOADS:

G = 0.0 kN

W_u = 0.0 kN

Q = 0.0 kN

W_s = 0.0 kN

BACKSPAN UNIFORMLY DISTRIBUTED LOADS:

Dead Loads, G:

roof: 0.45 kPa x 0.0 m = 0.0 kN/m
floor: 0.50 kPa x 0.0 m = 0.0 kN/m
internal walls: 0.35 kPa x 0.0 m = 0.0 kN/m
external walls: 0.50 kPa x 0.7 m = 0.0 kN/m
self weight (member) = 0.00 kN/m

G = 0.0 kN/m

ρ_u = 1.00 kPa
uplift C_{fig} = 1.20
$W_u = \rho_u \times C_{fig} \times$ 0.0 m

W_u = -0.8 kN/m

Live Loads, Q:

roof: 0.25 kPa x 0.0 m = 0.0 kN/m
external floor: 2.00 kPa x 0.0 m = 0.0 kN/m
internal floor: 1.50 kPa x 0.0 m = 0.0 kN/m

Q = 0.0 kN/m

ρ_s = 0.67 kPa
$W_s = W_u \times \rho_s / \rho_u$

W_s = -0.5 kN/m

CANTILEVER LOAD COMBINATIONS:

SLS = Serviceability Limit State
ULS = Ulitmate Limit State

ULS Distributed Loads:		**Point Loads:**
1.35G = 0.0 kN/m		0.0 kN
1.2G + 1.5Q = 0.0 kN/m		0.0 kN
0.9G + W_u = -0.8 kN/m		0.0 kN

Maximum ULS Distributed Load
w = 0.0 kN/m

SLS Distributed Loads:

G + ψ_sQ = 0.0 kN/m	(Steel)	0.0 kN
k_2G + ψ_sQ = 0.0 kN/m	(Timber)	0.0 kN
G + Q + W_s = -0.5 kN/m		0.0 kN
	(where Q = 0.0 kN/m)	

Load duration factor (short term), ψ_s = 1.0
Duration of Load factor, k_2 = 1.0
(moisture content < 18%)

Working Stress Loads:

G + Q = 0.0 kN/m	0.0 kN
G + W_s = -0.5 kN/m	0.0 kN

Hutchinson CONSULTING ENGINEERS	JOB: Three Blokes Ltd			
	SUBJECT: Grid line A parapet wall design			
	BY: Paul W	WALL: 4 (DS)	DATE: Nov 2017	JOB NO: 20145

ULTIMATE LIMIT STATE DESIGN:

design **moment (ULS):**

$$M_{cant}^* = \frac{w\ell^2}{2} + P\ell_p$$

$$M_{back}^* = \frac{w\ell_b^2}{8} - \frac{M_{cant}^*}{2}$$

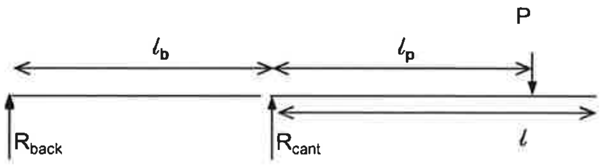
ℓ = Cantilever

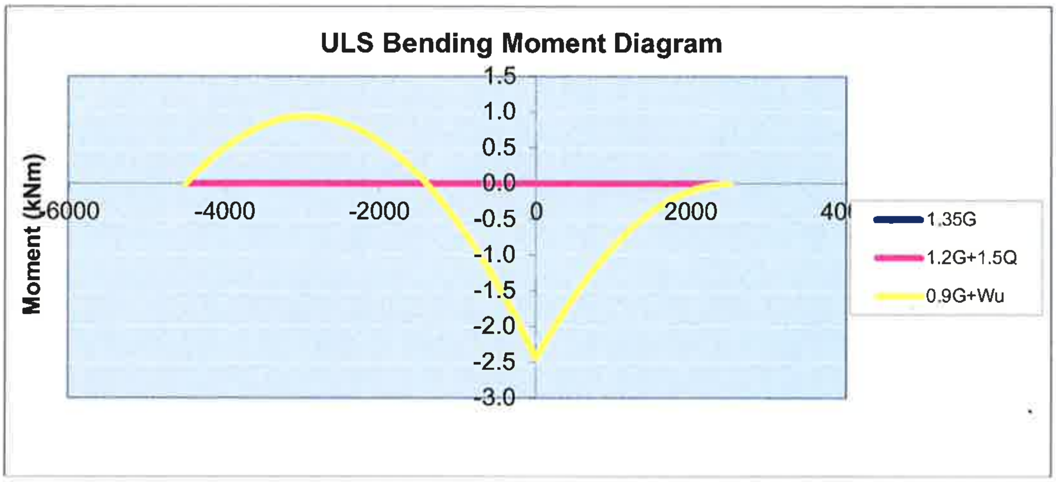
ℓ = 2500 mm

ℓ_p = 2500 mm

M^* = 2.4 kNm $< \Phi M_n$

backspan, ℓ_b = 4500 mm





MATERIAL PROPERTIES:

Timber member properties:

Member Type: Single
Timber Grade = Hyspan
Strength reduction factor, ϕ = 0.8
Load duration factor, k_1 = 0.6
Parallel support factor, k_4 = 1.00
Stability factor, k_8 = 1.00
Bending strength, f_b = 48 MPa

Strength reduction factor, ϕ = 0.9
Yield strength, f_y = 300 MPa

For Timber:

$F_b = \Phi k_1 k_4 k_8 f_b$

F_b = 23.0 MPa

For Steel:

$F_b = \Phi f_y$

F_b = 270 MPa

effective section moduli:

$$M^* = \Phi M_n$$
$$\Phi M_n = F_b Z$$
$$Z_{req} \geq \frac{M^*}{F_b}$$

$Z_{req} \geq$ **105.8** $\times 10^3\ mm^3$

$Z_{req} \geq$ **9.0** $\times 10^3\ mm^3$

Try:	2/140x45 HYSPAN

$Z_{(Actual)}$ = 294.0 $\times 10^3\ mm^3$

Hutchinson CONSULTING ENGINEERS	JOB: Three Blokes Ltd			
	SUBJECT: Grid line A parapet wall design			
	BY: Paul W	WALL: 4 (DS)	DATE: Nov 2017	JOB NO: 20145

SERVICABILITY LIMIT STATE DESIGN:

$$\Delta = \frac{w\,\ell^4}{8\,EI} + \frac{P\,\ell_p^3}{3\,EI} + \text{rotation}$$

limit **cantilever deflection** to $\frac{\text{span}}{150}$ = 17 mm & **cantilever wind deflection** to $\frac{\text{span}}{150}$ = 17 mm

limit **backspan deflection** to $\frac{\text{span}}{300}$ = 15 mm

MATERIAL PROPERTIES:

Timber member properties:

Distributed dead load, w = 0.0 kN/m
Distributed dead and live load, w = 0.0 kN/m
Distributed dead and wind load, w = -0.5 kN/m
Point load dead load, P = 0.0 kN
Point load dead and live load, P = 0.0 kN
Point load dead and wind load, P = 0.0 kN

Modulus of elasticity, E = 13200 MPa

total timber $I_{req} \geq$ 16.8 $\times 10^6$ mm^4
(WIND GOVERNS)
cantilever $I_{req} \geq$ 11.5 $\times 10^6$ mm^4
rotation $I_{req} \geq$ 5.3 $\times 10^6$ mm^4

Steel member properties:

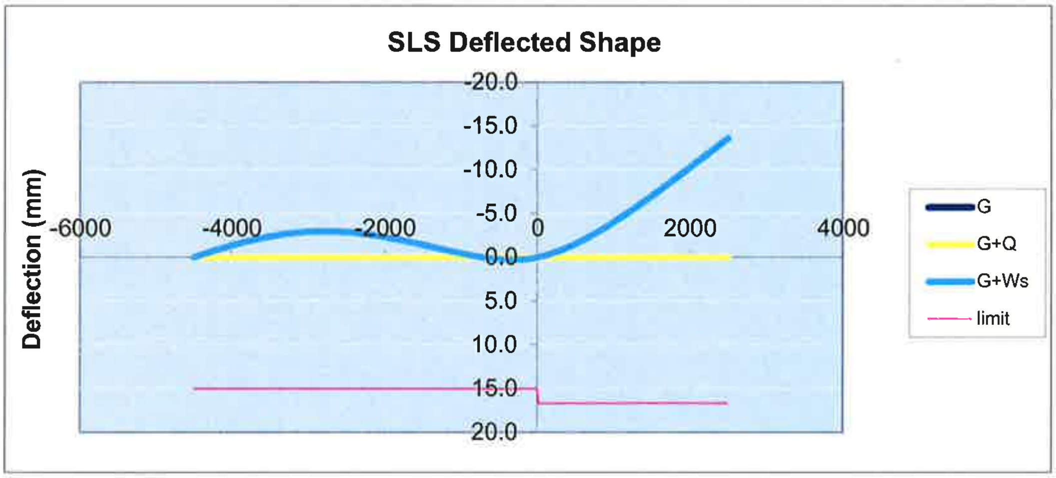
Distributed dead load, w = 0.0 kN/m
Distributed dead and live load, w = 0.0 kN/m
Distributed dead and wind load, w = -0.5 kN/m
Point load dead load, P = 0.0 kN
Point load dead and live load, P = 0.0 kN
Point load dead and wind load, P = 0.0 kN

Modulus of Elasticity, E = 200 GPa

total steel $I_{req} \geq$ 0.0 $\times 10^6$ mm^4
(WIND GOVERNS)
cantilever $I_{req} \geq$ 0.8 $\times 10^6$ mm^4
rotation $I_{req} \geq$ 0.3 $\times 10^6$ mm^4

Try:	2/140x45 HYSPAN

$I_{(Actual)}$ = 20.6 $\times 10^6$ mm^4



4 (DS) DESIGN SUMMARY:

Moment capacity, ϕM = 6.8 kNm	OK!	
Theoretical dead load deflection, Δ = 0.0 mm	OK!	
Theoretical dead and live load deflection, Δ = 0.0 mm	OK!	
Theoretical dead and wind load deflection, Δ = -13.6 mm	OK!	-0.005 mm l
Backspan dead load deflection, Δ = 0.0 mm	<SPAN/300 - OK!	
Backspan dead and live load deflection, Δ = 0.0 mm	<SPAN/300 - OK!	
Backspan dead and wind load deflection, Δ = -2.6 mm	<SPAN/150 - OK!	

Use 2/140x45 HYSPAN

SUPPORT REACTIONS:

Cantilever Support	***Backspan Support***
$1.35G$ = 0.0 kN	$1.35G$ = 0.0 kN
$1.2G + 1.5Q$ = 0.0 kN	$1.2G + 1.5Q$ = 0.0 kN
$0.9G + W_u$ = -4.2 kN	$0.9G + W_u$ = -1.2 kN
$G + \psi_s Q$ = 0.0 kN	$G + \psi_s Q$ = 0.0 kN
$k_2 G + \psi_s Q$ = 0.0 kN	$k_2 G + \psi_s Q$ = 0.0 kN
$G + Q + W_s$ = -2.8 kN	$G + Q + W_s$ = -0.8 kN
$G + Q$ = 0.0 kN	$G + Q$ = 0.0 kN

PILASTER & PORTAL FRAME ANCHOR DESIGN

hyFRAME HF0014 Reaction Summary: **23/11/2017**

Proposed Base Connection Design

Reactions

Load Case	k_1	Critical column reactions R_x kN	R_y kN	R_z kN
1.35g	0.57	2.59	11.21	0.00
1.2G+1.5Q	0.94	5.99	23.24	0.00
G+Eu	1.00	-6.52	12.98	0.00
0.9G+Wu (Lateral)	1.00	-13.52	-36.53	0.00
1.2G+Wu (Lateral)	1.00	-20.98	22.19	0.00
0.9G+Wu (Long)	1.00	8.41	-41.77	9.96
1.2G+Wu (Long)	1.00	2.72	34.59	9.96
0.9G+Wu (Long) - grids with RB16 bracing	1.00	8.41	-52.79	22.64
1.2G+Wu (Long) - grids with RB16 bracing	1.00	2.72	34.59	22.64

(-ve = uplift)

Proposed Mullion Connection Design, End wall

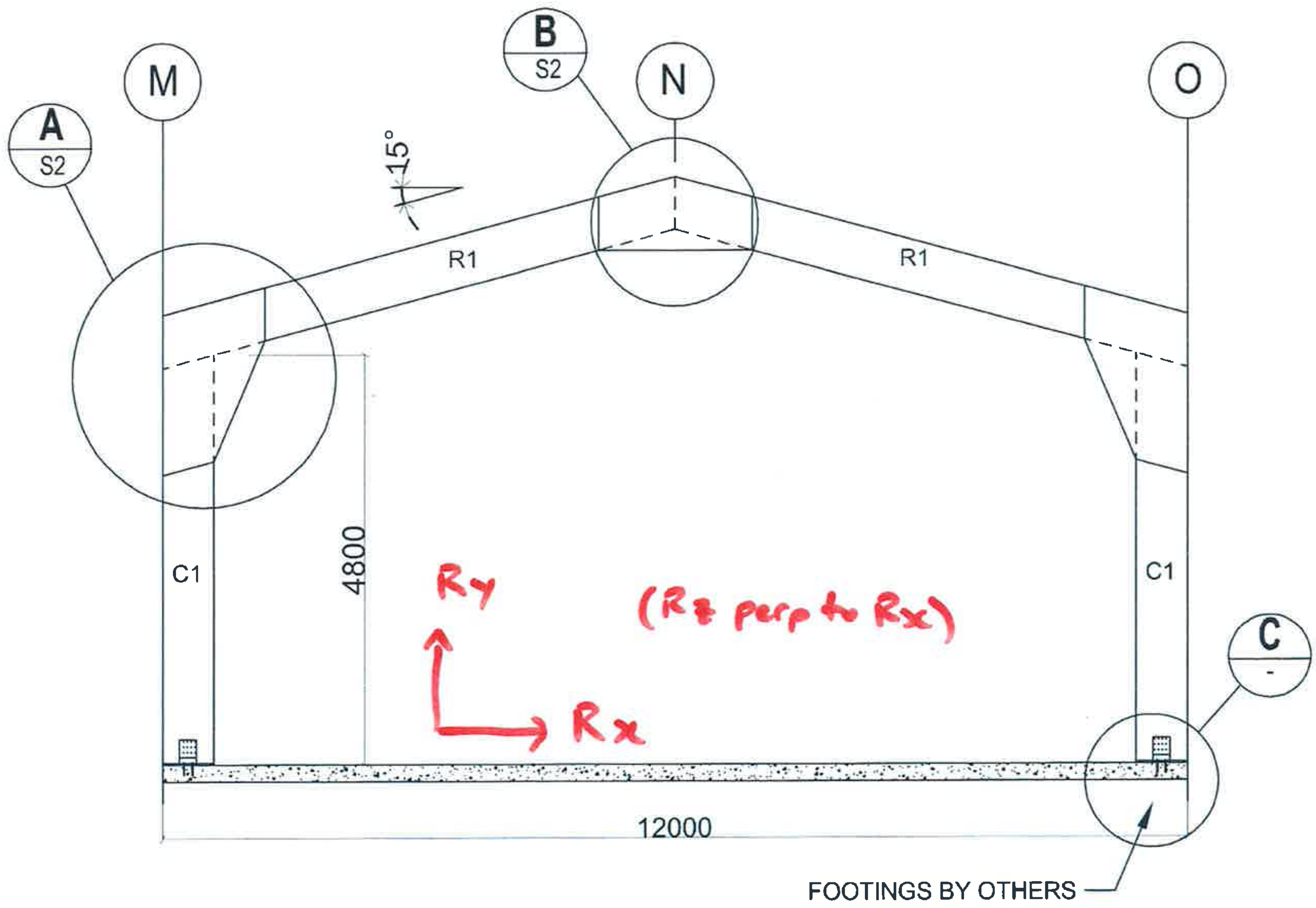
Reactions

Load Case	k_1	Critical mullion reactions R_x kN	R_y kN	R_z kN
Wu (+ve)	1.00	0.00	0.00	25.00
Wu (-ve)	1.00	0.00	0.00	-25.00

REACTION DIRECTIONS:

2 of 3
23/11/17

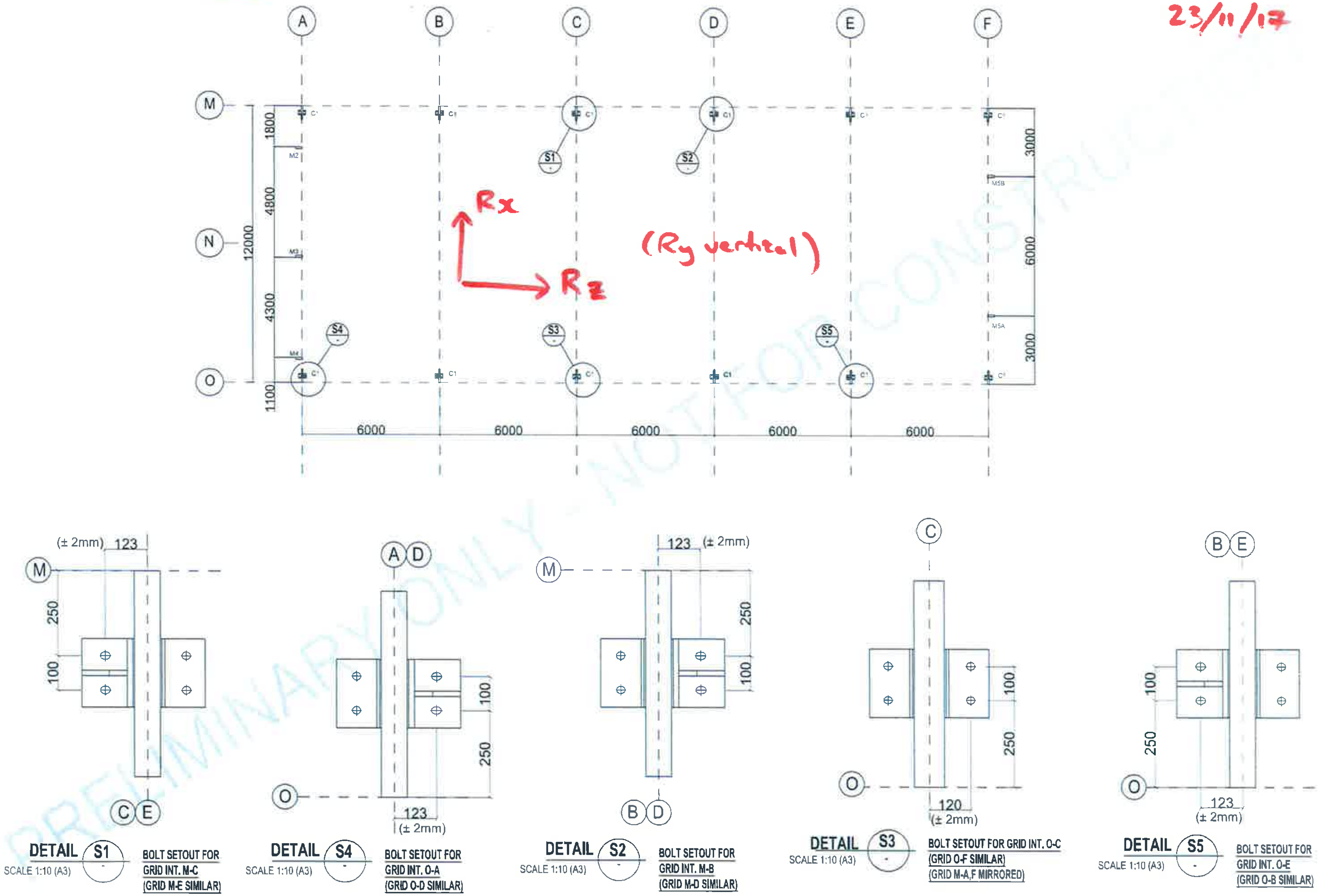
FIX C
24/14
SIDE



REACTION DIRECTIONS

3 of 3

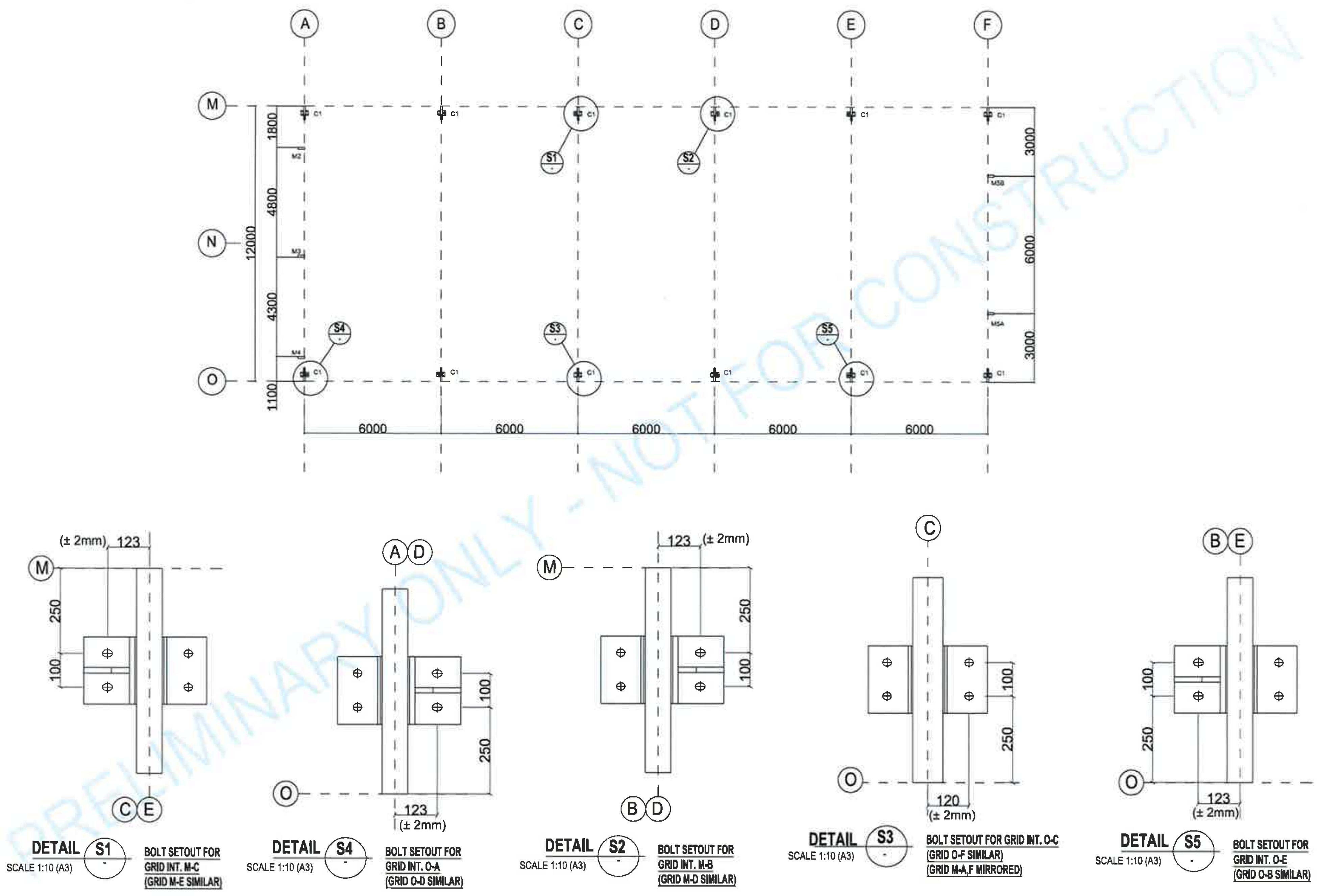
23/11/17



CarterHoltHarvey
Woodproducts New Zealand

hyFRAME

BASE BRACKET LAYOUT			
PROJECT: PROPOSED 12.0m x 4.8m x 30.0 hyFRAME BUILDING	DESIGNED: JVD	DATE:	23/11/2017
FOR: THREE BLOKES LTD	DRAWN: JRB	SCALE:	AS NOTED
AT: 362 MATAKANA VALLEY ROAD, MATAKANA	SHEET: S7 OF 7	JOB NO:	HF0014
	STRUCTURAL DRAWING	REVISION No. :	PRELIMINARY



CarterHoltHarvey Woodproducts New Zealand

hyFRAME

BASE BRACKET LAYOUT

PROJECT:	PROPOSED 12.0m x 4.8m x 30.0 hyFRAME BUILDING	DESIGNED:	JVD	DATE:	23/11/2017
FOR:	THREE BLOKES LTD	DRAWN:	JRB	SCALE:	AS NOTED
AT:	362 MATAKANA VALLEY ROAD, MATAKANA	SHEET:	S7 OF 7	JOB NO:	HF0014
		STRUCTURAL DRAWING		REVISION No. :	PRELIMINARY

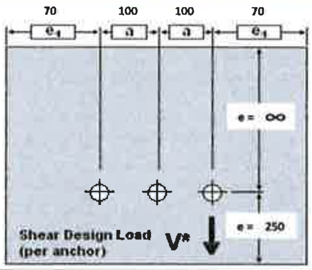
Chemical Anchoring - ChemSet Anchor Stud Design Calculator

European Technical Approval: ETA-13/0681

Ramset™ | Injection Sys: ChemSet™ 101 PLUS | Anchor Type: Anchor Stud - Gr 5.8 | Anchor Size d_b = M 16

Input Description (Strength Limit State Design)	Input Data (per anchor)		
1. Number of anchors (n)	n =	4	-
2. Anchor Spacing (a)	a =	100	mm
3. Concrete Edge Distance (e)	e =	250	mm
4. Concrete Cylinder Strength (f'c)	f'c =	25	MPa
5. Concrete Cube Strength (β)	β =	31	MPa
6. Effective Depth (h>6xdh)	h =	155	mm
7. Anchor Stud size (d_b) - M8 → M36	d_b =	16	mm
8. Concrete Edge Distance Corner (e1)	e_1 =	70	mm
9. Internal to a row (I) or end of row (E)	I or E	I	row
10. Dry Hole (D) or Wet hole (W)	D or W	W	-
11. Min Concrete Sub'te Thickness (b_m)	b_m =	194	mm
12. Anchor Stud Grade (5.8, 8.8, 316 SS)	Grade =	5.8	Gr
13. Fixture Thickness (t)	t =	10	mm
14. Effective Length (L_e)	L_e =	165	mm
15. Design Tensile Load-per anchor (N*)	N* =	15	kN
16. Design Shear Load-per anchor (V*)	V* =	5	kN
17. Direction of Shear design load (α)	α =	90	°
18. Service Temperature (˚C)	-40˚C to +80˚C		

Plan View - Generic (Dimensions in (mm))



Project Details

Project Name:-
Three Blokes Ltd
Project Site Address:-
Baseplate bolts
Company Name:-
Hutchinson
Design Identification:-
600x75
Date:-
4/12/2017

ChemSet™ Anchor Stud "Specification"

Part No. CS16190 or CS16190GH

ChemSet™ 101 PLUS "Specification"

C101J

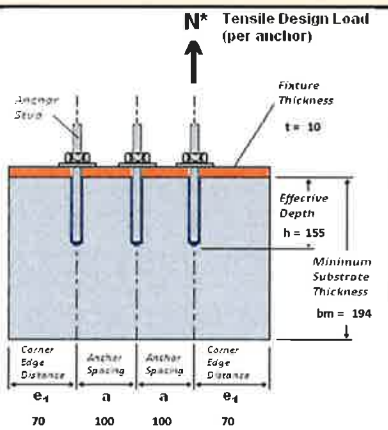
Hole Diameters (mm)	Capacity Reduction Factors
Drill d_h = 18	Conc. Tension/Shear ϕ = 0.6
Fixture d_f = 20	Steel Tension/Shear ϕ = 0.8

Direction of Shear Design Load - α

α = 0˚- towards edge
α = 180˚ - away from edge

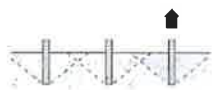
Output Description (Strength Limit State Design)	Output Data (per anchor)		
DESIGN O.K.	MIN. CRITERIA for a,e & h - O.K.		
Des. Red. Ult. CONC. Tensile Capacity	ϕN_{urc} =	25.9	kN
Red. Char. Ult. STEEL Tensile Capacity	ϕN_{us} =	64.7	kN
Des. Red. Ult. CONC. Shear Capacity	ϕV_{urc} =	30.9	kN
Red. Char. Ult. STEEL Shear Capacity	ϕV_{us} =	39.7	kN
Drill hole diameter	d_h =	18	mm
TENSION O.K.			
Design Red. Ult. Tensile Capacity	ϕN_{ur} =	25.9	kN
Tension Design Check	$N^*/\phi N_{ur}$ =	0.58	< 1
SHEAR O.K.			
Design Red. Ult. Shear Capacity	ϕV_{ur} =	30.9	kN
Shear Design Check	$V^*/\phi V_{ur}$ =	0.16	< 1
COMBINED TENSION SHEAR O.K.			
Combined Check - $N^*/\phi N_{ur} + V^*/\phi V_{ur}$ =		0.74	< 1.2

Elevation View - Generic (Dimensions in (mm))



Anchor Loaded

"E" *Anchor end of a row*



"I" *Anchor internal to a row*

Anchor Size	d_b	Metric	8	10	12	16	20	24	30	36
Drill hole diameter	d_h	(mm)	10	12	14	18	24	26	N/A	N/A
Stressed Area	A_n	(mm²)	33	53	79	154	232	337	N/A	N/A
Anchor Stud Yield Strength	f_y	(MPa)	430	430	430	420	420	420	N/A	N/A
Red.Char. Ult. Steel Tensile Capacity	ϕN_{us}	(kN)	14.3	22.7	33.8	64.7	97.6	141.3	N/A	N/A
Red.Char. Ult. Steel Shear capacity	ϕV_{us}	(kN)	8.9	14.1	21.0	39.7	59.9	86.8	N/A	N/A
Edge distance for no conc.cone reduction	e_c	(mm)	35	40	50	65	80	100	N/A	N/A
Anchor spacing for no conc.cone reduction	a_c	(mm)	50	60	75	100	120	145	N/A	N/A
Absolute Minimum edge dist. & anc'r spac.	e_m & a_m	(mm)	25	30	35	50	60	75	N/A	N/A

Effective Depth - h		Design Reduced Ultimate tensile capacity ϕN_{ur} (kN per anchor) Based on edge distance (e_c) and anchor spacing (a_c) for no conc.cone reduction							
60	(mm)	5.3							
65	(mm)	5.7							
70	(mm)	6.2	7.2						
80	(mm)	7.1	8.3						
90	(mm)	7.9	9.3	10.9					
100	(mm)	8.8	10.3	12.1					
110	(mm)	9.7	11.4	13.4	18.4				
125	(mm)	11.0	12.9	15.2	20.9				
140	(mm)	12.3	14.5	17.0	23.4				
150	(mm)	13.2	15.5	18.2	25.1	34.5			
160	(mm)	14.1	16.6	19.4	26.8	36.9	50.7		
170	(mm)	14.3	17.6	20.6	28.4	39.2	53.9		
180	(mm)	14.3	18.6	21.9	30.1	41.5	57.1		
190	(mm)	14.3	19.7	23.1	31.8	43.8	60.3	N/A	
220	(mm)	14.3	22.7	26.7	36.8	50.7	69.8	N/A	
240	(mm)	14.3	22.7	29.1	40.1	55.3	76.1	N/A	N/A
270	(mm)	14.3	22.7	32.8	45.2	62.2	85.6	N/A	N/A
330	(mm)	14.3	22.7	33.8	55.2	76.0	104.7	N/A	N/A
350	(mm)	14.3	22.7	33.8	58.5	80.6	111.0	N/A	N/A

The design engineer should ensure the structural element is capable of supporting these loads. Refer to Ramset™ Specifiers Anchoring Resource Book ANZ for more information or explanation of Tech Data.

M^* = 29.4 kNm V^* = 21.0 kN

MASONRY DESIGN

Try 20 series 390 mm wide by 590 mm deep lintel
with 2/H16 bottom bars   Steel reinforcement ratios exceeded

MASONRY PROPERTIES

Masonry Grade: B
Maximum design compressive strength, f'_m = 12 MPa
Area of reinforcement, A_s = 402.1 mm²
Reinforcement yeild strength, f_y = 500 MPa
Breadth of Masonry block, b = 390 mm
Depth to tension reinforcement, d = 495 mm
Strength reduction factor, ϕ = 0.85

MOMENT DESIGN

Depth of stress block, $a = \dfrac{A_s f_y}{0.85 f'_m b}$

= 50.5 mm

Ultimate Design Moment

$\phi M_u = \phi A_s f_y (d-a/2)$

= 80.3 kNm

$M^* < \phi M_u$ **O.K.**

SHEAR DESIGN

$V^* < \phi V_n$ $\phi =$ 0.75

where, V^* = the shear at the critical section, at a distance 'd' from support:
V^*_u = 21.0 kN

and, V_n = nominal shear strength of the wall
$V_n = \phi\, v_n\, b_w\, d$

total shear stress required, v_n = 0.14 MPa

$v_n = v_m + v_p + v_s$

where:
v_m = shear strength provided by the masonry
v_p = shear strength provided by axial load
v_s = shear strength provided by shear reinforcement

masonry grade	A	B	C
shear provided by masonry, v_m	0.70	0.70	0.30
maximum total shear, v_g (< v_n)	1.56	1.50	0.80

shear reinforcing required, v_s = $v_n - v_m$
v_s = 0.14 - 0.7
v_s = 0.00 MPa

Minimum Shear Area required, $A_v > v_s\, b_w\, s\, /\, f_y$
s = spacing between shear reinforcement
max spacing of stirrups = 0.5h or 600 mm where h = depth of masonry block
= 295 mm
f_y = 300 MPa

$A_{v\,min}$ = 195.0 mm² / m

Try 2 Leg R6 stirrups @ 200 mm centres

actual shear reinforcement, A_v = 282.7 mm² / m > Av minimum, OK

Use 390 x 590 Grade B masonry pilaster
reinforced with 4/H16 bars and
2 Leg, R6 stirrups at 200mm centres.

FOUNDATION DESIGN

Hutchinson
CONSULTING ENGINEERS

JOB: THREE BLOKES LTD			
SUBJECT: PAD FOOTING DESIGN			
BY: PRW	PAGE: 1/1	DATE: OCT 2019	JOB NO: 20145

PAD FOOTING DESIGN.

LOADS

DEAD — ROOF $0.5kPa \times 6m \times 6m = 18kN$
WALL $0.5kPa \times 6m \times 4m = 12kN.$ $\Sigma G = 42kN.$
CONC $25kN/m^3 \times 0.9m \times 0.9m \times 0.6m = 12kN.$

LIVE – ROOF $0.25kPa \times 6m \times 6m = 9kN.$

LOAD COMBINATIONS.

$[1.35DL] = 57kN$ $[1.2DL + 1.5LL] = 64kN.$

TRY 900mm SQ.

$\Phi R = 0.5 \times 300kPa \times 0.9m^2 = 120kN.$ OK!

$\boxed{\rightarrow \text{USE } 900 \times 900 \times 600 \text{ w/ HD16@150.}}$

Phone: 09 426 5702, Email: info@hc.co.nz, Website: www.hc.co.nz

JOB: Three Blokes Ltd			
SUBJECT: Footing design			
BY: Paul W	BEAM:	DATE: Oct 2017	JOB NO: 20145

UNIFORMLY DISTRIBUTED LOADS:

Dead Loads, G:

roof:	0.45 kPa x	0.0 m =	0.0 kN/m
floor:	0.5 kPa x	0.0 m =	0.0 kN/m
internal walls:	0.35 kPa x	0.0 m =	0.0 kN/m
masonry walls:	4.1 kPa x	1.8 m =	7.4 kN/m
	beam self weight =		2.88 kN/m

G = 10.3 kN/m

Live Loads, Q:

roof:	0.25 kPa x	0.0 m =	0.0 kN/m
external floor:	2.00 kPa x	0.0 m =	0.0 kN/m
internal floor:	1.50 kPa x	0.0 m =	0.0 kN/m

Q = 0.0 kN/m

POINT LOAD: (SINGLE LOAD ON ONE SPAN)

G = 0.0 kN **Q = 0.0 kN**

FOOTING PROPERTIES:

Footing Size:

height, h = 400 mm
width, b = 300 mm
height of blockwork = 0 mm

Footing Reinforcement:

longitudinal, A_s = 4/D12
transverse, A_v = D12
@ 600 mm crs

Footing Material Properties:

f'_c = 20 MPa
f'_m = 12 MPa
f_y = 300 MPa
f_{yt} = 300 MPa

LOAD COMBINATIONS:

ULS Distributed Loads:		**Point Loads:**
1.35G =	13.9 kN/m	0.0 kN
1.2G + 1.5Q =	12.3 kN/m	0.0 kN
Working Stress Loads:		
G + Q =	10.3 kN/m	0.0 kN

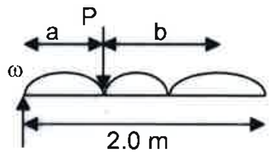
ULTIMATE LIMIT STATE

Try Pile Spacing, l = 2000 mm
Position of point load, b = 1500 mm
a = 500 mm

a) Worst case for flexure: Single span, simply supported beam

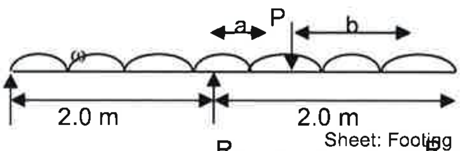
$$M^* = \frac{w\,l^2}{8} + \frac{Pab}{l}$$

= 6.9 kNm (Case 1.35G)



b) Worst case for reaction: 2 span, simply supported beam

R_a^* = 34.6 kN (Case 1.35G)



ULS CONCRETE DESIGN

DESIGN FOR FLEXURE

Clear cover = 75 mm

A_s = 113 mm² d = 307 mm

$$a = \frac{A_s\, f_y}{\alpha_1\, f'_c\, b_w}$$

= 6.65 mm

Ultimate Moment Capacity

$\phi M = \phi A_s f_y (d - a/2)$

= 8.8 kNm **> 6.9kNm, OK!**

DESIGN FOR SHEAR

$V^*_u < \phi V_n$ $\phi = 0.75$

V^*_u = ULS Shear Demand at the critical section, a distance 'd' from face of support:

= 10.3 kN Pile diameter = 400 mm

Nominal shear strength provided by concrete

$\phi V_c = \phi v_c A_{cv}$ where $v_c = (0.07 + 10\rho_w) \sqrt{f'_c}$ $(k_d = k_a = 1.0)$

= 25.4 kN = 0.368 MPa

A_{cv} = 92100 mm²

$V_{s,req}$ = -20.2 kN

since $V^*_u < 0.5\phi V_c$

no shear reinforcement required

Nominal shear strength provided by steel

$A_{v,req}$ = 0 mm² / m

s_{max} = 154 mm

s = 600 mm

$A_{v,prov}$ = 377 mm² / m **> 0mm² / m, OK!**

$V_s = A_v f_{yt} d/s$

= 0 kN

ϕV_n = 25.4 kN **> 10.3kN, OK!**

Use 300mm wide x 400mm deep footing reinforced with 2/D12 bars and D12 stirrups at 600mm crs. Min. 75mm cover to reinforcing

SOIL PROPERTIES

Soil Parameters:

Internal friction angle, ϕ = 30 degrees
Soil density, γ = 18 kN/m^3
Earth Pressure, K **At rest**
active coefficient, K_a = 0.33
at rest coefficient, K_o = 0.6 0.60

Strength Parameters:

ultimate soil capacity, U = 300 kPa
undrained shear strength, s_u = 100 kPa
ultimate soil adhesion, c = 36 kPa
ϕ = 0.5

Surcharge = 5 kPa

Ground Parameters:

Retained Height, f = 1.0 m
Backslope, β = 0 degrees
Frontslope, θ = 0 degrees
Design retained Height, H = 1.0 m

Geotechnical Parameters:

min embedment = 4 m
lateral load over 3 pile diameters

LATERAL PILE LOADS:

Soil Pressure, P_S:

soil pressure, P_S = 0.5 K γ h^2
= 5.4 kN/m
= 6.5 kN/pile

Surcharge Pressure, P_Q:

surcharge pressure, P_Q = K Q h
= 3.0 kN/m
= 3.6 kN/pile

Total Unfactored Force, P = 10.1 kN/pile $P_s{}^*+P_Q{}^*$

Total Factored Force, P* = 15.1 kN/pile $[1.5^*(P_s{}^*+P_Q{}^*)]$

acting 0.61 m below ground level

PILE DESIGN:

pile diameter, B = 400 mm

Embedment required to resist lateral load:

Using Rutledge formula

$$A = \frac{1.17\,P}{S\,B}$$
= 0.29484

required embedment, H_{req} = A (1+(1+2.18xL/A)$^{1/2}$) + retained height
= 0.877455 + 1
= 1.9 m

embedment, H =	**4.0 m**

Design Actions:

height of applied lateral force, f = 0.39 m
% lateral force to be resisted by isolated pile, ψ = 1.00

design moment, M* = P* x f
= 5.94 kNm

design shear, V* = P*
= 15.12 kN

PILE EMBEDMENT FOR BEARING

$$\text{pile embedment} = \frac{W - (\pi r^2 \times \phi U)}{\pi D \phi c} + 1$$

$= 1.26$ m

W = 24.62 kN
Pile radius, r = 0.20 m
ultimate soil capacity, U = 300 kPa
ultimate soil adhesion, c = 36 kPa
ϕ = 0.5
Min. Depth = 4.00 m
Soil Shrinkage Allowance = 1.00 m

Use 400mm dia concrete piles at 2m max centres, reinforced with 2/D16 bars and R6 links at 300mm crs. Min. 75mm cover to reinforcing

Minimum embedment = 4m into firm original ground

REINFORCED CONCRETE PILE DESIGN

Material Properties and Dimensions:

f'_c = 20 MPa
Longitudinal bars = 16 mm
f_y = 500 MPa
Transverse bars = 6 mm
f_{yt} = 300 MPa
Clear cover = 75 mm

Pile diameter = 400 mm
Pile spacing = 2000 mm
A_g = 125664 mm²
A_{cv} = 44488 mm²

$\phi_{bending}$ = 0.85
ϕ_{shear} = 0.75

Imposed Lateral Loads:

V* = 15.1 kN
M* = 5.9 kNm

Design for Bending:

From Response 2000
Use 4 - HD16 longitudinal bars A_{st} = 804 mm²

ϕM_n = 49.3 kNm > M* = 5.9kNm, OK (From Response 2000)

Design for Shear:

Nominal shear strength, $V_n \geq$ 20.16 kN

p_w = 0.0060

Concrete shear stress, v_c = 0.58 MPa

Concrete shear strength, V_c = 26 kN

Req'd steel shear strength, V_s = -6 kN

s ≤ -577 mm

Try D6 hoops at 100 mm crs

Provided steel shear strength, V_s = 33 kN

$0.33\sqrt{f'_c}A_{cv}$ = 66 kN

s_{max} = 142 mm (d/2)

Design shear strength, ϕV_n = 44 kN > V* = 15.1kN, OK

ADOPT A 400mm Ø PILE AT 2000mm CRS WITH 4-HD16 LONGITUDINAL BARS AND R6 HOOPS AT 100mm CRS

MASONRY RETAINING WALL DESIGN

RETAINING WALL A

CONCRETE MASONRY
(20 SERIES MASONRY)

NO BACKSLOPE

NO FRONTSLOPE

5 kPa SURCHARGE

UNDRAINED SHEAR STRENGTH = 100 kPa

Client: Three Blokes Ltd

Site Address: 362 Matakana Valley Road

Job Number: 20145

MASONRY RETAINING WALL CONSTRUCTION NOTES:

1. Unless otherwise specified or otherwise shown on the drawings all masonry shall be constructed in strict accordance with:

   NZS 4230 Code of Practice for Masonry Structures

   NZS 4210 Code of Practice for Masonry Buildings – Materials and Workmanship

   NZS 3102 Concrete Masonry Units

   NZS 3109 Concrete Construction

   NZS 3402 Hot Rolled Steel Bars for Concrete Reinforcement

   NZS 3122 Portland Cement (ordinary, rapid hardening, and modified).

   The documents above, with current amendments, and all related documents cited in those documents, are deemed to form part of this specification. However, this specification (which includes contract drawings) takes precedence in the event of it being at variance with the above documents.

2. Construction of the blockwork must be carried out by a competent, experienced tradesman in accordance with NZS 4210. Evidence of suitable experience and skill shall be supplied for the approval of the Designer prior to the commencement of work.

3. Inspection of the works shall be undertaken in accordance with NZS 4230 Chapter 3. The type of supervision shall be appropriate for the grade or grades of masonry construction shown on the drawings.

   Inspections shall be done of the works at critical stages thereby ensuring that the works are in general accordance with NZS 4210, NZS 4230 and all other relevant standards.

   The Contractor shall give 24 hours notice to the Designer of the commencement of typical critical stages and those the Designer will nominate prior to commencement of the contract.

   Masonry incorporating faulty masonry units, faulty mortar, faulty filling concrete, inadequate preparations, incorrect steel (placing and type), unapproved details or work practices, or any other aspects not complying with this specification as disclosed by testing or otherwise shall be rejected.

   Any element of the construction that is rejected shall be made good at the Contractor's expense.

4. All concrete blocks shall comply with NZS 3102 and shall be dense, hard, sound and true to size and shape. Any necessary cutting shall be by saw, neat and true to lines.

   All blocks shall be delivered to site, stored off the ground and kept clean and dry suitable for their end use.

5. Reinforcing steel shall be Grade 300 or Grade 500 complying with NZS 3402 unless otherwise shown on the drawings. All reinforcing shall be of the deformed type, except that ties, stirrups, spirals and joint reinforcing may be of the round (undeformed type), or unless otherwise shown on the drawings.

   Steel reinforcement shall be clean, rust scale-free and undamaged.

   Steel reinforcement shall be cut, bent and placed for construction in accordance with NZS 4230 or as shown on the drawings.

   Lap lengths for reinforcing shall be 40 bar diameters for Grade 300 steel and 70 bar diameters for Grade 500 reinforcing.

   Minimum bend radii shall be as follows:

Bar diameter	Bend Radius
6 – 20mm	5 x diameter
25 – 32mm	6 x diameter

6. Excavation shall be carried out immediately prior to constructing the retaining wall. Exposed cut batters shall be protected with a weather-proof polythene cover until the wall has been constructed.

   Excavations shall be completed in stages to restrict unsupported lengths of cut batters. Excavations in excess of 1.2 m height or within 1.2 m of a property boundary shall be directly supervised by the Engineer. Notification must be given by the Contractor, to the Engineer, prior to commencing the excavation. All surplus spoil shall be removed from the site.

   Unless otherwise noted the ground profile above and below the wall shall be level and free draining.

7. The rear face of the blockwork shall be protected with three coats of flint-kote, or similar approved waterproofing agent. The waterproofing agent shall be subsequently permanently protected with hardiflex soft board or similar prior to placing scoria backfill. The waterproofing shall extend 200 mm above the proposed finished ground level.

8. All concrete shall be 17.5 MPa unless otherwise noted.

9. All mortar joints after initial hardening, shall be tooled including the rear face of the wall.

10. The drainage blanket behind the wall shall be formed with at least a 300 mm thick layer of AP20 scoria.

11. The invert of the 100 mm draincoil pipe shall be a minimum of 200 mm below the finished floor level in front of the wall. The 100 draincoil shall be wrapped with filter cloth and be free draining into a sealed stormwater system.

12. All masonry cells shall be solid filled with grout.

13. All concrete cast against and permanently exposed to the unprotected footing excavation shall provide a 75 mm minimum cover to the reinforcing steel.

14. Clean-out ports shall be provided at the first blockwork course at each reinforced cell position or at a greater spacing as approved by the Engineer.

15. All masonry retaining walls shall be backfilled with AP20 scoria. Do NOT backfill any part of the wall with surplus masonry components and/or any other material other than AP20 scoria.

16. If the masonry retaining wall forms a perimeter foundation wall the AP20 scoria shall be completed 200 mm below the proposed finished ground level. Filter cloth (Terram 2000 or approved equivalent) shall then be placed over the top level surface of AP20 scoria. The filter cloth shall lap 100 mm vertically up the wall and 300 mm horizontally over the clay/scoria interface. A 200 mm compacted depth of topsoil shall then be placed over the filter cloth.

17. The ground profile behind the top of the wall shall direct all overland run-off away from the rear face of the retaining wall.

18. The lower concrete floor slab (if specified) shall be poured and cured prior to backfilling behind the masonry retaining wall.

19. Vertical shrinkage control joints shall be constructed at no more than 6.0m centres. Control joints shall be constructed in very respect to the details and requirements of NZS 4210, unless otherwise specified on the drawings.

20. The Contractor is responsible for ensuring that the control joints are waterproofed and fireproofed, as necessary, with the fillers and sealers as shown on the drawings or with approved alternatives.

REINFORCED MASONRY WALL DESIGN

GRADE A MASONRY
200mm BLOCKWORK

f'_m = 8 MPa v_i = 0.30 MPa

t = 190 mm

Longitudinal Bar Size and Spacing	Steel Area, A_s (mm^2)	Steel Ratio A_s / A_g	Grade 300 Steel Moment, ϕM_i (kNm) Side	Central	Grade 430 Steel Moment, ϕM_i (kNm) Side	Central	Grade 300 & 430 Shear, ϕV_i (kN) Side	Central
D 10 @ 200	392.7	0.21%	12.7	8.6	17.6	11.9	32.4	22.8
D 10 @ 400	196.3	0.10%	6.5	4.5	9.2	6.4	32.4	22.8
D 12 @ 200	565.5	0.30%	17.5	11.9	24.0	15.9	32.16	22.8
D 12 @ 400	282.7	0.15%	9.2	6.4	12.9	8.9	32.16	22.8
D 12 @ 600	188.5	0.10%	6.2	4.4	8.8	6.1	32.16	22.8
D 12 @ 800	141.4	0.07%	4.7	3.3	6.7	4.7	32.16	22.8
D 16 @ 200	1005.3	0.53%	28.2	18.7	36.8	23.2	31.68	22.8
D 16 @ 400	502.7	0.26%	15.5	10.8	21.3	14.5	31.68	22.8
D 16 @ 600	335.1	0.18%	10.6	7.5	14.9	10.3	31.68	22.8
D 16 @ 800	251.3	0.13%	8.1	5.7	11.4	8.0	31.68	22.8
D 16 @ 1000	201.1	0.11%	6.5	4.6	9.2	6.5	31.68	22.8
D 20 @ 200	1570.8	0.83%	38.2	24.2			31.2	22.8
D 20 @ 400	785.4	0.41%	22.6	15.6	30.2	20.1	31.2	22.8
D 20 @ 600	523.6	0.28%	15.8	11.1	21.7	15.0	31.2	22.8
D 20 @ 800	392.7	0.21%	12.2	8.6	16.9	11.9	31.2	22.8
D 20 @ 1000	314.2	0.17%	9.9	7.1	13.8	9.8	31.2	22.8
D 24 @ 200	2261.9	1.19%	45.1	26.0			30.72	22.8
D 24 @ 400	1131.0	0.60%	29.7	20.2	38.1	24.5	30.72	22.8
D 24 @ 600	754.0	0.40%	21.4	15.1	28.7	19.6	30.72	22.8
D 24 @ 800	565.5	0.30%	16.7	11.9	22.8	15.9	30.72	22.8
D 24 @ 1000	452.4	0.24%	13.6	9.8	18.8	13.3	30.72	22.8

NOTES:

All cells to be grout filled.

Design is in accordance with NZS 4230:1990 'Code of Practice for THE DESIGN OF MASONRY STRUCTURES'.

Side reinforcing shall be placed with 50mm cover between the longitudinal bars and the outside face of the blockwork on the tension side of the wall.

REINFORCED MASONRY WALL DESIGN

GRADE B MASONRY
200mm BLOCKWORK

f'_m = 8 MPa v_i = 0.24 MPa

t = 190 mm

Longitudinal Bar Size and Spacing	Steel Area, A_s (mm^2)	Steel Ratio A_s / A_g	Grade 300 Steel Moment, ϕM_i (kNm)		Grade 430 Steel Moment, ϕM_i (kNm)		Grade 300 & 430 Shear, ϕV_i (kN)	
			Side	Central	Side	Central	Side	Central
D 10 @ 200	392.7	0.21%	12.7	8.6	17.6	11.9	25.92	18.24
D 10 @ 400	196.3	0.10%	6.5	4.5	9.2	6.4	25.92	18.24
D 12 @ 200	565.5	0.30%	17.5	11.9	24.0	15.9	25.728	18.24
D 12 @ 400	282.7	0.15%	9.2	6.4	12.9	8.9	25.728	18.24
D 12 @ 600	188.5	0.10%	6.2	4.4	8.8	6.1	25.728	18.24
D 12 @ 800	141.4	0.07%	4.7	3.3	6.7	4.7	25.728	18.24
D 16 @ 200	1005.3	0.53%	28.2	18.7	36.8	23.2	25.344	18.24
D 16 @ 400	502.7	0.26%	15.5	10.8	21.3	14.5	25.344	18.24
D 16 @ 600	335.1	0.18%	10.6	7.5	14.9	10.3	25.344	18.24
D 16 @ 800	251.3	0.13%	8.1	5.7	11.4	8.0	25.344	18.24
D 16 @ 1000	201.1	0.11%	6.5	4.6	9.2	6.5	25.344	18.24
D 20 @ 200	1570.8	0.83%	38.2	24.2			24.96	18.24
D 20 @ 400	785.4	0.41%	22.6	15.6	30.2	20.1	24.96	18.24
D 20 @ 600	523.6	0.28%	15.8	11.1	21.7	15.0	24.96	18.24
D 20 @ 800	392.7	0.21%	12.2	8.6	16.9	11.9	24.96	18.24
D 20 @ 1000	314.2	0.17%	9.9	7.1	13.8	9.8	24.96	18.24
D 24 @ 200	2261.9	1.19%	45.1	26.0			24.576	18.24
D 24 @ 400	1131.0	0.60%	29.7	20.2	38.1	24.5	24.576	18.24
D 24 @ 600	754.0	0.40%	21.4	15.1	28.7	19.6	24.576	18.24
D 24 @ 800	565.5	0.30%	16.7	11.9	22.8	15.9	24.576	18.24
D 24 @ 1000	452.4	0.24%	13.6	9.8	18.8	13.3	24.576	18.24

NOTES:

All cells to be grout filled.

Design is in accordance with NZS 4230:1990 'Code of Practice for THE DESIGN OF MASONRY STRUCTURES'.

Side reinforcing shall be placed with 50mm cover between the longitudinal bars and the outside face of the blockwork on the tension side of the wall.

REINFORCED MASONRY WALL DESIGN

GRADE C MASONRY
200mm BLOCKWORK

f'_m = 4 MPa v_i = 0.15 MPa

t = 190 mm

Longitudinal Bar Size and Spacing	Steel Area, A_s (mm^2)	Steel Ratio A_s / A_g	Grade 300 Steel Moment, ϕM_i (kNm)		Grade 430 Steel Moment, ϕM_i (kNm)		Grade 300 & 430 Shear, ϕV_i (kN)	
			Side	Central	Side	Central	Side	Central
D 10 @ 200	392.7	0.21%	11.8	7.8	15.8	10.1	16.2	11.4
D 10 @ 400	196.3	0.10%	6.3	4.3	8.8	5.9	16.2	11.4
D 12 @ 200	565.5	0.30%	15.7	10.1	20.3	12.2	16.08	11.4
D 12 @ 400	282.7	0.15%	8.8	6.0	12.0	8.0	16.08	11.4
D 12 @ 600	188.5	0.10%	6.0	4.2	8.4	5.7	16.08	11.4
D 12 @ 800	141.4	0.07%	4.6	3.2	6.5	4.4	16.08	11.4
D 16 @ 200	1005.3	0.53%	22.5	13.0	25.1	11.5	15.84	11.4
D 16 @ 400	502.7	0.26%	14.1	9.3	18.4	11.6	15.84	11.4
D 16 @ 600	335.1	0.18%	10.0	6.9	13.6	9.0	15.84	11.4
D 16 @ 800	251.3	0.13%	7.7	5.4	10.7	7.3	15.84	11.4
D 16 @ 1000	201.1	0.11%	6.3	4.4	8.8	6.0	15.84	11.4
D 20 @ 200	1570.8	0.83%	24.3	10.3			15.6	11.4
D 20 @ 400	785.4	0.41%	19.1	12.1	23.1	13.0	15.6	11.4
D 20 @ 600	523.6	0.28%	14.3	9.6	18.5	11.8	15.6	11.4
D 20 @ 800	392.7	0.21%	11.3	7.8	15.1	10.1	15.6	11.4
D 20 @ 1000	314.2	0.17%	9.3	6.5	12.6	8.6	15.6	11.4
D 24 @ 200	2261.9	1.19%	16.3	-2.8			15.36	11.4
D 24 @ 400	1131.0	0.60%	22.5	13.0	23.3	9.7	15.36	11.4
D 24 @ 600	754.0	0.40%	18.2	11.9	22.1	13.0	15.36	11.4
D 24 @ 800	565.5	0.30%	14.9	10.1	19.1	12.2	15.36	11.4
D 24 @ 1000	452.4	0.24%	12.5	8.7	16.4	11.0	15.36	11.4

NOTES:

All cells to be grout filled.

Design is in accordance with NZS 4230:1990 'Code of Practice for THE DESIGN OF MASONRY STRUCTURES'.

Side reinforcing shall be placed with 50mm cover between the longitudinal bars and the outside face of the blockwork on the tension side of the wall.

MASONRY RETAINING WALL DESIGN

Retaining Wall Properties:

Retained Height	1000	mm
Total Wall Height	1000	mm
Wall Thickness	190	mm
Stem Density	4.1	kN/m^2
Slab at Top?	yes	
Slab at Bottom?	no	

Soil Properties:

Soil Density	18	kN/m^3
Surcharge on Wall	5	kPa
Backslope Behind Wall	0	degrees
Soil Shearing Resistance	30	degrees
Soil Cohesion	0	kPa
Active Pressure Coeff	0.33	
At Rest Pressure Coeff	0.50	

Footing Properties:

Total Footing Length	700	mm
Footing Thickness	200	mm
Key Depth	200	mm
Toe Projection	0	mm
Heel Projection	500	mm

Overturning Moments:	Force (kN)	Lever (m)	Moment (kNm)	Restoring Moments:	Force (kN)	Lever (m)	Moment (kNm)
Soil Pressure on Stem	4.32	0.40	1.73	Stem above Retained	0.00	0.10	0.00
Surcharge Pressure on Stem	2.00	0.60	1.20	Stem below Retained	4.10	0.10	0.41
				Footing Under Stem	0.96	0.10	0.10
				Toe	0.00	0.00	0.00
				Floor Slab Over Toe	0.00	0.00	0.00
				Heel	2.40	0.45	1.08
				Soil over Heel	9.00	0.45	4.05
TOTALS	**6.32**		**2.93**		**16.46**		**5.64**

Cantilever Design:

ULS Stem Cantilever Moment	2.93	kNm
ULS Stem Force	7.47	kN
ULS Stem Shear Stress	0.07	MPa

Overturning FOS	1.9	
Max Soil Pressure	66.7	kPa

Grade C Masonry

Propped Cantilever Design:

ULS Stem Rear Moment	1.49	kNm
ULS Stem Front Moment	0.67	kNm
ULS Stem Force	8.96	kN
ULS Stem Shear Stress	0.08	MPa

Use 20 series Grade C Masonry
with D12@600 vertical rear steel
and D12@600 vertical steel centrally placed
Use D12@600 horizontal steel

Use 700 x 200 concrete footing

MASONRY RETAINING WALL DESIGN

Retaining Wall Properties:

Retained Height	1200	mm
Total Wall Height	1200	mm
Wall Thickness	190	mm
Stem Density	4.1	kN/m^2
Slab at Top?	yes	
Slab at Bottom?	no	

Soil Properties:

Soil Density	18	kN/m^3
Surcharge on Wall	5	kPa
Backslope Behind Wall	0	degrees
Soil Shearing Resistance	30	degrees
Soil Cohesion	0	kPa
Active Pressure Coeff	0.33	
At Rest Pressure Coeff	0.5	

Footing Properties:

Total Footing Length	800	mm
Footing Thickness	200	mm
Key Depth	200	mm
Toe Projection	0	mm
Heel Projection	600	mm

Overturning Moments:	Force (kN)	Lever (m)	Moment (kNm)	Restoring Moments:	Force (kN)	Lever (m)	Moment (kNm)
Soil Pressure on Stem	5.88	0.47	2.74	Stem above Retained	0.00	0.10	0.00
Surcharge Pressure on Stem	2.33	0.70	1.63	Stem below Retained	4.92	0.10	0.49
				Footing Under Stem	0.96	0.10	0.10
				Toe	0.00	0.00	0.00
				Floor Slab Over Toe	0.00	0.00	0.00
				Heel	2.88	0.50	1.44
				Soil over Heel	12.96	0.50	6.48
TOTALS	**8.21**		**4.38**		**21.72**		**8.51**

Cantilever Design:

ULS Stem Cantilever Moment	4.68	kNm
ULS Stem Force	10.11	kN
ULS Stem Shear Stress	0.09	MPa

Overturning FOS	1.9	
Max Soil Pressure	76.1	kPa

Grade C Masonry

Propped Cantilever Design:

ULS Stem Rear Moment	2.43	kNm
ULS Stem Front Moment	1.09	kNm
ULS Stem Force	12.13	kN
ULS Stem Shear Stress	0.11	MPa

Use 20 series Grade C Masonry
with D12@600 vertical rear steel
and D12@600 vertical steel centrally placed
Use D12@600 horizontal steel

Use 800 x 200 concrete footing

MASONRY RETAINING WALL DESIGN

Retaining Wall Properties:

Retained Height	1400	mm
Total Wall Height	1400	mm
Wall Thickness	190	mm
Stem Density	4.1	kN/m^2
Slab at Top?	yes	
Slab at Bottom?	no	

Soil Properties:

Soil Density	18	kN/m^3
Surcharge on Wall	5	kPa
Backslope Behind Wall	0	degrees
Soil Shearing Resistance	30	degrees
Soil Cohesion	0	kPa
Active Pressure Coeff	0.33	
At Rest Pressure Coeff	0.5	

Footing Properties:

Total Footing Length	900	mm
Footing Thickness	200	mm
Key Depth	200	mm
Toe Projection	0	mm
Heel Projection	700	mm

Overturning Moments:	Force (kN)	Lever (m)	Moment (kNm)	Restoring Moments:	Force (kN)	Lever (m)	Moment (kNm)
Soil Pressure on Stem	7.68	0.53	4.10	Stem above Retained	0.00	0.10	0.00
Surcharge Pressure on Stem	2.67	0.80	2.13	Stem below Retained	5.74	0.10	0.57
				Footing Under Stem	0.96	0.10	0.10
				Toe	0.00	0.00	0.00
				Floor Slab Over Toe	0.00	0.00	0.00
				Heel	3.36	0.55	1.85
				Soil over Heel	17.64	0.55	9.70
TOTALS	**10.35**		**6.23**		**27.70**		**12.22**

Cantilever Design:

ULS Stem Cantilever Moment	7.00	kNm
ULS Stem Force	13.14	kN
ULS Stem Shear Stress	0.12	MPa

Overturning FOS	2.0	
Max Soil Pressure	85.4	kPa

Grade C Masonry

Propped Cantilever Design:

ULS Stem Rear Moment	3.68	kNm
ULS Stem Front Moment	1.65	kNm
ULS Stem Force	15.77	kN
ULS Stem Shear Stress	0.15	MPa

Use 20 series Grade C Masonry
with D12@400 vertical rear steel
and D12@600 vertical steel centrally placed
Use D12@800 horizontal steel

Use 900 x 200 concrete footing

MASONRY RETAINING WALL DESIGN

Retaining Wall Properties:

Retained Height	1600	mm
Total Wall Height	1600	mm
Wall Thickness	190	mm
Stem Density	4.1	kN/m^2
Slab at Top?	yes	
Slab at Bottom?	no	

Soil Properties:

Soil Density	18	kN/m^3
Surcharge on Wall	5	kPa
Backslope Behind Wall	0	degrees
Soil Shearing Resistance	30	degrees
Soil Cohesion	0	kPa
Active Pressure Coeff	0.33	
At Rest Pressure Coeff	0.5	

Footing Properties:

Total Footing Length	1000	mm
Footing Thickness	200	mm
Key Depth	200	mm
Toe Projection	0	mm
Heel Projection	800	mm

Overturning Moments:	Force (kN)	Lever (m)	Moment (kNm)	Restoring Moments:	Force (kN)	Lever (m)	Moment (kNm)
Soil Pressure on Stem	9.72	0.60	5.83	Stem above Retained	0.00	0.10	0.00
Surcharge Pressure on Stem	3.00	0.90	2.70	Stem below Retained	6.56	0.10	0.66
				Footing Under Stem	0.96	0.10	0.10
				Toe	0.00	0.00	0.00
				Floor Slab Over Toe	0.00	0.00	0.00
				Heel	3.84	0.60	2.30
				Soil over Heel	23.04	0.60	13.82
TOTALS	**12.72**		**8.53**		**34.40**		**16.88**

Cantilever Design:

ULS Stem Cantilever Moment	9.97 kNm
ULS Stem Force	16.55 kN
ULS Stem Shear Stress	0.16 MPa

Overturning FOS	2.0
Max Soil Pressure	94.5 kPa
Grade B Masonry	

Propped Cantilever Design:

ULS Stem Rear Moment	5.30 kNm
ULS Stem Front Moment	2.37 kNm
ULS Stem Force	19.87 kN
ULS Stem Shear Stress	0.19 MPa

Use 20 series Grade B Masonry
with D16@600 vertical rear steel
and D12@600 vertical steel centrally placed
Use D12@800 horizontal steel

Use 1000 x 200 concrete footing

MASONRY RETAINING WALL DESIGN

Retaining Wall Properties:

Retained Height	1800	mm
Total Wall Height	1800	mm
Wall Thickness	190	mm
Stem Density	4.1	kN/m^2
Slab at Top?	yes	
Slab at Bottom?	no	

Soil Properties:

Soil Density	18	kN/m^3
Surcharge on Wall	5	kPa
Backslope Behind Wall	0	degrees
Soil Shearing Resistance	30	degrees
Soil Cohesion	0	kPa
Active Pressure Coeff	0.33	
At Rest Pressure Coeff	0.5	

Footing Properties:

Total Footing Length	1200	mm
Footing Thickness	200	mm
Key Depth	200	mm
Toe Projection	0	mm
Heel Projection	1000	mm

Overturning Moments:	Force (kN)	Lever (m)	Moment (kNm)	Restoring Moments:	Force (kN)	Lever (m)	Moment (kNm)
Soil Pressure on Stem	12.00	0.67	8.00	Stem above Retained	0.00	0.10	0.00
Surcharge Pressure on Stem	3.33	1.00	3.33	Stem below Retained	7.38	0.10	0.74
				Footing Under Stem	0.96	0.10	0.10
				Toe	0.00	0.00	0.00
				Floor Slab Over Toe	0.00	0.00	0.00
				Heel	4.80	0.70	3.36
				Soil over Heel	32.40	0.70	22.68
TOTALS	**15.33**		**11.33**		**45.54**		**26.87**

Cantilever Design:

ULS Stem Cantilever Moment	13.65	kNm
ULS Stem Force	20.35	kN
ULS Stem Shear Stress	0.19	MPa

Overturning FOS	2.4	
Max Soil Pressure	89.0	kPa
Grade B Masonry		

Propped Cantilever Design:

ULS Stem Rear Moment	7.33	kNm
ULS Stem Front Moment	3.28	kNm
ULS Stem Force	24.42	kN
ULS Stem Shear Stress	0.23	MPa

Use 20 series Grade B Masonry
with D16@400 vertical rear steel
and D12@600 vertical steel centrally placed
Use D12@800 horizontal steel

Use 1200 x 200 concrete footing

MASONRY RETAINING WALL DESIGN

Retaining Wall Properties:

Retained Height	2000 mm
Total Wall Height	2000 mm
Wall Thickness	190 mm
Stem Density	4.1 kN/m^2
Slab at Top?	yes
Slab at Bottom?	no

Soil Properties:

Soil Density	18 kN/m^3
Surcharge on Wall	5 kPa
Backslope Behind Wall	0 degrees
Soil Shearing Resistance	30 degrees
Soil Cohesion	0 kPa
Active Pressure Coeff	0.33
At Rest Pressure Coeff	0.5

Footing Properties:

Total Footing Length	1300 mm	Toe Projection	0 mm
Footing Thickness	200 mm	Heel Projection	1100 mm
Key Depth	200 mm		

Overturning Moments:	Force (kN)	Lever (m)	Moment (kNm)	Restoring Moments:	Force (kN)	Lever (m)	Moment (kNm)
Soil Pressure on Stem	14.52	0.73	10.65	Stem above Retained	0.00	0.10	0.00
Surcharge Pressure on Stem	3.67	1.10	4.03	Stem below Retained	8.20	0.10	0.82
				Footing Under Stem	0.96	0.10	0.10
				Toe	0.00	0.00	0.00
				Floor Slab Over Toe	0.00	0.00	0.00
				Heel	5.28	0.75	3.96
				Soil over Heel	39.60	0.75	29.70
TOTALS	**18.19**		**14.68**		**54.04**		**34.58**

Cantilever Design:

ULS Stem Cantilever Moment	18.13 kNm	Overturning FOS	2.4
ULS Stem Force	24.53 kN	Max Soil Pressure	97.9 kPa
ULS Stem Shear Stress	0.24 MPa	**Grade A Masonry**	

Propped Cantilever Design:

ULS Stem Rear Moment	9.81 kNm
ULS Stem Front Moment	4.39 kNm
ULS Stem Force	29.44 kN
ULS Stem Shear Stress	0.27 MPa

Use 20 series Grade A Masonry
with D20@400 vertical rear steel
and D12@600 vertical steel centrally placed
Use D12@800 horizontal steel

Use 1300 x 200 concrete footing

MASONRY RETAINING WALL - NO BACKSLOPE - NO TOE - 5 kPa SURCHARGE

Retained Height	Vertical Reinforcing	Horizontal Reinforcing	Footing Dimensions	Rear Cover	Masonry Series/Grade
1000	D12@600	D12@600	700 x 200	50	200 / C
1200	D12@600	D12@600	800 x 200	50	200 / C
1400	D12@400	D12@800	900 x 200	50	200 / C
1600	D16@600	D12@800	1000 x 200	50	200 / B
1800	D16@400	D12@800	1200 x 200	50	200 / B
2000	D20@400	D12@800	1300 x 200	50	200 / A

RETAINING WALL B

CONCRETE MASONRY
(20 SERIES MASONRY)

NO BACKSLOPE

NO FRONTSLOPE

5 kPa SURCHARGE

UNDRAINED SHEAR STRENGTH = 100 kPa

Client: Three Blokes Ltd

Site Address: 362 Matakana Valley Road

Job Number: 20145

SOIL PROPERTIES	
Soil Density, γ	18 kN/m³
Internal Friction Angle, ϕ	30 degrees
Allowable Bearing Capacity, S_U (Φ = 3)	100 kPa
Dependable Bearing Capacity (Φ = 2)	150 kPa
Ultimate Bearing Capacity (Φ = 1)	300 kPa

SITE CONDITIONS	
Surcharge, Q	5 kPa
Backslope, ω	0 degrees
Frontslope, θ	0 degrees
Earth Pressure	Active
Earth Pressure Coefficent, K	0.50
At Rest Earth Pressure Coefficient, K_O	0.50
Soil Shrinkage Allowance	0.25 m

MASONRY WALL PROPERTIES	
Masonry Series	20
Masonry Density, γ_m	4.4 kN/m²
Wall thickness, T =	190 mm
Strength reduction factor, ϕ =	0.85
Concrete slab located at top of wall?	No
Constant or variable total wall height?	Variable

CONCRETE FOOTING PROPERTIES	
Concrete Density, γ_c	24 kN/m³
Heel Projection, p_h	200 mm
Minimum Footing Thickness, $t_{f,min}$	200 mm
Key Depth	400 mm

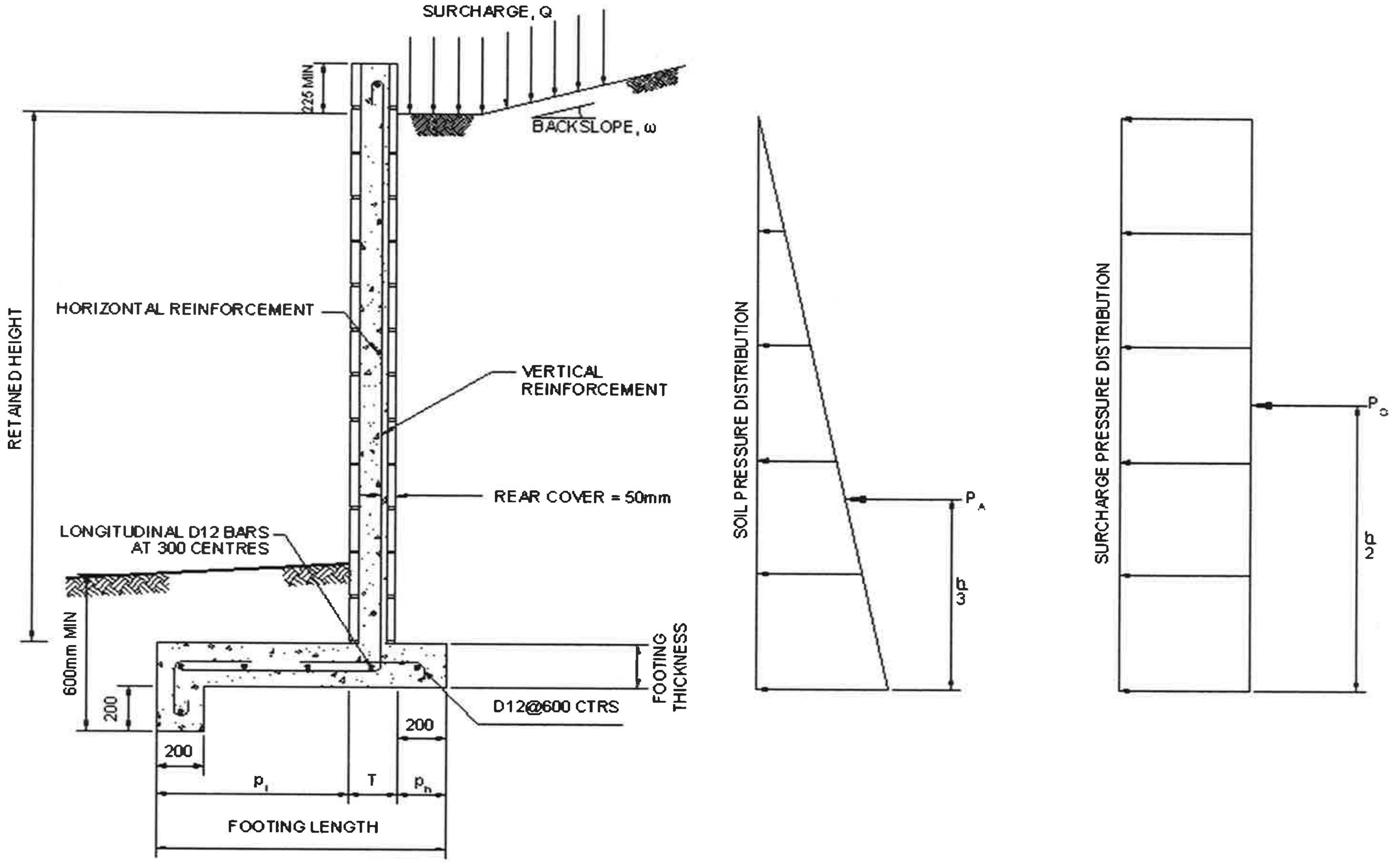
LOAD COMBINATIONS

1 G & 1.5 P_A & 1.5 P_S

NOTES:

Constant wall height:	The wall height is constant across varying levels of retained height
Variable wall height:	The wall height is equal to the retained height
Wall Design:	The effective design height shall be the the retained height plus the footing thickness

CONCRETE MASONRY RETAINING WALL DESIGN



RETAINED HEIGHT, h (m)	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
MASONRY WALL DESIGN														
Active Soil Force, $P_A = ½K\gamma h^2$ (kN)	1.13	1.62	2.21	2.88	3.65	4.50	5.45	6.48	7.61	8.82	10.13	11.52	13.01	14.58
Surcharge Force, P_S =Kqh (kN)	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50
Active Soil Moment, $M_A = P_A h/3$ (kNm)	0.19	0.32	0.51	0.77	1.09	1.50	2.00	2.59	3.30	4.12	5.06	6.14	7.37	8.75
Surcharge Moment, $M_S = P_S h/2$ (kNm)	0.31	0.45	0.61	0.80	1.01	1.25	1.51	1.80	2.11	2.45	2.81	3.20	3.61	4.05
$P^* = 1.5\,P_A + 1.5\,P_S$ (kN)	3.56	4.68	5.93	7.32	8.84	10.50	12.29	14.22	16.28	18.48	20.81	23.28	25.88	28.62
$M^* = 1.5\,M_A + 1.5\,M_S$ (kNm)	0.75	1.16	1.69	2.35	3.16	4.13	5.26	6.59	8.11	9.85	11.81	14.02	16.47	19.20
Maximum ULS shear stress demand, $v_m^* = P^* / (\phi\, b_w d)$	0.036	0.047	0.059	0.073	0.088	0.105	0.123	0.142	0.162	0.191	0.215	0.240	0.258	0.306
Minimum Required Masonry Observation Type	**Type C**	**Type C**	**Type C**	**Type C**	**Type C**	**Type C**	**Type C**	**Type C**	**Type B**	**Type B**	**Type B**	**Type A**	**Type A**	**Type A**
Vertical Reinforcement Required	**D12@600**	**D12@600**	**D12@600**	**D12@600**	**D12@600**	**D12@600**	**D12@600**	**D12@400**	**D12@400**	**D16@600**	**D16@400**	**D16@400**	**D12@200**	**D20@400**
FOOTING DESIGN														
Effective Design Height, $h' = h + t_f$ (m)	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
Overturning Moments														
Active Soil Force, $P_A = ½K\gamma h'^2 s$ (kN)	2.21	2.88	3.65	4.50	5.45	6.48	7.61	8.82	10.13	11.52	13.01	14.58	16.25	18.00
Surcharge Force, P_S =Kqh's (kN)	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
Active Soil Moment, $M_A = P_A h'/3$ (kNm)	0.51	0.77	1.09	1.50	2.00	2.59	3.30	4.12	5.06	6.14	7.37	8.75	10.29	12.00
Surcharge Moment, $M_S = P_S h'/2$ (kNm)	0.61	0.80	1.01	1.25	1.51	1.80	2.11	2.45	2.81	3.20	3.61	4.05	4.51	5.00
$P^* = 1.5\,P_A + 1.5\,P_S$ (kN)	5.93	7.32	8.84	10.50	12.29	14.22	16.28	18.48	20.81	23.28	25.88	28.62	31.49	34.50
$M^* = 1.5\,M_A + 1.5\,M_S$ (kNm)	1.69	2.35	3.16	4.13	5.26	6.59	8.11	9.85	11.81	14.02	16.47	19.20	22.20	25.50
Restoring Forces and Moments														
Force due to SW of Wall Above Retained Height (kN) = $(H-h)\gamma_m$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Moment (kNm) = Force x $(p_t+T/2)$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Force due to SW of Wall Below Retained Height = $h\gamma_m$	2.20	2.64	3.08	3.52	3.96	4.40	4.84	5.28	5.72	6.16	6.60	7.04	7.48	7.92
Moment (kNm) = Force x $(p_t+T/2)$	0.66	0.79	1.23	1.76	2.38	2.64	3.39	4.22	5.15	6.16	7.26	8.45	9.72	11.09
Force due to SW of Footing Under Wall = $t_f L_f \gamma_c$	2.88	2.88	3.36	3.84	4.32	4.32	4.80	5.28	5.76	6.24	6.72	7.20	7.68	8.16
Moment (kNm) = Force x $L_f/2$	0.86	0.86	1.18	1.54	1.94	1.94	2.40	2.90	3.46	4.06	4.70	5.40	6.14	6.94
Due to SW of Soil and Surcharge Over Heel = $hp_h\gamma_s$	1.80	2.16	2.52	2.88	3.24	3.60	3.96	4.32	4.68	5.04	5.40	5.76	6.12	6.48
Moment (kNm) = Force x $(p_t + T + p_h/2)$	0.90	1.08	1.51	2.02	2.59	2.88	3.56	4.32	5.15	6.05	7.02	8.06	9.18	10.37
Total Restoring Force, V_R (kN)	6.88	7.68	8.96	10.24	11.52	12.32	13.60	14.88	16.16	17.44	18.72	20.00	21.28	22.56
Total Restoring Moment, M_R (kNm)	2.42	2.74	3.92	5.31	6.91	7.46	9.35	11.45	13.75	16.26	18.98	21.91	25.05	28.39
Toe Projection Required, p_t (mm)	200	200	300	400	500	500	600	700	800	900	1000	1100	1200	1300
Check Soil Pressure														
Centroid of Soil Reaction from Heel Projection, $x = (M_R - M^*) / V_R$ (m)	0.11	0.05	0.08	0.12	0.14	0.071	0.09	0.11	0.12	0.13	0.13	0.14	0.13	0.128
Distance of x from center of footing, $e = L_f/2 - x$	0.19	0.25	0.27	0.28	0.31	0.379	0.41	0.44	0.48	0.52	0.57	0.61	0.67	0.72
Soil Bearing Pressure (kPa)	43.02	102.40	70.33	58.89	53.67	115.51	99.44	92.31	89.76	90.20	93.04	98.22	106.06	117.32
Length of footing required, L_f (mm)	**600**	**600**	**700**	**800**	**900**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**	**1600**	**1700**

Masonry Series: 20 Series

WALL HEIGHT (mm)	VERTICAL REINFORCEMENT	HORIZONTAL REINFORCEMENT	FOOTING LENGTH (mm)	MIN MASONRY OBS TYPE
500	D12@600	D12@600	600	Type C
600	D12@600	D12@600	600	Type C
700	D12@600	D12@600	700	Type C
800	D12@600	D12@600	800	Type C
900	D12@600	D12@600	900	Type C
1000	D12@600	D12@600	900	Type C
1100	D12@600	D12@600	1000	Type C
1200	D12@400	D12@600	1100	Type C
1300	D12@400	D12@600	1200	Type B
1400	D16@600	D12@600	1300	Type B
1500	D16@400	D12@600	1400	Type B
1600	D16@400	D12@600	1500	Type A
1700	D12@200	D12@600	1600	Type A
1800	D20@400	D12@600	1700	Type A

CONCRETE MASONRY RETAINING WALL

20 Series Masonry
No Backslope
No Frontslope
5 kPa Surcharge
Undrained Shear Strength = 100 kPa
Internal Friction Angle = 30 degrees
Earth Pressure Coefficient, K = 0.50

NOTES:

1) Retaining wall design is in accordance with NZS 4230:2004 'Code of practice for THE DESIGN OF MASONRY STRUCTURES'.
2) All masonry cells shall be solid filled with grout with a 28 day minimum compressive strength of 17.5 MPa.
3) Vertical reinforcement shall be placed with 60mm cover to the outside face of the blockwork on the tension side of the wall
4) All concrete shall have a minimum 28 day compressive strength of 17.5 MPa.
5) The retaining wall has been designed to support vertical cuts in original firm clay subgrades only. Any variation to this design assumption should be referred to the Engineer.
6) The masonry retaining wall shall be constructed in accordance with the construction specification included with these specific design details.