FMG ENGINEERING

Site Investigation and Footing Construction Report

Site ID/Job Number:	**S42166/262926**
Client Ref:	**CAF 20/8/18**
Client:	**Bojack Pty Ltd** **PO Box 964, GLENELG SA 5045**
Site:	**Dwellings 1-3, Lot 131, 638 Burbridge Road, WEST BEACH SA 5024**
Date:	**30/01/2019**

TO THE OWNER,

This soil report is a very important document and should be kept in a safe place so that you may refer to it in the future. You should hand it on to the next purchaser of this house.

It contains not only design details about the footings for your house but the notes contain important recommendations on how drainage, landscaping and tree planting can affect your home. Refer to the notes when planning your garden.

I/We hereby acknowledge receipt of this Report and I/We undertake to accept the terms and conditions of design as outlined under Appendix A of this Report.

Site:	Dwellings 1-3, Lot 131, 638 Burbridge Road, WEST BEACH SA 5024
Owner's Signature(s)	.....
Witness	.....
Date	.....
FMG Engineering	.....

SIGN AND RETURN A COPY OF THIS PAGE TO FMG ENGINEERING
enquiry@fmgengineering.com.au

Index:

Attached Documents:

Note: Not all hard copies include Appendix A and B and the CSIRO notes. Please contact this office if you require a copy.

- Borelogs
- Siteplan (borehole location)
- Footing Layout Plan
- Construction Details Sheets: CD1 CD5-1 CD5-4 DD1A DD2
- Civil Plan
- Control Joint/Articulation Plan
- Calculations
- Appendix A - Important Notes to the Owner(s)
- Appendix B - Important Notes to the Builder/Licensed Works Supervisor
- CSIRO notes

1. Introduction and Summary

FMG Engineering has assessed the subsurface conditions at Dwellings 1-3, Lot 131, 638 Burbridge Road WEST BEACH SA 5024. Based on this assessment, a raft footing system supported on piers is suitable for a double storey articulated masonry veneer (lower) and 'RendaPanel' frame (upper) dwelling proposed on this site in accordance with AS2870-2011. The site classifier was FMG Engineering.

Maximum Surface Movement, y_s	20mm
Potential Movement (trees), y_t	14mm
Site Class	P
Footings Sizes for Class	S
Windspeed	N2 = Vhu < 40m/s
Bushfire Construction Class	Excluded
Corrosion Environment	Yes
Flexible Connections to Stormwater and Waste Drains	Yes
Footings Details	Refer to Footing and Control Joint/Articulation Layout

2. Fieldwork and Site Conditions

In preparing this report FMG Engineering has made the following observations:

- At the time of sampling the site had a slope of approx level..
- An existing house was present on site.
- Trees were observed on site next door and at street frontage.
- 400mm of fill was observed in the core samples taken. However, deeper fill may be present.
- Fill may be deeper when holes are backfilled after demolition of the building on site.
- Groundwater was encountered at approximately 2100mm in the boreholes undertaken. It should be noted that groundwater levels are seasonal and may vary throughout the year.

Details of the observed subsurface conditions encountered have been recorded on the borelogs attached. In classifying this site, the broad experience of the classifier has been relied upon. Specific soil reports on adjacent sites were referred to. The Soil Association Map for the Adelaide region was consulted.

3. Site classification

Free swell Ys values, calculated in accordance with AS2870-2011, are shown on the attached bore logs. The maximum Ys (characteristic surface movement (mm)) value calculated at this site is 20mm. The site was classified 'P' to account for:

- Abnormal moisture conditions caused by the presence of a tree/s which may affect footing performance. The maximum potential surface movement, Yt, due to tree induced suction change (in addition to the normal design suction change) calculated at this site is 14mm.
- Abnormal moisture conditions caused by the presence of an existing house with timber floors to be demolished.
- Disturbance of soil due to the removal of the existing house.

4. Tree Effects on Soil Moisture Conditions

The influence of trees on the footing design has been considered. It must be noted that due to matters such as complex tree root geometry, variable moisture extraction (depending upon tree species) and the difficulty in predicting future growth and watering patterns, a PRECISE rational design for the effects of trees is outside current Engineering knowledge. Engineers are not experts in tree growth and cannot be expected to know the anticipated growth and mature height of trees.

While a design using current knowledge of tree effects has been carried out it must be accepted that there is a higher probability of damage occurring due to 'abnormal' soil moisture than would be anticipated in this case for a site subjected to only 'normal moisture conditions", as defined in AS2870 - 2011 Section 1.3.

5. Construction Requirements

Site Preparation

1. Remove surface soil containing grass, roots and organic matter from the building area.
2. Cut and/or fill the site ensuring it complies with the following drainage notes. Refer to the attached Appendix B, Section 2 for details on filling material type and compaction requirements.
3. Place additional approved filling material as a base for the proposed floor slabs.
4. Excavate for footing beams. Ensure that beams are trenched or piered 200mm minimum into Firm Natural Soil. Pier details and locations are given on the footing plan. They are only required where footing trenches do not bear on the specified material.
5. Lay plumbing lines making sure that beam penetrations comply with the detail sheet(s).
6. Lay out an approved 0.2mm plastic membrane over the building area.
7. Place the steel reinforcement as shown on the footing plan and detail sheet.

Site Inspection Requirements

- Trenches and piers must be inspected by this office.
- Steel inspection prior to concrete pour and as outlined under Appendix A of this Report.

Inspections must be booked 24 hours prior to the site visit. Each inspection (unless previously paid for) will incur an additional charge with travel charges applicable outside a 50 km radius from the GPO.

Note that where the depth of piers is greater than 1 metre, the piers must be poured separately (to allow for shrinkage) and inspected prior to the concrete pour.

Windspeed Classification

The wind classification for the proposed house on this site was assessed in accordance with AS4055-2012 "Wind Loads for Housing" and was found to have the wind classification:

- N2 = Vhu < 40m/s

The windspeed calculated, Vh is for use in ultimate strength limit state design only. It has been calculated for a domestic construction in accordance with the limitations as in AS4055.

Bushfire Planning and Construction Requirements

The site has been identified as being in an Excluded Area from Bushfire Protection Planning provisions.

Corrosion Zone

Corrosion environments of South Australia are defined by maps provided by SA Planning. This site has been identified as being within 1km of the coast and is therefore subject to special corrosion protection requirements in accordance with the NCC/BCA.

Control Joints/Articulation

Masonry walls shall be articulated in the locations shown on the attached control joint plan, which includes the necessary construction details in order to comply with the requirements of AS2870-2011 Residential Slabs and Footings, the NCC/BCA and TN61.

Rendered or sheet clad frame construction should incorporate articulation joints in the external panelling in accordance with the cladding manufacturer's recommendations.

Site Drainage

During construction provide temporary storm water drains and down pipes to direct water flow away from the footing system. The building area is to be graded away from the house so water drains to collection sumps and cannot pond beside or adjacent to the footings. On the cut side, water must drain away along the base of the cut. Provide a spoon drain if necessary. The full final drainage system must be installed as soon as practicable.

Sewer/Easement Present

Footings are to be constructed such that a line drawn from the base of the footing beam at an angle of 30 degrees for sandy soils and 45 degrees for clayey soils does not intersect with any existing or proposed service trench. Where the line does intersect, the footings are to be supported on piers at each beam intersection, such that the line drawn from the base of the pier does not intersect with the existing or proposed trench. It is the responsibility of the builder and/or owner to determine the depth of service trenches within easements and the required pier depths, prior to construction.

Brittle Floor Coverings

Where brittle floor coverings are to be used, e.g. large tiled areas, the reinforcement in the slab shall be not less than SL92 or a flexible adhesive grout bed must be used to accommodate shrinkage movement associated with concrete and screeds.

Pre-Wetting Requirement Due to Removal of Structure

Where an existing house with timber floors is to be removed from the site and a new building with a slab is proposed, pre-wetting is mandatory using the following procedure. Demolish existing house but leave strip/stone footings in place. Fill between footing beams with water and allow to soak in. Repeat often, for 14 days minimum. Allow further time for surface to dry sufficiently, to allow work to proceed on site, then demolish and remove the old footings. Fill holes with non porous fill compacted in maximum 150 mm layers to 95% standard compaction per AS1289, Section 5.1.1.

Scrape site and remove all remaining rubble and organic matter, then proceed with footing preparation.

Where an existing house with timber floors is to be removed and footing beams have been removed, the site will require pre-wetting. Pre-wetting can be carried out using sprinklers or similar and pre-soak area for approximately 3 hours daily for 10 days. Allow a minimum of 3 days prior to preparing benches. Fill holes with non porous fill compacting in 150 mm (max) layers.

6. Other important information about this report

Variations from Report

FMG Engineering advises that soil bore logs are most often based upon disturbed auger samples or continuous core samples taken down to a depth in one or more positions on the site. It is not possible by this means to detect all sub-surface features which may exist at a particular site. For example, the depth to solid rock may vary greatly over the area of a site. A filled well or cellar may go undetected and naturally occurring anomalies in an otherwise homogeneous soil mass can be easily missed. As such, any variations or discrepancies in soil type, colour, horizon depth, or rocks encountered must be reported to the Footing Design Engineer immediately so that their potential influence on the footings may be assessed. Studies have shown that a large number of boreholes leads to only a slight increase in the probability of detecting hidden site features in foundation soils. The number of boreholes drilled at the site has been carried out in accordance with current standard industry practice. A more detailed site investigation can be carried out, if required. An additional fee will be charged for this work.

It must be emphasised that in classifying this site, FMG Engineering did not place sole reliance on the soil bore logs as a means of being an absolute representation of all subsurface features existing at this site.

Relevant information and guidance used in classifying this site has been taken into consideration and is tabled below:

1. The broad experience of FMG Engineering.
2. Well established and relevant local knowledge of the general behavioural characteristics of foundation soils in the vicinity of the site.
3. Reference to FMG Engineering's extensive database of specific soil reports and classifications of sites in the region.
4. FMG Engineering's vast experience relating to past performance of existing structures in the general area.
5. Published data found in publications such as The Soils and Geology of the Adelaide Area (Bulletin 46), Engineering Geology of the Adelaide City Area (Bulletin 51) and the Soils Association Map of the Adelaide Region.
6. The characteristic surface movement (Ys) is determined by estimating the movement of each soil layer. The calculation is based on estimated Ips values as noted on the borelog, Ips values are determined either by laboratory testing or by the visual tactile identification method.

7. It can occasionally be difficult to distinguish between natural soil and controlled fill during testing. **It is not possible to distinguish between uncontrolled FILL and controlled FILL in the laboratory as the supervision of the compaction process and the requirement to check the subgrade is part of the certification requirement. Ie Satisfactory compaction test results alone are not acceptable for certification of controlled fill.** Controlled FILL must be accompanied with a certificate stating that all fill has been placed and compacted under Level 1 Supervision in accordance with AS3798-2007, Guidelines on Earthworks for Commercial and Residential Developments and can be considered as controlled fill in accordance with AS2870-2011, Residential Slabs and Footings. It shall be the Client's responsibility to determine whether any controlled FILL certificate is available for the fill on the site, and to provide FMG with the relevant Certificates(s) at the time of our engagement, prior to the fieldwork being carried out. FMG takes no responsibility for any additional costs which may be incurred due to the presence of Controlled FILL which is not logged as either (uncontrolled) FILL or natural material.

Future Tree Planting/Landscaping

Proposed landscaping and tree planting may affect footing performance. A review of the site classification and footing design is required when information on future planting and landscaping is available.

If, following construction of the house, the Property Owner changes the vegetation on the site (either by planting or removing trees or large shrubs) the Property Owner should seek advice from a Footing Design Engineer on the potential effects of any such changes on the footings system.

A qualified Arborist can check and establish the species of plants and how they may influence the site. FMG Engineering recommends the Property Owner consults an Arborist for such advice.

Reference should be made to CSIRO Sheet 10-91'Guide to Home Owners on Foundation Maintenance and Footing Performance' for tree root zone of influence.

Foundation Maintenance

The appropriate site drainage, paving, and foundation maintenance should be implemented as soon as possible after completion of construction of the building.

A copy of the CSIRO Sheet No. 10-91 'Guide to Homeowner or Foundation Maintenance and Footing Performance' has been included in the Property Owner's copy of this report.

AS2870 embraces the philosophy that optimum performance of rational and economical footing designs can only be achieved with the co operation of informed Property Owners who pay attention to maintaining a stable moisture condition of the foundation soils as recommended in the above referenced CSIRO Notes.

7. Provisions

Property Owner

The Client, or agent of the Property Owner, Builders, Designers, or any person(s) acting on behalf of the Property Owner, must ensure that the Property Owner receives a copy of this report so they are fully informed about their obligations and responsibilities.

Design - Management - Quality

The work carried out in the preparation of this report has been performed in accordance with the requirements of FMG Engineering's Quality Management System which is certified by BSI Group to comply with the requirements of ISO9001.

Copyright

8. Workplace Health and Safety

Workplace health and safety (WHS) is important to FMG Engineering and Safety in Design is a core component of our service. We recognise that identifying design solutions that eliminate hazards, not only improves WHS outcomes, but also has potential to reduce costs associated with fixing design problems.

Under harmonised WHS legislation, there are a range of legislative and regulatory requirements, supported by a suite of codes of practice clarifying how these obligations can be met. FMG Engineering is committed to its legislative obligations. In this instance, we cannot foresee any significant WHS implications or risks that can be avoided by design.

The construction and installation of:

1. Residential footings and slabs
2. Residential swimming pools
3. Retaining walls up to 1m in height
4. Effluent systems
5. Service trenches under 1.5m in depth

Can be reasonably expected to be constructed in accordance with a construction process that is an 'industry standard' process within the capabilities of a licensed contractor. On this basis, this work is generally a low risk operation and the site in question does not pose any unique risks or hazards. Therefore, providing that all other parties associated with the design and construction conduct their duties in a professional manner and in accordance with the legislative obligations including approved Codes of Practice, all requirements relating to the Work Health and Safety Act 2012 (SA) should be satisfied.

FMG ENGINEERING

SURFACE SOIL BORE LOG

Job: S42166/262926

Job Date: 29/8/2018

Sample Method: Rig Mounted Push Tube And Hand Held Equipment

Site: Dwellings 1-3, Lot 131, 638 Burbridge Road
WEST BEACH SA 5024

Horizon	Hole 1 Depth (mm)	Hole 2 Depth (mm)	Hole 3 Depth (mm)	Hole 4 Depth (mm)	Hole 5 Depth (mm)	Description	USCS	Moisture	Strength	Est Ips %
FILL				0 - 300	0 - 200	FILL - MIXTURE OF SAND, SILT, CLAY AND GRAVELS (SM-SC) - pale grey brown yellow. Low Plasticity.	-	Damp to Moist	Low	0.5
A	0 - 1300	0 - 1500	0 - 1300	300 - 1100	200 - 1200	SILTY SAND - pale grey brown over grey yellow. Some fine roots Non Plastic.	SM	Damp	Low	0.0
B	1300 - 2200	1500 - 2100	1300 - 2200	1100 - 2100	1200 - 1700	SILTY CLAY - pale grey brown to black. Trace of sand. Medium to high Plasticity.	CH-CI	Moist	Medium to High	2.0
BC	2200 - 2400	2100 - 2300	2200 - 2400	2100 - 2300	1700 - 1900	SANDY SILTY CLAY - pale grey brown yellow. Highly calcareous. Medium Plasticity.	CI	Damp to Moist	Medium	1.0
B1	2400 - 2800	2300 - 2800	2400 - 2600	2300 - 2700	1900 - 2700	SAND (FINE AND MEDIUM) - pale grey brown yellow orange. Non Plastic.	SP	Moist to Wet	Low	0.0
B2	2800 - 3000	2800 - 3000	2600 - 3000	2700 - 3000	2700 - 3000	SANDY SILTY CLAY - pale grey brown yellow blue. Medium Plasticity.	CI	Wet	Medium	1.0
Y_s	16	12	17	20	13	Y_s = Characteristic surface movement (mm)				
Y_t	13	12	14	14	11	Y_t = Potential surface movement due to tree induced suction change (mm)				

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SURFACE SOIL BORE LOG

Job: S42166/262926

Site: Dwellings 1-3, Lot 131, 638 Burbridge Road

Job Date: 29/8/2018

WEST BEACH SA 5024

Sample Method: Rig Mounted Push Tube And Hand Held Equipment

Horizon	Hole 6 Depth (mm)	Description	USCS	Moisture	Strength	Est Ips %
FILL	0 - 400	FILL - MIXTURE OF SAND, SILT, CLAY AND GRAVELS (SM-SC) - pale grey brown yellow. Low Plasticity.	-	Damp to Moist	Low	0.5
A	400 - 1100	SILTY SAND - pale grey brown over grey yellow. Some fine roots Non Plastic.	SM	Damp	Low	0.0
B	1100 - 1500	SILTY CLAY - pale grey brown to black. Trace of sand. Medium to high Plasticity.	CH-CI	Moist	Medium to High	2.0
BC	1500 - 1700	SANDY SILTY CLAY - pale grey brown yellow. Highly calcareous. Medium Plasticity.	CI	Damp to Moist	Medium	1.0
B1	1700 - 2800	SAND (FINE AND MEDIUM) - pale grey brown yellow orange. Non Plastic.	SP	Moist to Wet	Low	0.0
B2	2800 - 4000	SANDY SILTY CLAY - pale grey brown yellow blue. Medium Plasticity.	CI	Wet	Medium	1.0
Y_s	13	Y_s = Characteristic surface movement (mm)				
Y_t	10	Y_t = Potential surface movement due to tree induced suction change (mm)				

Observations: Groundwater encountered at 2100mm in all BHs.

Ground water encountered at: 2.1 m

Groundwater encountered is considered seasonal and therefore does not effect calculation of Ys

Surface Suction Change: 1.2 pF

Depth of design soil suction change (H_s): 4.0 m

Tree: Group of Trees

Tree Distance (D_t): 5.0 m

Design Height of Tree (HT): 10.0 m

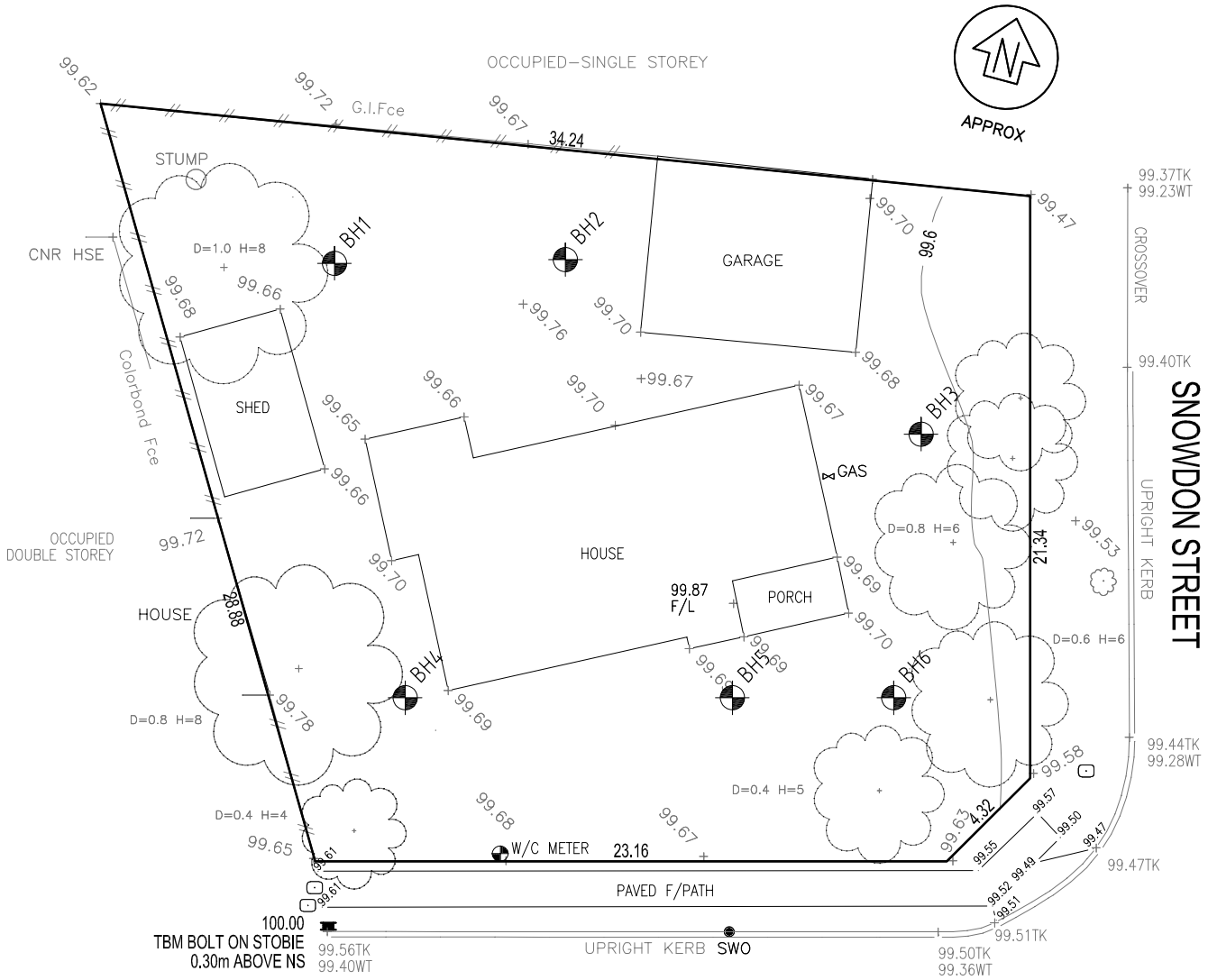
0.9 tree factor has not been applied

Max Design Drying Depth (H_t): 4.5 m

Influence distance (D_i): 1.5xHT

Calculation in accordance with AS 2870 - 2011

REV	DESCRIPTION	DATE	INIT	APP	SIGNATURE



BURBRIDGE ROAD

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SOIL & MATERIAL TESTING | HOUSING | COMMERCIAL | PROJECT MANAGEMENT | SURVEY

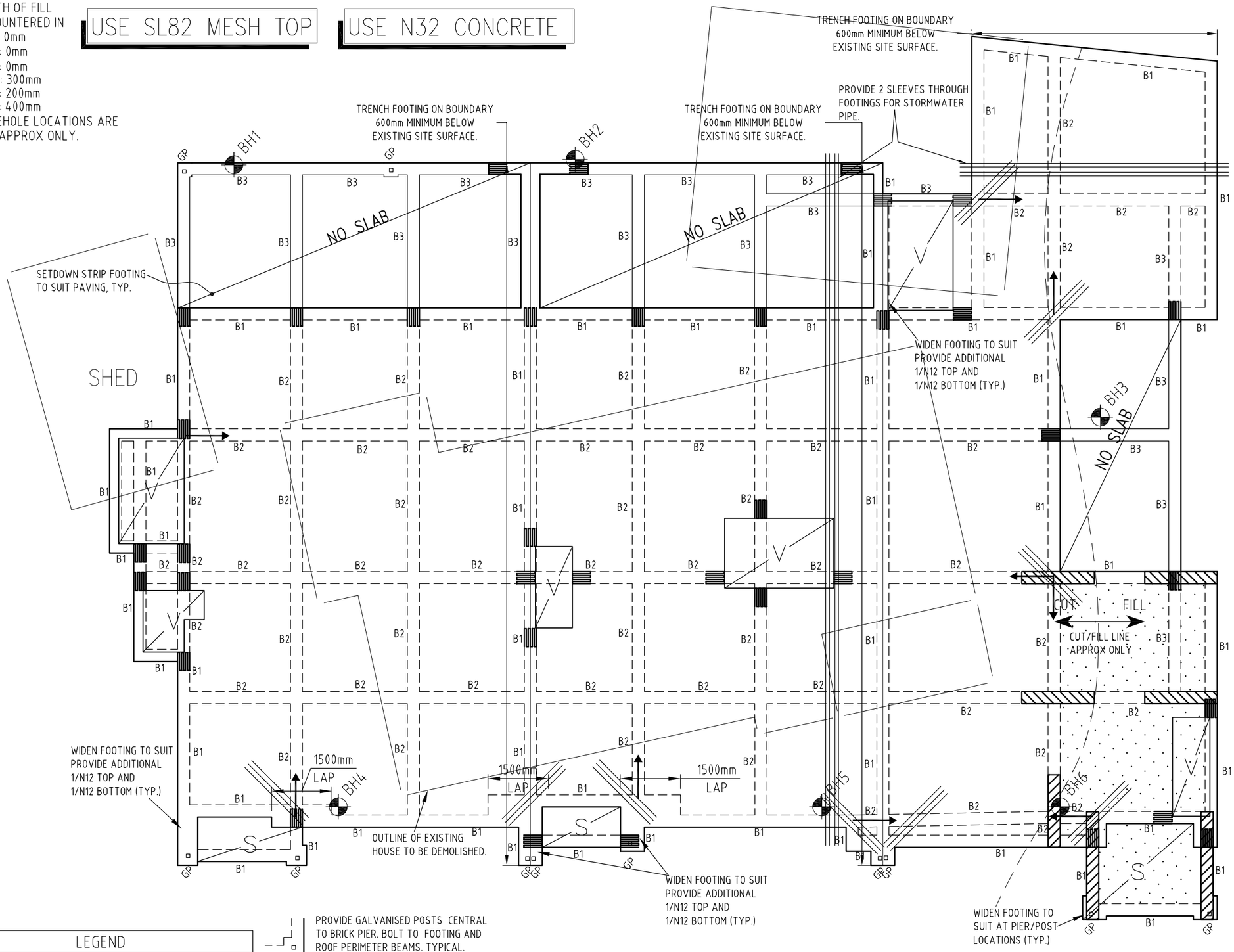
CLIENT	Bojack Pty Ltd
TITLE	PROPOSED RESIDENCE
SITE ADDRESS	Dwellings 1-3, Lot 131, 638 Burbridge Road, WEST BEACH, SA 5024
DRAWING TITLE	BOREHOLE LOCATION PLAN

DESIGNED	DRAWN: S.K
CHECKED	No. OF SHEETS: 1 OF 1
SCALE: NTS @ A4	DATE STARTED: 31.08.2018
SITE ID & JOB No.: S42166 / 262926	REV.
DRAWING No.: BH01	

DEPTH OF FILL ENCOUNTERED IN
BH1 : 0mm
BH2 : 0mm
BH3 : 0mm
BH4 : 300mm
BH5 : 200mm
BH6 : 400mm
BOREHOLE LOCATIONS ARE APPROX ONLY.

USE SL82 MESH TOP

USE N32 CONCRETE



BEAM	WIDTH mm	DEPTH mm	BEAM REINFORCEMENT TOP	BOTTOM
B1	300	450	4/N12	4/N12
B2	300	450	3/N12	3/N12
B3	300	600	4/N12	4/N12

LIGATURES: W6 @ 1200cts BUT @ 300cts BETWEEN PIERS

SPLICE BARS 500mm 1/T & 1/B AT "L" INTERSECTIONS

NOTES

1. THIS PLAN SHALL BE READ IN CONJUNCTION WITH THE CONSTRUCTION REPORT, ARCHITECTURAL DRAWINGS & DETAIL SHEETS.
2. FOOTINGS SHALL BE POURED AS A RAFT UNLESS NOTED OTHERWISE.
3. CONCRETE STRENGTH TO BE N32
4. USE 100 THICK SLAB WITH SL82 MESH PLACED 20mm FROM TOP FACE. WHERE DEPTH OF UNCONTROLLED FILL EXCEEDS 400mm USE 125mm SLAB. REINFORCE WITH SL82 MESH TOP & SL72 MESH BOTTOM.
5. ANY DISCREPANCY BETWEEN FOOTING REPORT AND THE FOOTING PLAN SHALL BE REPORTED TO THE ENGINEER IMMEDIATELY.
6. WRITTEN DIMENSIONS SHALL TAKE PRECEDENCE OVER SCALED DIMENSIONS.
7. IF ANY FOOTING IS LOCATED SUCH THAT A LINE DRAWN AT 45 DEGREES FROM IT'S BASE INTERSECTS A SERVICE TRENCH, THEN PIERS ARE REQUIRED. CONTACT THIS OFFICE PRIOR TO FURTHER CONSTRUCTION.
8. FOR QUERIES RELATING TO FOOTING DESIGN PLEASE CONTACT THE DESIGN ENGINEER
9. ENSURE THAT ALL FOOTING BEAMS ARE TRENCHED OR PIERED TO FIRM NATURAL SOIL.
   PIER FOOTING WIDTH WIDE x 1800mm LONG WITH 6/N12 WHEN PIER DEPTH EXCEEDS 400mm. ONLY USE PIERS WHERE NECESSARY.

REV	DESCRIPTION	DATE	INIT	APP

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SIGNATURE

CLIENT
Bojack Pty Ltd

PROJECT TITLE
PROPOSED RESIDENCE

SITE ADDRESS
Dwellings 1-3, Lot 131, 638 Burbridge Road, WEST BEACH, SA 5024

DRAWING TITLE
FOOTING PLAN

No. OF SHEETS	SCALE	DATE STARTED
1 OF 1	1:100 @ A3	24/01/2019

DRAWN	SITE ID & JOB No.	REV.
AH	S42166 - 262926	
DESIGNED: AH	DRAWING No.	
CHECKED	HF01	

LEGEND

- 3/N12 x 2000 LONG CRACK CONTROL BARS TO UNDERSIDE OF MESH.
- STEP IN FOOTING, REFER TO DETAIL SHEET.
- V – DENOTES SET DOWN, SLAB POURED AS PART OF RAFT, UNLESS NOTED OTHERWISE THE MAXIMUM SET DOWN IS 50mm
- X – DENOTES SET DOWN, SLAB POURED AFTER.
- S – DENOTES SET DOWN, SLAB POURED AS PART OF RAFT.

GP – PROVIDE GALVANISED POSTS CENTRAL TO BRICK PIER. BOLT TO FOOTING AND ROOF PERIMETER BEAMS. TYPICAL.

CONTINUE 4/N12 BARS TOP & BOTTOM FOR 1m MIN. TYPICAL.

AREA SHOWN HATCHED SHALL HAVE A SLAB DEPTH OF 125mm WITH 2 LAYERS OF MESH (SL82 TOP & SL72 BOTTOM) WHERE DEPTH OF FILL EXCEEDS 400mm. DETERMINE FILL DEPTH WHEN TRENCHING FOOTING BEAMS. AREA SHOWN HATCHED APPROXIMATE ONLY.

NOTE:
THE SITE IS CLASSIFIED AS 'P' (DUE TO EXISTING HOUSE AND TREES) AND 'S' DUE TO SOIL REACTIVITY IN ACCORDANCE WITH AS 2870-2011

TRENCH, PIER AND STEEL INSPECTION REQUIRED

SCALE 0 1 2 3 4 5 METRES

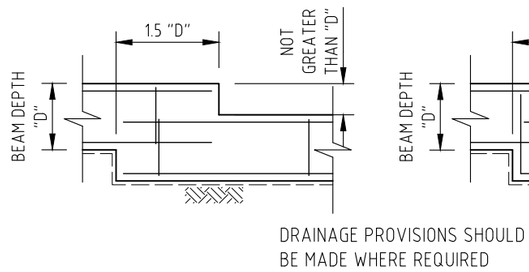
BAR		N12	N16	N20	N24	N28	N32
LAP (mm)	TOP	400	750	1200	1650	2150	2400
	BOTTOM	400	600	950	1300	1700	2000

NOTE: REFER TO DETAIL SHEET CD5-1 FOR ALL INFORMATION ON PERIMETER PAVING, EXTERNAL MOISTURE BARRIER & SLAB EDGE DAMPNESS PREVENTION SHEET.

NOTE: WHERE D (DEPTH OF FOOTING) > 800mm DRAPE D.P.M DOWN BOTH SIDES OF TRENCHES TO BASE OF TRENCH. (TYPICAL)

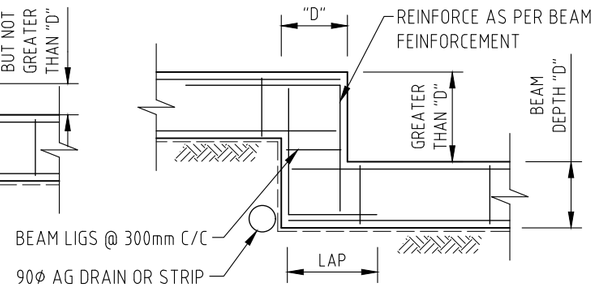
REFER TO FOOTING CONSTRUCTION REPORT FOR PIER REINFORCEMENT AND FOUNDING DEPTH.

× NOTE: FOOTING BEAM WIDTH SHALL BE 200mm UNLESS NOTED OTHERWISE IN FOOTING CONSTRUCTION REPORT.

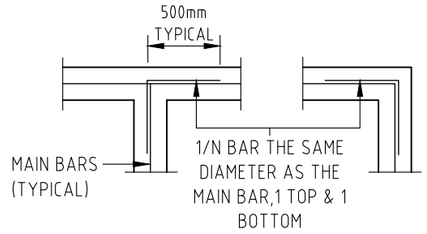


DRAINAGE PROVISIONS SHOULD BE MADE WHERE REQUIRED

STEPPED FOOTING DETAILS

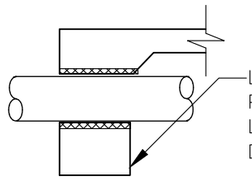


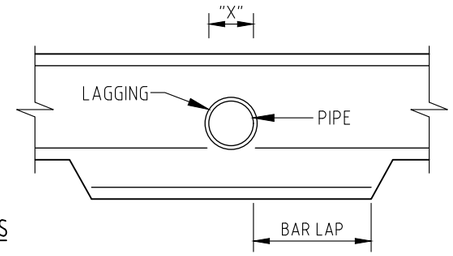
DROP PIER SECTION



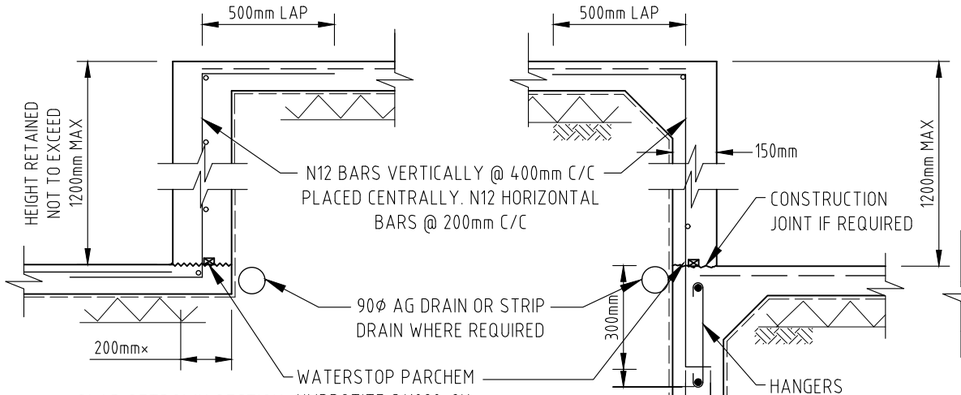
NOTE: CONTINUE ONE BAR AT EXTERNAL CNRS TOP & BOTTOM FOR 500mm OR 1 SPLICE BAR TOP & BOTTOM TO LAP 500mm.

SPLICE BAR DETAILS



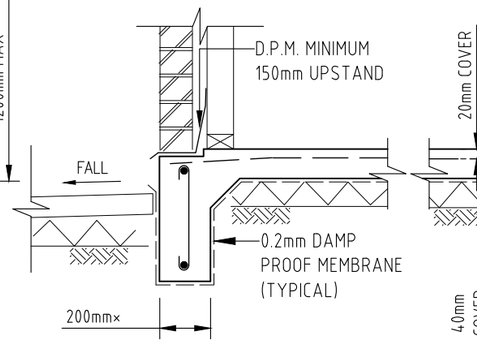


BEAM PENETRATION DETAILS

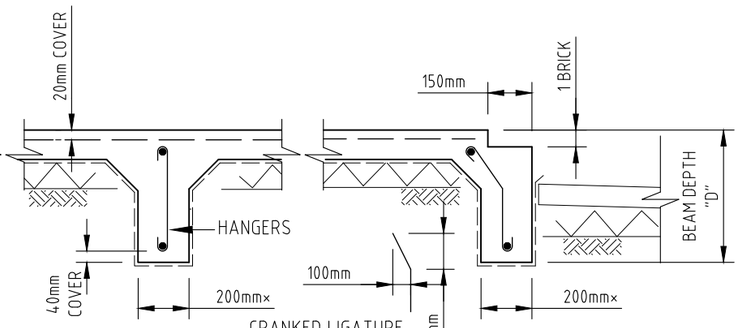


SLAB SETDOWN SECTION

SPLIT LEVEL SECTION

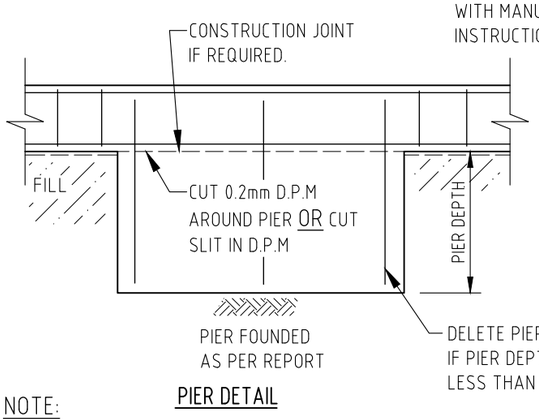


EXTERNAL FOOTING DETAIL
25mm REBATE

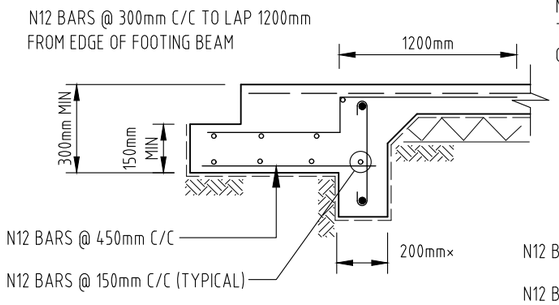


INTERNAL FOOTING DETAIL

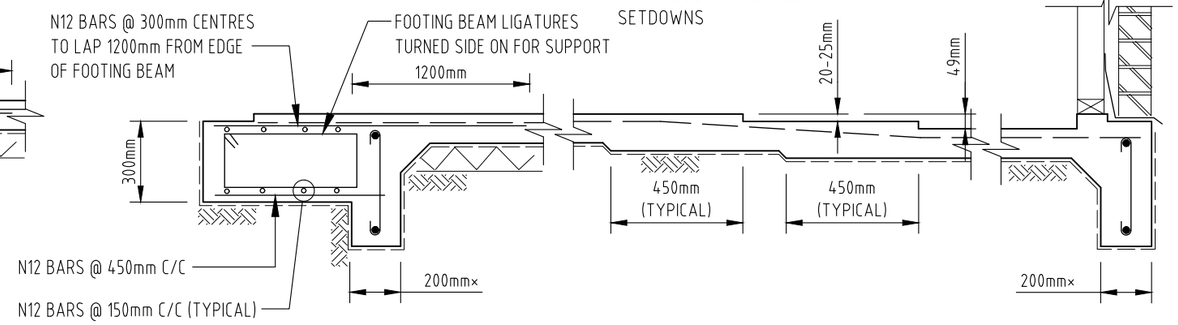
EXTERNAL FOOTING DETAIL
1 BRICK REBATE
(REFER TO FOOTING PLAN IF REBATE > 1 BRICK)



PIER DETAIL



THICKENED EDGE (DEEP REBATE)



THICKENED EDGE SECTION

NOTE: MAINTAIN SLAB THICKNESS THROUGHOUT SETDOWNS

WET AREA SETDOWN DETAIL

NOTE:
1. CONCRETE TO BE GRADE N20 OR ELSE NOTED OTHERWISE.
2. DAMP PROOF MEMBRANE TO BE APPROVED 0.2mm MINIMUM THICKNESS AND IS TO BE TAPED AROUND PIPES AND LAPPED A MINIMUM OF 200mm WITH ADJACENT SHEETS.
3. BEAM REINFORCEMENT TO HAVE 40mm MINIMUM COVER TO SIDES & BOTTOM, AND TO BE LAPPED IN ACCORDANCE WITH TABLE 1, TIED AT SPLICES AND LAPPED FOR THE FULL BEAM WIDTH AT INTERSECTIONS.
4. SLAB REINFORCEMENT TO HAVE 20mm TOP COVER AND TO BE SUPPORTED ON BAR CHAIRS AT 1000mm MAXIMUM SPACING IN EITHER DIRECTION.

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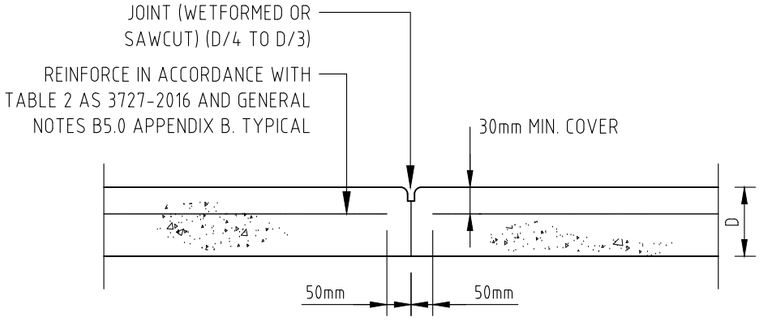
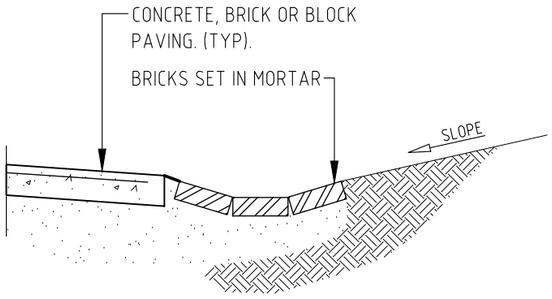
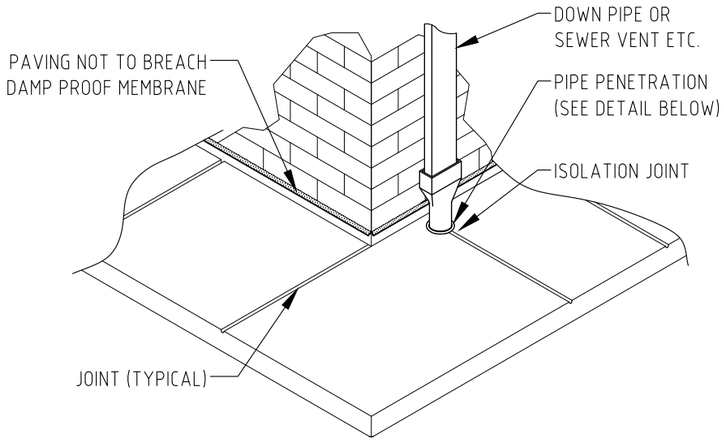
TITLE :
CONSTRUCTION DETAIL SHEET

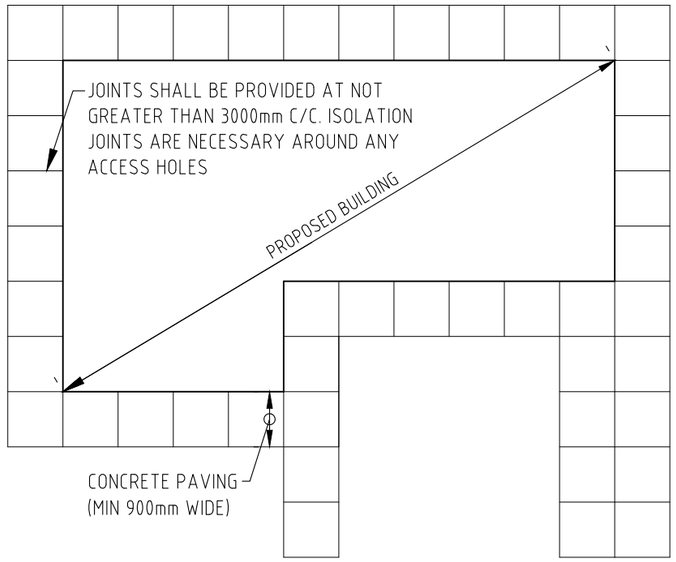
LAST REVISED :	OCT' 2018
SCALE :	N.T.S.
PAPER SIZE:	A3

DETAIL SHEET: **CD3**





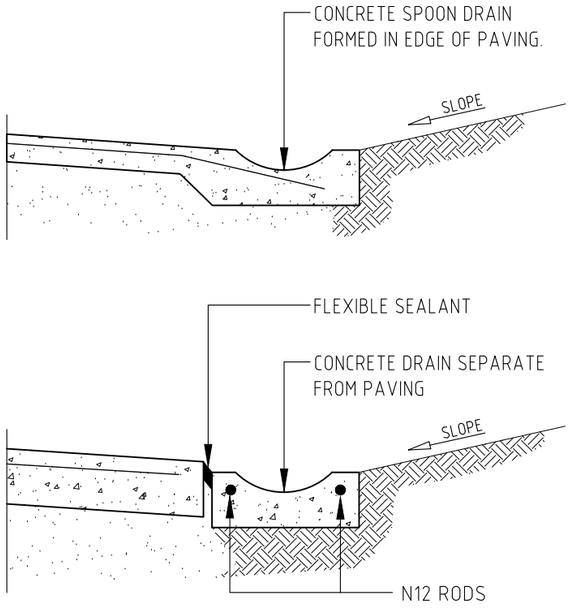




TYPICAL PLAN OF PAVING AROUND A BUILDING

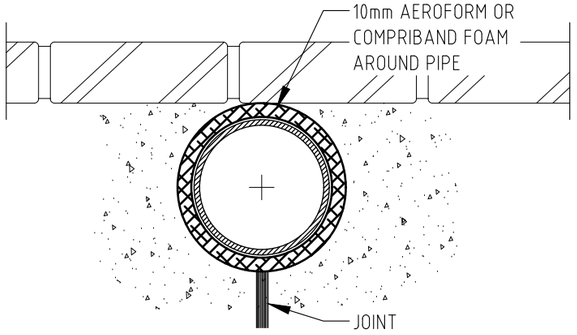
(REFER ALSO TO APPENDIX B PAGE B6 B5.0 "PAVING REQUIREMENTS").

NOTE: PAVING TO HAVE A MINIMUM CROSS-FALL AWAY FROM FOOTINGS PER 1.0m WIDTH OF;
:25mm FOR CLASS A, S, M-D SITES
:35mm FOR CLASS H-D SITES
:50mm FOR CLASS E SITES



TYPICAL SPOON DRAIN DETAILS

REFER: A.S. 3727-2016 GUIDE TO RESIDENTIAL PAVEMENTS - "LIGHT" TRAFFIC CONDITION & APPENDIX B, PAVEMENT REQUIREMENTS



PIPE PENETRATION DETAIL

IMPORTANT NOTE:

FOR DETAILS OF HOW TO ACHIEVE SPECIFIED BCA EDGE DAMPPROOFING REQUREMENTS WHEN PAVING AGAINST SLAB FOOTING REFER TO ATTACHED DRAWING TITLED "SLAB EDGE DAMPNESS PROTECTION".

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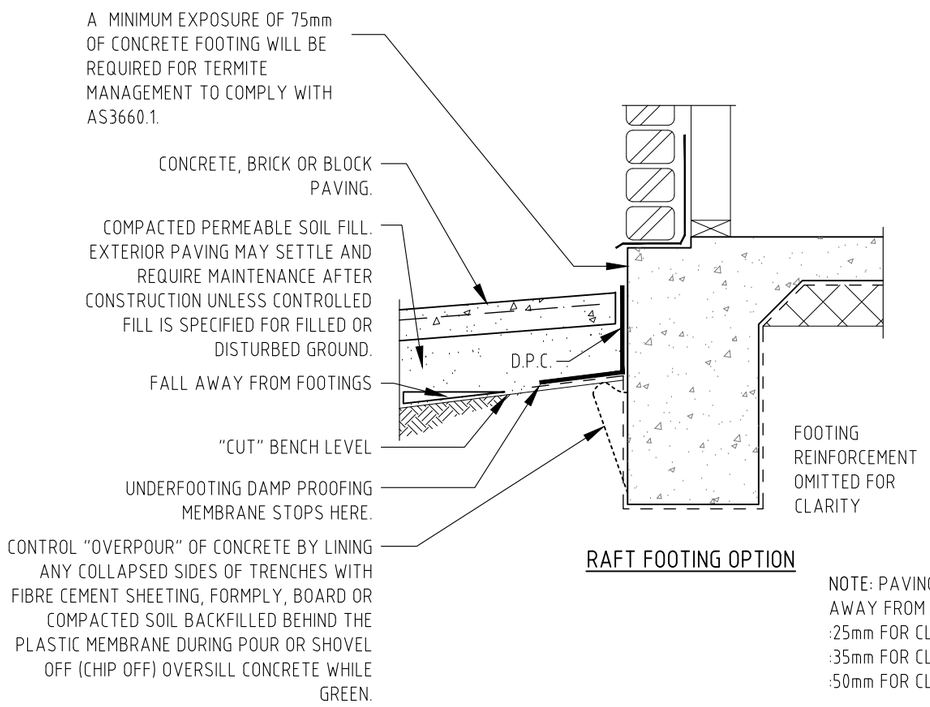
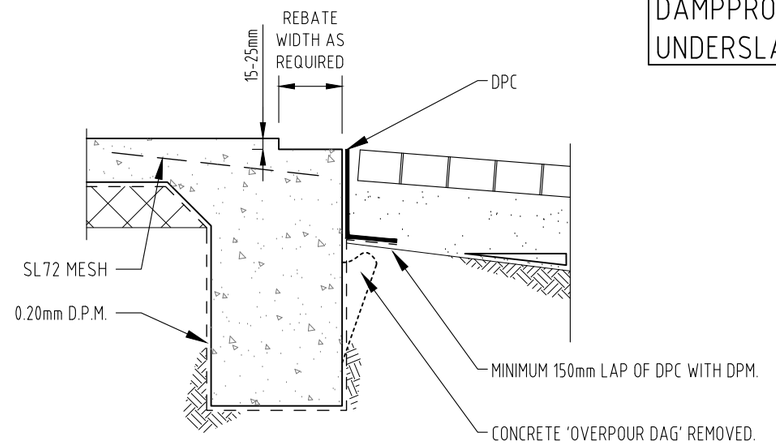
TITLE :
PAVEMENT CONSTRUCTION DETAIL SHEET

LAST REVISED :	OCT' 2018	DETAIL SHEET:	**CD5-1**
SCALE :	N.T.S.		
PAPER SIZE:	A3		

ACHIEVING BCA REQUIREMENTS USING DAMPPROOFING MEMBRANE AND DAMPPROOF COURSE ONLY AND WHEN UNDERSLAB DPM BECOMES DAMAGED



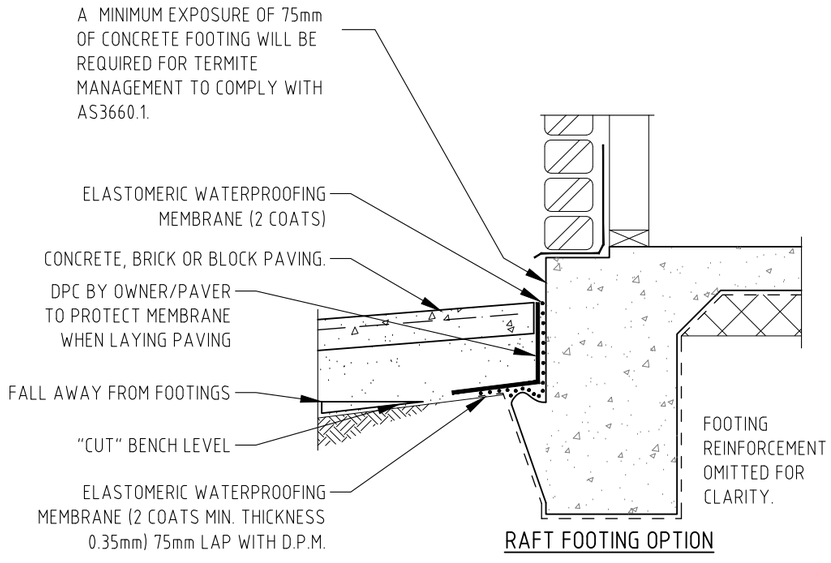
RAFT FOOTING OPTION



GARAGE REBATE DETAIL 1

NOTE: PAVING TO HAVE A MINIMUM CROSS-FALL AWAY FROM FOOTINGS PER 1.0m WIDTH OF;
:25mm FOR CLASS A, S, M-D SITES
:35mm FOR CLASS H-D SITES
:50mm FOR CLASS E SITES

ALTERNATIVE METHOD - SLAB EDGE DAMPPROOFING USING SPRAY ON ELASTOMERIC WATERPROOFING COMPOUND

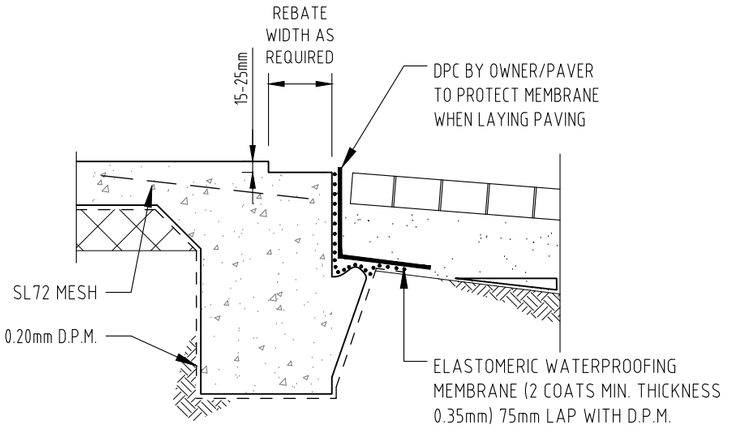


RAFT FOOTING OPTION

NOTE: PAVING TO HAVE A MINIMUM CROSS-FALL AWAY FROM FOOTINGS PER 1.0m WIDTH OF;
:25mm FOR CLASS A, S, M-D SITES
:35mm FOR CLASS H-D SITES
:50mm FOR CLASS E SITES

METHOD STATEMENT:

- APPLY A TWO COAT (MINIMUM-TOTAL THICKNESS 0.35mm) SPRAY OF AN ELASTOMERIC WATERPROOFING COMPOUND (EMER-CLAD OR SIMILAR) TO THE FOOTING EDGE FROM TOP OF SLAB LEVEL CONTINUOUSLY DOWN TO THE POINT OF EMERGENCE OF THE ORANGE COLOURED (IN SA) FOOTING DPM. ENSURE MIN 75mm OVERLAP WITH THE DPM. ENSURE FULL COVERAGE OVER ALL VERTICAL EDGE CONCRETE AND ANY HORIZONTAL OVERPOURED CONCRETE.
- BEFORE SPRAYING ENSURE:
  - IF OVERPOUR GUTTER IS LONGER THAN 2 METRES CUT DRAIN OUTLETS AT 2m SPACINGS.
  - THOROUGHLY CLEAN AND BLOW AWAY ANY LOOSE MATERIAL FROM AROUND FOOTING BEFORE SPRAYING.
- THE INTEGRITY OF THIS COATING SHALL BE MAINTAINED BY THE BUILDER UP TO THE TIME OF HANDOVER AFTER WHICH TIME IT SHALL BE MAINTAINED BY THE OWNER. A RECOMMENDED MEANS OF PROTECTION FOR OWNERS AGAINST DAMAGE DURING PAVING OPERATIONS IS TO INSTALL A VERTICAL AND PARTIALLY HORIZONTAL 0.5mm THICKNESS EMBOSSED VISCOURSE DPC AS SHOWN.



GARAGE REBATE DETAIL 2

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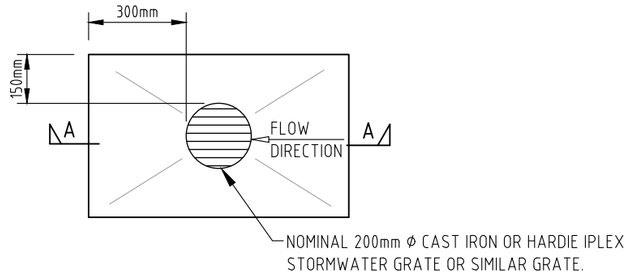
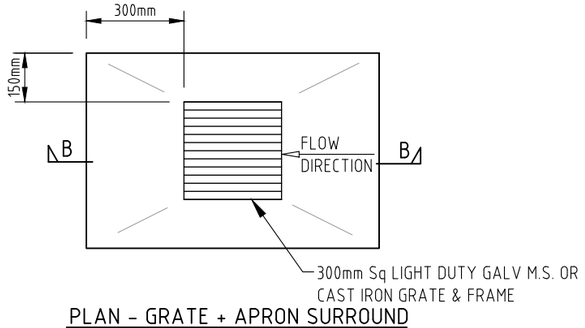
TITLE:
SLAB EDGE DAMPNESS PREVENTION (25mm REBATE RAFT)

LAST REVISED:	OCT' 2018
SCALE:	N.T.S.
PAPER SIZE:	A3

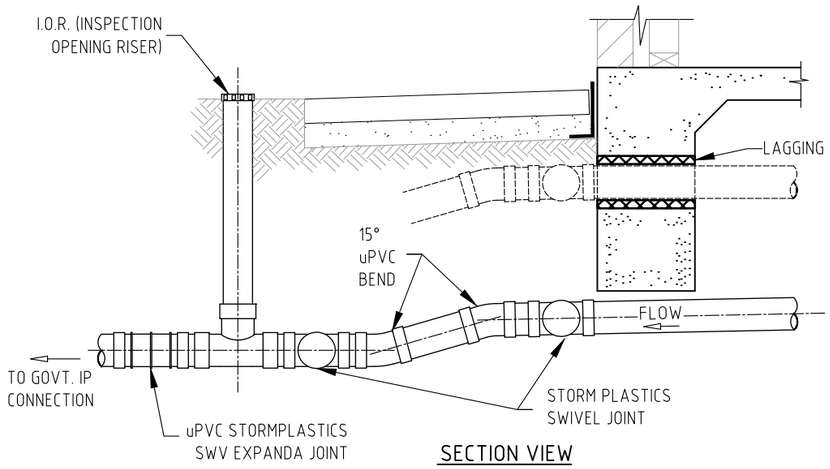
DETAIL SHEET: **CD5-4**



PLAN - GRATE + APRON SURROUND

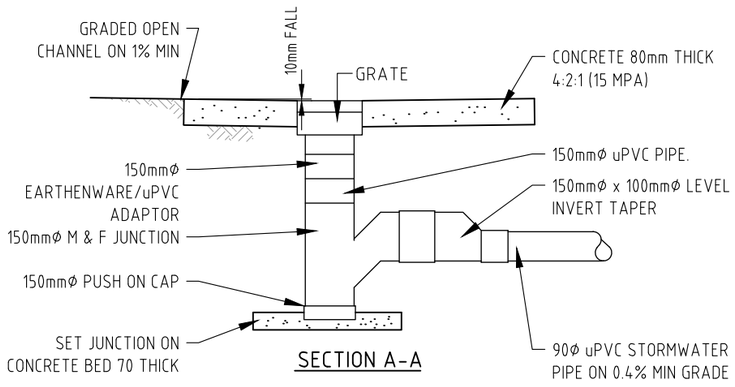


PLAN - GRATE + APRON SURROUND

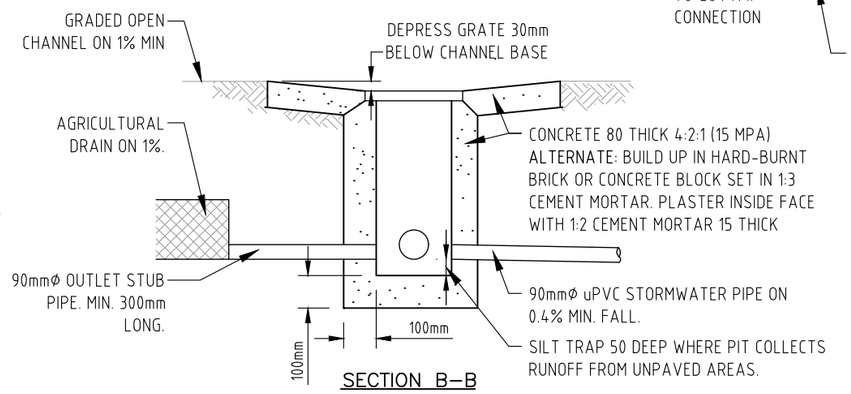


SECTION VIEW

UNDERSLAB SEWER & WASTE DRAINS CLASS H & E SITES



SECTION A-A



SECTION B-B

AGRICULTURAL DRAIN OUTLET DETAIL (WHERE APPLICABLE)

NOTE:

- FLEXIBLE CONNECTIONS ARE REQUIRED FOR UNDERSLAB SEWER & WASTE PLUMBING AS SHOWN ABOVE AT EXIT POINT.
- FLEXIBLE JOINTS MUST BE SEALED TO PROTECT AGAINST PLANT ROOT AND GRIME INTRUSION BY WRAPPING WITH DENSO TAPE. THE DENSO TAPE MUST BE IMPREGNATED WITH COPPER SULPHATE CRYSTALS PRIOR TO WRAPPING.

NOTE:

1. ADAPTOR SOCKET JUNCTION MAY BE REDUCED IN DEPTH TO RAISE LEVEL OF OUTLET PIPE.
2. LEVEL INVERT TAPER MAY BE ROTATED TO VARY LEVEL OF OUTLET PIPE.
3. ALL uPVC JOINTS TO BE SOLVENT WELDED.
4. DETAIL NOT TO BE USED WHERE LIKELY TO BE SUBJECTED TO VEHICULAR LOADINGS.
5. DETAIL SUITABLE ONLY FOR PITS AT TOP END OF DRAIN LINES.
6. NOT TO BE USED FOR OUTLET PIT FROM AGRICULTURAL DRAIN.

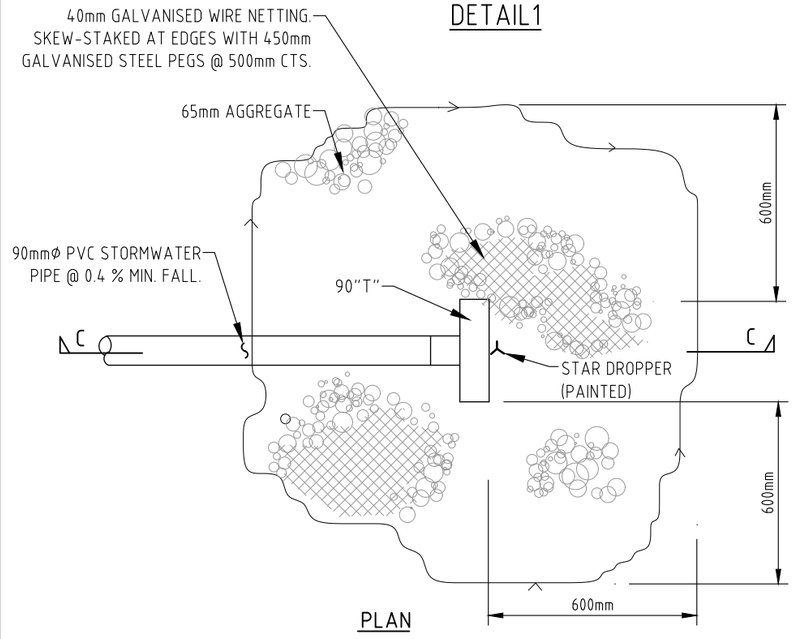
GRADED INLET PIT FOR RESIDENTIAL INSTALLATIONS ALTERNATE DETAIL

DETAIL1

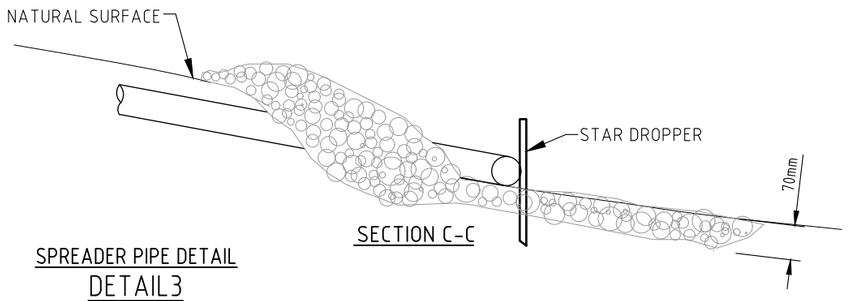
1. DETAIL NOT TO BE USED WHERE:
   a. PIT LIKELY TO BE SUBJECTED TO VEHICULAR TRAFFIC
   b. PIT IS GREATER THAN 700 DEEP.

GRADED INLET PIT FOR RESIDENTIAL INSTALLATIONS DETAIL

DETAIL2



PLAN



SECTION C-C

SPREADER PIPE DETAIL

DETAIL3

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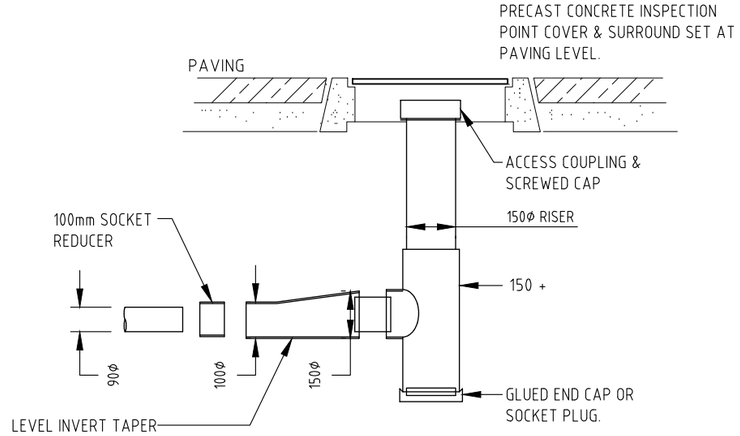
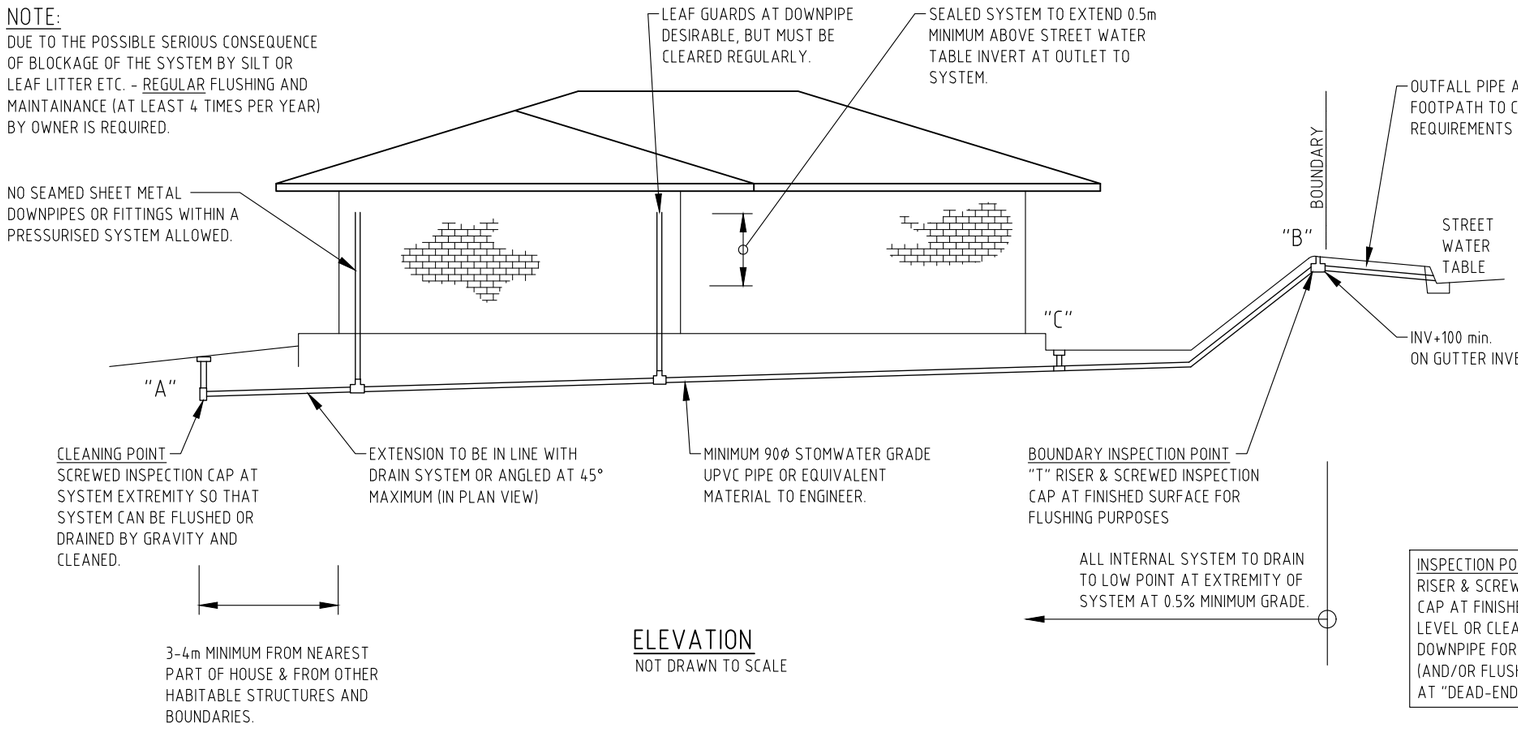
LAST REVISED :	OCT' 2018
SCALE :	N.T.S.
PAPER SIZE:	A3
DETAIL SHEET:	**DD1A**

NOTE:
NO SURFACE INLETS (SUMPS OR GRATED INLET PITS) PERMITTED INTO SEALED SYSTEM
SEALED SYSTEM TO BE CONSTRUCTED TO PRESSURE LINE STANDARD (SOLVENT WELDED JOINTS FOR UPVC PIPE). PREFERABLY STATIC WATER TESTED BEFORE BACKFILLING.



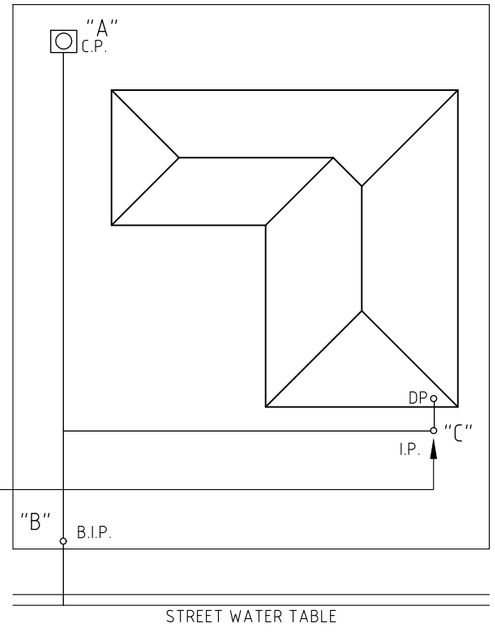
DETAIL "A"
NOT DRAWN TO SCALE

NOTE:
DUE TO THE POSSIBLE SERIOUS CONSEQUENCE OF BLOCKAGE OF THE SYSTEM BY SILT OR LEAF LITTER ETC. - REGULAR FLUSHING AND MAINTAINANCE (AT LEAST 4 TIMES PER YEAR) BY OWNER IS REQUIRED.



ELEVATION
NOT DRAWN TO SCALE

INSPECTION POINT
RISER & SCREWED INSPECTION CAP AT FINISHED SURFACE LEVEL OR CLEANING EYE IN DOWNPIPE FOR RODDING (AND/OR FLUSHING) PURPOSES AT "DEAD-END" BRANCHES.



PLAN
NOT DRAWN TO SCALE

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TITLE :
DOMESTIC ROOF STORMWATER DRAINAGE SEALED PIPE SYSTEM (PRESSURISED SYSTEM) (TYPICAL) - CP (CLEANING POINT) TYPE

LAST REVISED :	OCT' 2018
SCALE :	N.T.S.
PAPER SIZE:	A3

DETAIL SHEET: **DD2**

NOTES:

- ANY RETAINING WALLS SHOWN ARE TO BE CONSTRUCTED BY OWNER AFTER HAND OVER, EXCEPT THOSE THAT ARE NECESSARY FOR THE PHYSICAL CONSTRUCTION OF THE DWELLING.
- RETAIN ANY CUT/FILL ON BOUNDARY WITH MINOR CONCRETE SLEEPER RETAINING WALL OR CONCRETE PLINTH AS/IF REQUIRED (BY OWNER)
- NO PEGS FOUND.
- 1 x MIN. 4500L COMBINATION RETENTION & DETENTION TANK (20mm ORIFICE) (BY OWNER)
  3500L DETENTION, 1000L RETENTION
  PLUMBED INTO HOUSE WITH MAINS WATER BACK UP
  "SLIMLINE" OR SIMILAR
  ALL DP'S & RWH'S TO TANK
  (ENSURE ANY FILL PLACED UNDER TANK BASE LOCATION IS COMPACTED AT LEAST AS "ROLLED FILL". HOWEVER SOME SETTLEMENT MAY OCCUR IF "CONTROLLED FILL IS NOT USED OR IF TANK BASE SUPPORT IS NOT PIERED TO FIRM NATURAL GROUND)
  TANK STAND TO BE LOCATED ON HORIZONTAL PLATFORM
- ENSURE SEALED SYSTEM DRAIN LAID LOW ENOUGH WHERE REQUIRED TO ALLOW GRAVITY FLOW DRAIN TO PASS ABOVE WITH SPECIFIED GRADE AND COVER.
- GRADE PAVING AND FILL AND/OR GRADE GROUND TO SUMP LOCATIONS OR PROVIDE LINED SPOON DRAIN BETWEEN SUMPS AT 0.30% FALL-REFER SHEET CD5-1 AND DD1
- THE NUMBER AND LOCATION OF SUMPS SHOWN ON THIS DRAWING ARE INDICATIVE ONLY AND MAY CHANGE SUBJECT TO ACTUAL SITE CONDITIONS AND THE EXTENT AND TYPE OF PAVEMENTS SELECTED.
- CL: COVER LEVEL OF SUMP
- IL: INVERT LEVEL (ie. BOTTOM OF PIPE)

ANY WORKS BEYOND THE PROPERTY BOUNDARY ARE TO BE COMPLETED AS PER COUNCIL REQUIREMENTS AND STANDARD DETAILS.

THIS PLAN SHALL NOT BE TAKEN AS A CADASTRAL OR IDENTIFICATION SURVEY. BOUNDARY DATA SHOWN IS TO BE TAKEN AS A GUIDE ONLY. IF REQUIRED, EXACT RESIDENCE LOCATION AND BOUNDARY LENGTHS TO BE ESTABLISHED BY QUALIFIED CONSULTANT.

LEGEND

	LINED SPOON DRAIN TO FALL AT MIN. OF 0.30% (BY OWNER)
	250sq x 280d "POLYSUMP" (MAY NEED TO BE A "WET" SUMP. IE. OULET/INLET PIPES NOT FOUND AT BASE OF SUMP- C.O.S)
	90ø GRATED SURFACE S/W SUMP(TYPICAL)
	TANK INLET PIPE SEALED SYSTEM (REFER SHEET DD2) 90 ø PVC
	TANK OVERFLOW PIPE AND SURFACE STORMWATER TO FRONT SUMP AND THEN STREET W.T. (GRAVITY FLOW) 90 ø PVC
	SEWER 100 ø AT 2.0% MIN (i.e. 1 in 50)
Top / Bottom	GRADE BANKS 1 IN 2 UNLESS NOTED OTHERWISE
TREES	
	EXISTING TREE
	EXISTING TREE TO BE REMOVED BY OWNER PRIOR TO CONSTRUCTION UNLESS OTHERWISE STATED
FENCING	
	EXISTING FENCING
	FENCING INCLUDED IN CONTRACT

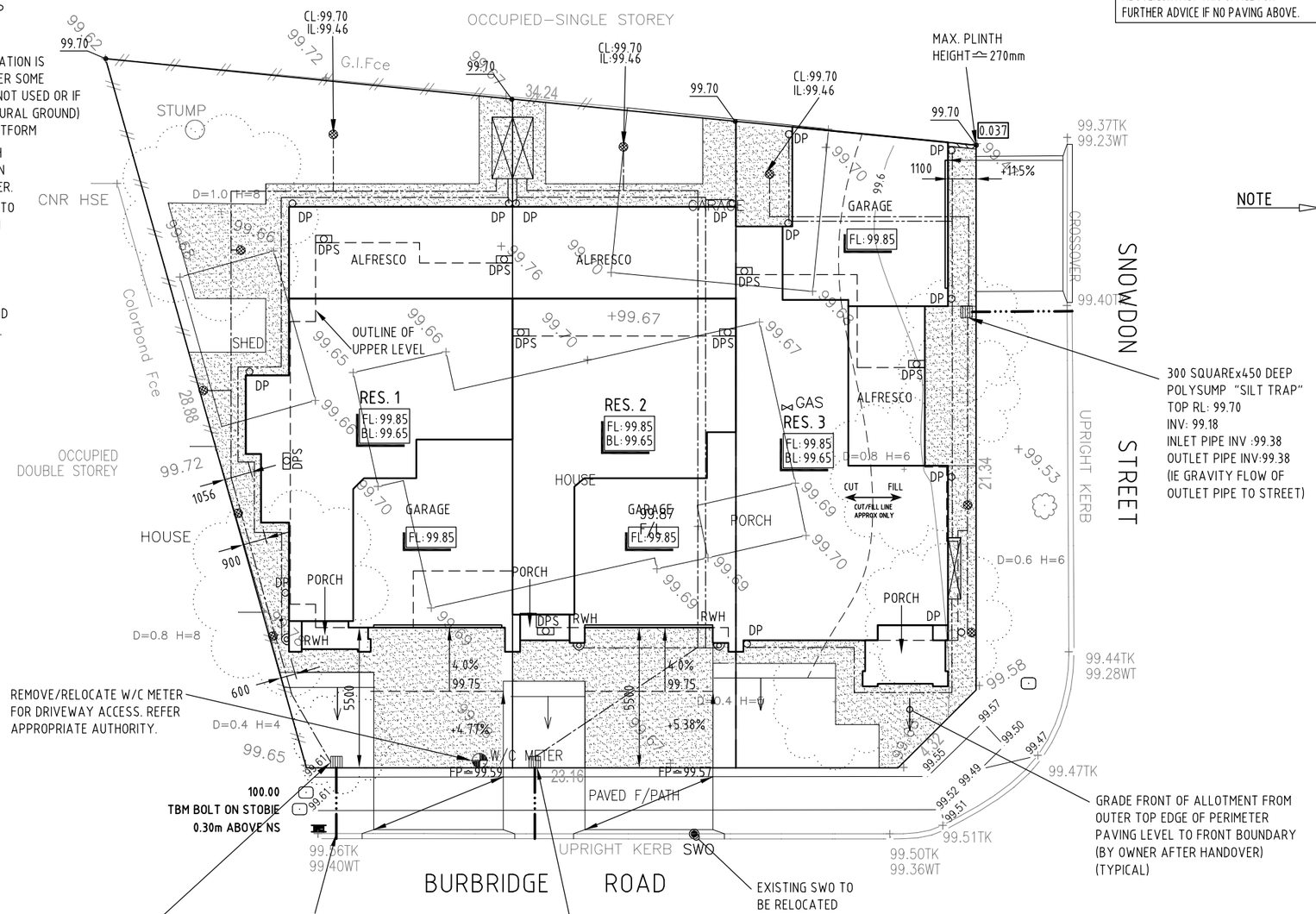
ETSA PILLAR · LPOLE · WAT CON · SEWER IP · METAL POINT (MP) · SWIP · TELSTRA · GAS IP · BDRY CNR (PEG FOUND) · BDRY CNR (NO PEG)

DATA FLOOD LEVELS AS IDENTIFIED BY COUNCIL DATABASE

TORRENS TITLE

APPROX

DRIVEWAY: 300mm COVER ONLY REQUIRED WHERE PIPE NOT PROTECTED BY PAVING ABOVE.CONTACT THIS OFFICE FOR FURTHER ADVICE IF NO PAVING ABOVE.



NOTE

300 SQUAREx450 DEEP POLYSUMP "SILT TRAP"
TOP RL: 99.70
INV: 99.18
INLET PIPE INV :99.38
OUTLET PIPE INV:99.38
(IE GRAVITY FLOW OF OUTLET PIPE TO STREET)

SCALE 0 2 4 6 8 10 METRES

BENCH:
ENSURE BENCH IS GRADED FROM HOUSE.
SLOPE OF 1 IN 40 FOR PAVED AREAS.
SLOPE OF 1 IN 100 FOR GRASSED AREAS.

SEWER LAYOUT:
THE SEWER LAYOUT IS INDICATIVE ONLY, THE INVERTS SHOWN HAVE BEEN CALCULATED TO DETERMINE WHETHER ADDITIONAL FOOTING PIERS MAY BE REQUIRED. IT IS NOT NECESSARILY A FINAL SEWER DESIGN. IF SEWER IS TO BE LAID DEEPER THAN INVERT POINTS SHOWN THEN A REVIEW OF FOOTING DESIGN IS REQUIRED BY THIS OFFICE. MAXIMUM LEVEL OF PATH AT FLOOD GULLY TO BE 165mm BELOW F.F.L.

STORMWATER:
PROVIDE ADEQUATE PROTECTION OR COVER TO STORMWATER PIPES (300mm COVER WHERE PIPE IS LIKELY TO BE SUBJECTED TO VEHICULAR LOADING AND 100mm MINIMUM COVER OTHERWISE). WHEN A SEALED STORMWATER SYSTEM IS USED REFER TO DETAIL SHEET. 1 IN 250 MIN FALL ON STORMWATER DRAINS EXCEPT IN SEALED SYSTEMS.

FLEXIBLE CONNECTIONS:
FLEXIBLE CONNECTIONS TO STORM WATER AND WASTE DRAINS ARE NOT NECESSARY ON THIS SITE.

SITE:
LEVELS SHOWN ARE APPROXIMATE ONLY AND ARE TO AN ASSUMED DATUM AS INDICATED ON SITE PLAN. SITE DIMENSIONS SHOWN IN BRACKETS ( ) AND BOUNDARIES ARE ASSUMED ACCORDING TO INFORMATION AVAILABLE OR FOUND ON SITE, AND SHALL BE CONFIRMED BY THE OWNER.

OWNER PLEASE NOTE
STORMWATER DISPOSAL INCLUDING SURFACE DRAINAGE, AS PER PLAN AND TO COUNCIL REQUIREMENTS ALL TO BE CONSTRUCTED BY OWNER, INCLUDING RETAINING WALLS, UNLESS STATED OTHERWISE IN THE CONTRACT. THE STORMWATER DISPOSAL SYSTEM AS INDICATED MUST BE INSTALLED AS SOON AS PRACTICABLE.
ANY EXCAVATIONS ADJACENT TO FOOTINGS SHALL COMPLY WITH THE REQUIREMENTS OF CLAUSE 4 IN APPENDIX B OF FOOTING REPORT. WRITTEN DIMENSIONS SHALL TAKE PRIORITY OVER SCALED DIMENSIONS.
ANY DISCREPANCY BETWEEN THE FOOTING PLAN/REPORT AND THE CIVIL PLAN SHALL BE REPORTED TO FMG ENGINEERING IMMEDIATELY. FLOOR LEVELS MAY BE INCREASED TO ACCOMMODATE SEWER GRADE REQUIREMENTS. OWNER AND/OR BUILDER ARE TO CHECK SEWER INVERTS PRIOR TO SITEWORKS COMMENCING.

REV	DESCRIPTION	DATE	INIT	APP
B	DOWNPIPE AMENDED	24.01.2019	AH	
A	ARCHITECTURAL PLAN REVISED	19.12.2018	AL	

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SIGNATURE

CLIENT
Bojack Pty Ltd

PROJECT TITLE
PROPOSED RESIDENCE

SITE ADDRESS
Dwellings 1-3, Lot 131, 638 Burbridge Road,
WEST BEACH, SA 5024

DRAWING TITLE
CIVIL PLAN

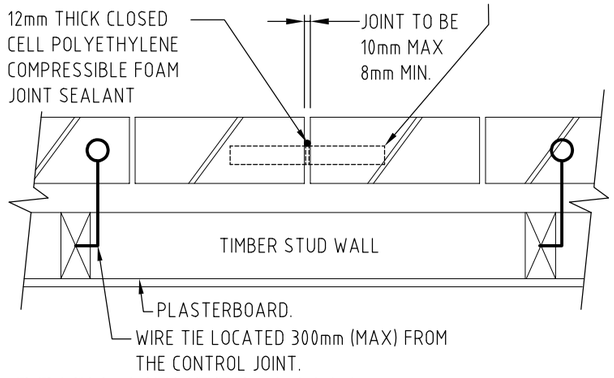
No. OF SHEETS: 1 OF 1	SCALE: 1:200 @ A3	DATE STARTED: 31.08.0018
DRAWN: S.K	SITE ID & JOB No.: S42166 / 262926	REV.
DESIGNED: S.K	DRAWING No.: HC01	B
CHECKED		

LEGEND:

C.J — CONTROL JOINT – ARTICULATION JOINT LOCATION.

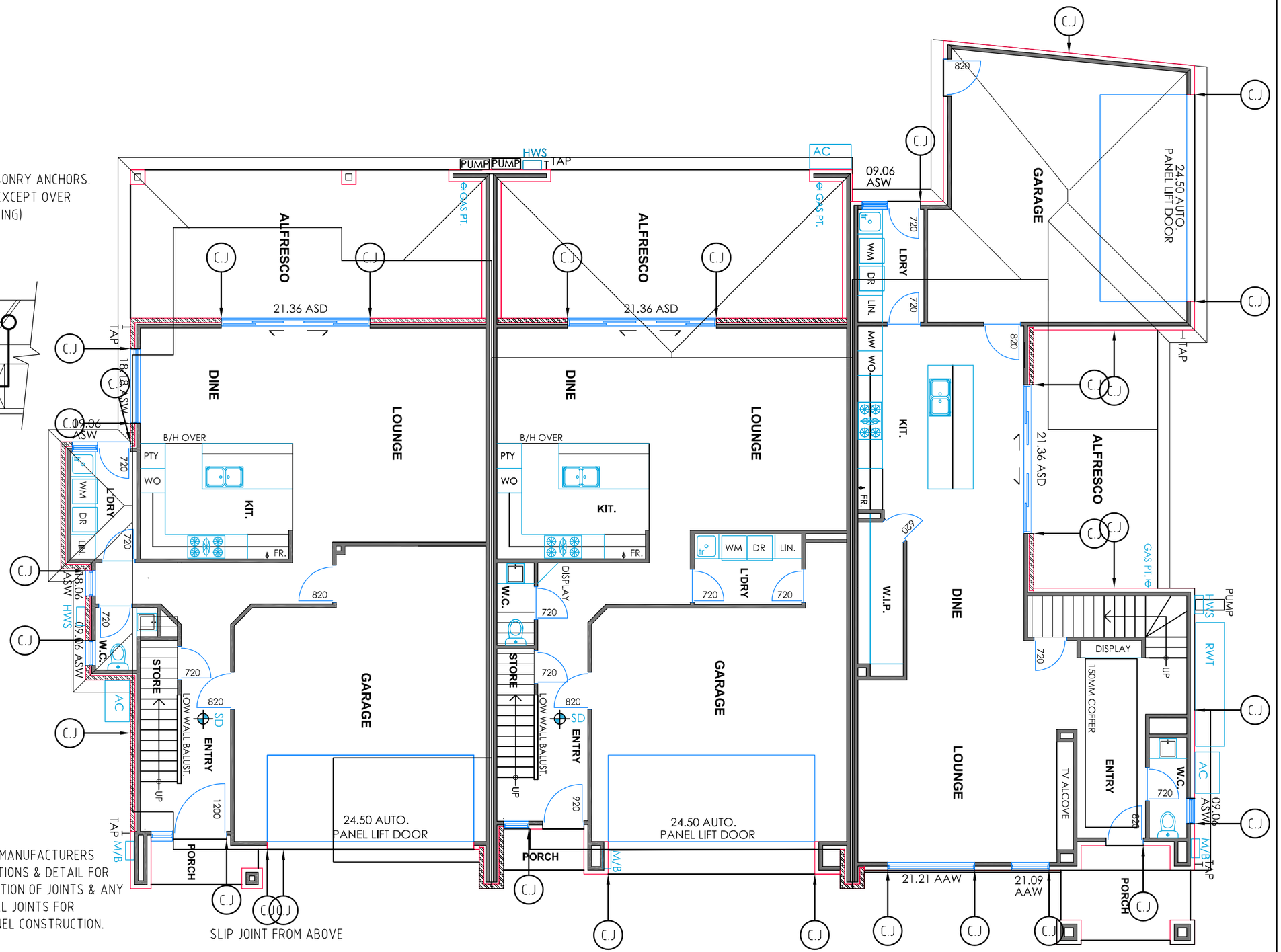
NOTE:
FOR CONTROL JOINTS IN A SINGLE LEAF MASONRY WALL, CONSTRUCT CJ WITH 2/6mm ø x 150mm LONG GALVANISED PINS PLACED CENTRALLY ACROSS JOINT EVERY THIRD BRICK COURSE OR USE MFA3 ANCHOR (TJ INDUSTRIES) ACROSS EVERY SIXTH COURSE.

FLEXIBLE MASONRY ANCHORS. (OPTIONAL – EXCEPT OVER GARAGE OPENING)



BRICK VENEER WALL ARTICULATION JOINT DETAIL

NOT TO SCALE



NOTE:
REFER TO MANUFACTURERS SPECIFICATIONS & DETAIL FOR CONSTRUCTION OF JOINTS & ANY ADDITIONAL JOINTS FOR RENDAPANEL CONSTRUCTION.

REV	DESCRIPTION	DATE	INIT	APP

FMG Engineering
PO Box 707, Kent Town SA 5071
42 Fullarton Rd, Norwood SA 5067
P 08 8363 0222
F 08 8363 1555
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ABN 58 083 071 185
fmg ENGINEERING incorporating BURNS HAMILTON
CIVIL | STRUCTURAL | ENVIRONMENTAL | GEOTECHNICAL | BUILDING ASSESSMENT & FORENSIC | SOIL & MATERIAL TESTING | HOUSING | COMMERCIAL | PROJECT MANAGEMENT | SURVEY

SIGNATURE

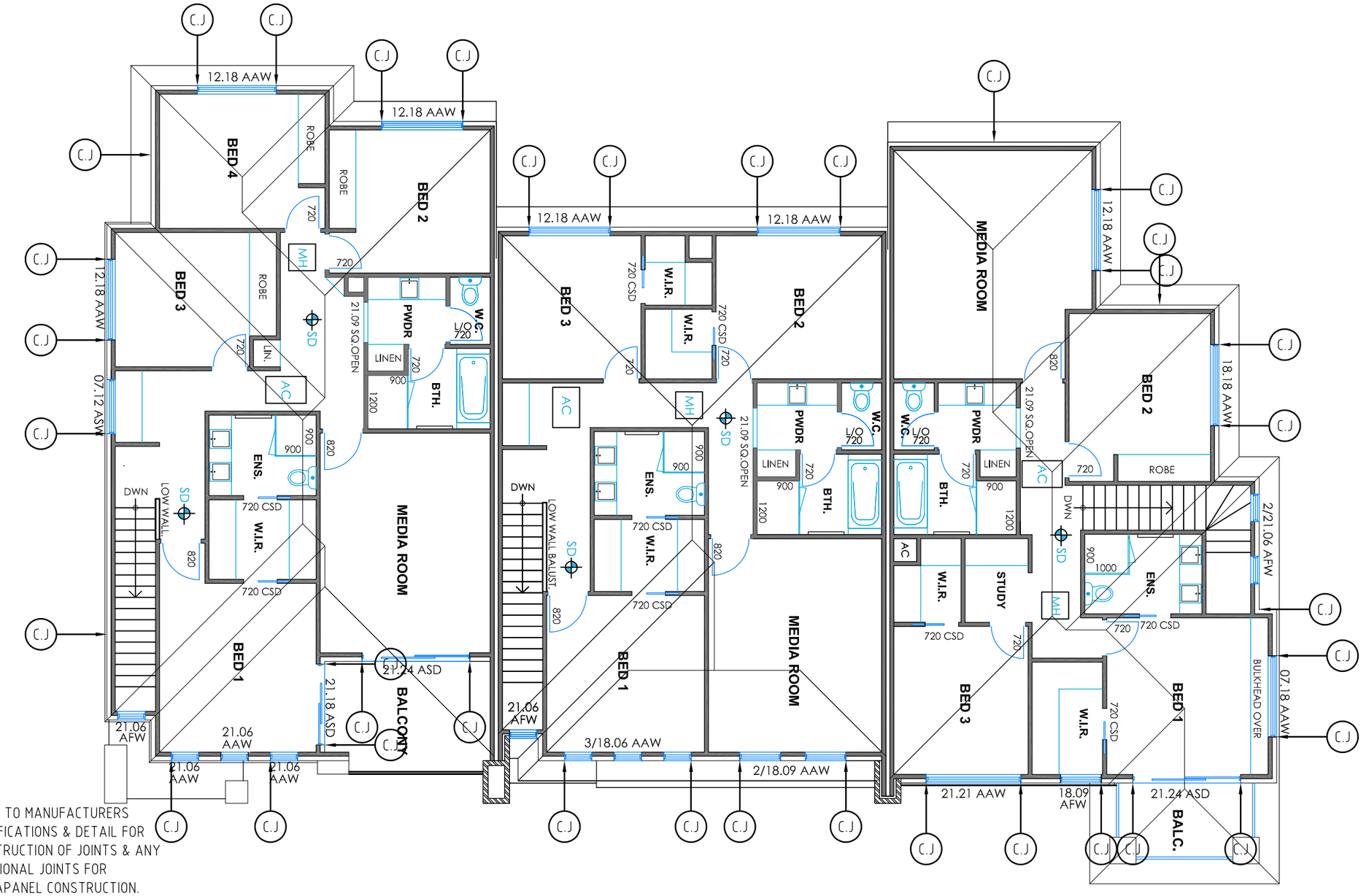
CLIENT: Bojack Pty Ltd

PROJECT TITLE: PROPOSED RESIDENCE

SITE ADDRESS: Dwellings 1-3, Lot 131, 638 Burbridge Road, WEST BEACH, SA 5024

DRAWING TITLE: ARTICULATION PLAN

DESIGNED	DRAWN
AH	AH
CHECKED	No. OF SHEETS
	1 OF 2
SCALE	DATE STARTED
1:100 @ A3	24/01/2019
SITE ID & JOB No.	REV.
S42166 – 262926	
DRAWING No.	
CJ01	



NOTE:
REFER TO MANUFACTURERS SPECIFICATIONS & DETAIL FOR CONSTRUCTION OF JOINTS & ANY ADDITIONAL JOINTS FOR RENDAPANEL CONSTRUCTION.

REV	DESCRIPTION	DATE	INIT	APP

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SIGNATURE

CLIENT
Bojack Pty Ltd

PROJECT TITLE
PROPOSED RESIDENCE

SITE ADDRESS
Dwellings 1-3, Lot 131, 638 Burbridge Road, WEST BEACH, SA 5024

DRAWING TITLE
ARTICULATION PLAN

DESIGNED	DRAWN
AH	AH
CHECKED	No. OF SHEETS
	2 OF 2
SCALE	DATE STARTED
1:100 @ A3	24/01/2019
SITE ID & JOB No.	REV.
S42166 - 262926	
DRAWING No.	
CJ02	

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:10)

Code Oriented Raft Design (Version 8.0)
****

FOOTING DESIGN TO AS2870 - 2011
-- Raft Footing --

****
RECTANGLE 1 of 3 (25.81m x 16.48m)

THE FOLLOWING VALUES WILL BE USED:

External Wall Weight
- Side 1 .....= 2 kPa
- Side 2 .....= 2 kPa
- Side 3 .....= 2 kPa
- Side 4 .....= 2 kPa

Wall Height Externally
- Side 1 .....= 5.8 m
- Side 2 .....= 5.8 m
- Side 3 .....= 5.8 m
- Side 4 .....= 5.8 m

Roof Eaves Overhang
- Side 1 .....= 0.6 m
- Side 2 .....= 0.6 m
- Side 3 .....= 0.6 m
- Side 4 .....= 0.6 m

Internal Wall Weight .....= 0.5 kPa
Roof Type - Trussed
Roof Weight .....= 0.45 kPa
Wall Height Internally .....= 2.7 m
Internal Wall Length .....= 100 m
Slab Live Load .....= 1.5 kPa
Deflection Ratio .....= 1 / 400
E conc. long term (max) .....= 19.581 GPa
Hs .....= 4 m
Footing design modified for tree effects - Yes

Ys .....= 20 mm

Yt .....= 14 mm

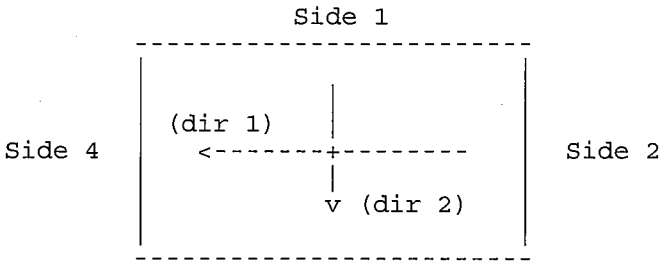
Ym tree (centre) --> 0.7Ys + Yt = 28 mm

Ym (edge) --> 0.5Ys .....= 10 mm

Footing design accounts for tree removal - No

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:10)

Code Oriented Raft Design (Version 8.0)
****



****
LOAD CALCULATION (Note: Footing self-weight is generated automatically)

External line load PE (kN/m)
Wall load
Side 1 (5.8 x 2) = 11.60 kN/m
Side 2 (5.8 x 2) = 11.60 kN/m
Side 3 (5.8 x 2) = 11.60 kN/m
Side 4 (5.8 x 2) = 11.60 kN/m
Roof eaves load
Side 1 (0.6 x (25.81 + 0.6 + 0.6) / 25.81 x 0.45) = 0.28 kN/m
Side 2 (0.6 x (16.48 + 0.6 + 0.6) / 16.48 x 0.45) = 0.29 kN/m
Side 3 (0.6 x (25.81 + 0.6 + 0.6) / 25.81 x 0.45) = 0.28 kN/m
Side 4 (0.6 x (16.48 + 0.6 + 0.6) / 16.48 x 0.45) = 0.29 kN/m
NOTE: Roof load (excluding eaves overhang) is borne only by sides 1 & 3.
Roof load
side 1 (0.45 x (16.48 / 2 + 0.6) = 3.98 kN/m
side 2 0.45 x 0.6 x (16.48 + 0.6 + 0.6) / 16.48 = 0.29 kN/m
side 3 (0.45 x (16.48 / 2 + 0.6) = 3.98 kN/m
side 4 0.45 x 0.6 x (16.48 + 0.6 + 0.6) / 16.48 = 0.29 kN/m
Footing self weight:-
Direction 1 (0.35 x 0.3 x 24) = 2.52 kN/m
Direction 2 (0.35 x 0.3 x 24) = 2.52 kN/m
- -
PE (Side 1) = 18.10 kN/m
PE (Side 2) = 14.41 kN/m
PE (Side 3) = 18.10 kN/m
PE (Side 4) = 14.41 kN/m

Distributed internal load W (kPa)
Internal walls (100 x 0.5 x 2.7 / (25.81 x 16.48)) = 0.32 kPa
Slab self weight (0.1 x 24) = 2.40 kPa
Additional slab load = 0.60 kPa
Footing self weight:-
Direction 1 ((4 x 0.3 x (0.45 - 0.1) x 24) / 16.48) = 0.61 kPa
Direction 2 ((7 x 0.3 x (0.45 - 0.1) x 24) / 25.81) = 0.68 kPa
Live load = 1.50 kPa
Sub Total (Omega) = 6.11 kPa
Longitudinal edge loads
Direction 1 ((18.10 + 18.10) / 16.48) = 2.20 kPa
Direction 2 ((14.41 + 14.41) / 25.81) = 1.12 kPa
- -
W (Direction 1) = 8.31 kPa
W (Direction 2) = 7.23 kPa

Total distributed load Q (kPa)
Omega = 6.11 kPa
Line loads
Direction 1 ((18.10 + 18.10) x 25.81) / (25.81 x 16.48) = 2.20 kPa
Direction 2 ((14.41 + 14.41) x 16.48) / (16.48 x 25.81) = 1.12 kPa
- -
Q = 9.43 kPa

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:10)

Code Oriented Raft Design (Version 8.0)
****

****
RECTANGLE 2 of 3 (16.48m x 8.91m)

THE FOLLOWING VALUES WILL BE USED:

External Wall Weight
- Side 1 .....= 2 kPa
- Side 2 .....= 2 kPa
- Side 3 .....= 2 kPa
- Side 4 .....= 2 kPa

Wall Height Externally
- Side 1 .....= 5.8 m
- Side 2 .....= 5.8 m
- Side 3 .....= 5.8 m
- Side 4 .....= 5.8 m

Roof Eaves Overhang
- Side 1 .....= 0.6 m
- Side 2 .....= 0.6 m
- Side 3 .....= 0.6 m
- Side 4 .....= 0.6 m

Internal Wall Weight .....= 0.5 kPa
Roof Type - Trussed
Roof Weight .....= 0.45 kPa
Wall Height Internally .....= 2.7 m
Internal Wall Length .....= 50 m
Slab Live Load .....= 1.5 kPa
Deflection Ratio .....= 1 / 400
E conc. long term (max) .....= 19.581 GPa
Hs .....= 4 m
Footing design modified for tree effects - Yes

Ys .....= 20 mm

Yt .....= 14 mm

Ym tree (centre) --> 0.7Ys + Yt = 28 mm

Ym (edge) --> 0.5Ys .....= 10 mm

Footing design accounts for tree removal - No

```
                             Side 1
                   -------------------------
                   |                       |
                   |           |           |
                   |  (dir 1)  |           |
        Side 4     |  <--------+--------   |    Side 2
                   |           |           |
                   |           v (dir 2)   |
                   |                       |
                   -------------------------
                             Side 3
*************************************************************************
LOAD CALCULATION (Note: Footing self-weight is generated automatically)
-------------------------------------------------------------------------
External line load PE (kN/m)
  Wall load
    Side 1  (5.8 x 2)............................................= 11.60 kN/m
    Side 2  (5.8 x 2)............................................= 11.60 kN/m
    Side 3  (5.8 x 2)............................................= 11.60 kN/m
    Side 4  (5.8 x 2)............................................= 11.60 kN/m
  Roof eaves load
    Side 1  (0.6 x (16.48 + 0.6 + 0.6) / 16.48 x 0.45)...........= 0.29 kN/m
    Side 2  (0.6 x (8.91 + 0.6 + 0.6) / 8.91 x 0.45).............= 0.31 kN/m
    Side 3  (0.6 x (16.48 + 0.6 + 0.6) / 16.48 x 0.45)...........= 0.29 kN/m
    Side 4  (0.6 x (8.91 + 0.6 + 0.6) / 8.91 x 0.45).............= 0.31 kN/m
NOTE: Roof load (excluding eaves overhang) is borne only by sides 1 & 3.
  Roof load
    side 1  (0.45 x (8.91 / 2 + 0.6) ............................= 2.27 kN/m
    side 2  0.45 x 0.6 x (8.91 + 0.6 + 0.6) / 8.91 ..............= 0.31 kN/m
    side 3  (0.45 x (8.91 / 2 + 0.6) ............................= 2.27 kN/m
    side 4  0.45 x 0.6 x (8.91 + 0.6 + 0.6) / 8.91 ..............= 0.31 kN/m
  Footing self weight:-
    Direction 1 (0.35 x 0.3 x 24)................................= 2.52 kN/m
    Direction 2 (0.35 x 0.3 x 24)................................= 2.52 kN/m
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  PE (Side  1) ..................................................= 16.39 kN/m
  PE (Side  2) ..................................................= 14.43 kN/m
  PE (Side  3) ..................................................= 16.39 kN/m
  PE (Side  4) ..................................................= 14.43 kN/m
-------------------------------------------------------------------------
Distributed internal load W (kPa)
  Internal walls  (50 x 0.5 x 2.7 / (16.48 x 8.91))..............= 0.46 kPa
  Slab self weight (0.1 x 24)....................................= 2.40 kPa
  Additional slab load ..........................................= 0.60 kPa
  Footing self weight:-
    Direction 1       ((2 x 0.3 x (0.45 - 0.1) x 24) / 8.91).....= 0.57 kPa
    Direction 2       ((4 x 0.3 x (0.45 - 0.1) x 24) / 16.48)....= 0.61 kPa
  Live load .....................................................= 1.50 kPa
  Sub Total (Omega) .............................................= 6.14 kPa
Longitudinal edge loads
  Direction 1       ((16.39 + 16.39) / 8.91).....................= 3.68 kPa
  Direction 2       ((14.43 + 14.43) / 16.48)....................= 1.75 kPa
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  W (Direction 1) ...............................................= 9.82 kPa
  W (Direction 2) ...............................................= 7.89 kPa
-------------------------------------------------------------------------
Total distributed load Q (kPa)
  Omega .........................................................= 6.14 kPa
  Line loads
    Direction 1       ((16.39 + 16.39) x 16.48) / (16.48 x 8.91) = 3.68 kPa
    Direction 2       ((14.43 + 14.43) x 8.91) / (8.91 x 16.48) .= 1.75 kPa
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Q .............................................................= 11.57 kPa
-------------------------------------------------------------------------
```

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:10)

Code Oriented Raft Design (Version 8.0)
****

****
RECTANGLE 3 of 3 (20.11m x 8.45m)

THE FOLLOWING VALUES WILL BE USED:

External Wall Weight
- Side 1 .....= 2 kPa
- Side 2 .....= 2 kPa
- Side 3 .....= 2 kPa
- Side 4 .....= 2 kPa

Wall Height Externally
- Side 1 .....= 5.8 m
- Side 2 .....= 5.8 m
- Side 3 .....= 5.8 m
- Side 4 .....= 5.8 m

Roof Eaves Overhang
- Side 1 .....= 0.6 m
- Side 2 .....= 0.6 m
- Side 3 .....= 0.6 m
- Side 4 .....= 0.6 m

Internal Wall Weight .....= 0.5 kPa
Roof Type - Trussed
Roof Weight .....= 0.45 kPa
Wall Height Internally .....= 2.7 m
Internal Wall Length .....= 50 m
Slab Live Load .....= 1.5 kPa
Deflection Ratio .....= 1 / 400
E conc. long term (max) .....= 19.581 GPa
Hs .....= 4 m
Footing design modified for tree effects - Yes

Ys .....= 20 mm

Yt .....= 14 mm

Ym tree (centre) --> 0.7Ys + Yt = 28 mm

Ym (edge) --> 0.5Ys .....= 10 mm

Footing design accounts for tree removal - No

```
                                  Side 1
                        -------------------------
                        |                       |
                        |           |           |
                        |  (dir 1)  |           |
             Side 4     |   <-------+--------   |    Side 2
                        |           |           |
                        |           v  (dir 2)  |
                        |                       |
                        -------------------------
                                  Side 3
***********************************************************************
LOAD CALCULATION (Note: Footing self-weight is generated automatically)
-----------------------------------------------------------------------
External line load PE (kN/m)
  Wall load
    Side 1  (5.8 x 2)..............................................= 11.60 kN/m
    Side 2  (5.8 x 2)..............................................= 11.60 kN/m
    Side 3  (5.8 x 2)..............................................= 11.60 kN/m
    Side 4  (5.8 x 2)..............................................= 11.60 kN/m
  Roof eaves load
    Side 1  (0.6 x (20.11 + 0.6 + 0.6) / 20.11 x 0.45)...........= 0.29 kN/m
    Side 2  (0.6 x (8.45 + 0.6 + 0.6) / 8.45 x 0.45).............= 0.31 kN/m
    Side 3  (0.6 x (20.11 + 0.6 + 0.6) / 20.11 x 0.45)...........= 0.29 kN/m
    Side 4  (0.6 x (8.45 + 0.6 + 0.6) / 8.45 x 0.45).............= 0.31 kN/m
NOTE: Roof load (excluding eaves overhang) is borne only by sides 1 & 3.
  Roof load
    side 1  (0.45 x (8.45 / 2 + 0.6) ...........................= 2.17 kN/m
    side 2  0.45 x 0.6 x (8.45 + 0.6 + 0.6) / 8.45 .............= 0.31 kN/m
    side 3  (0.45 x (8.45 / 2 + 0.6) ...........................= 2.17 kN/m
    side 4  0.45 x 0.6 x (8.45 + 0.6 + 0.6) / 8.45 .............= 0.31 kN/m
  Footing self weight:-
    Direction 1 (0.35 x 0.3 x 24)................................= 2.52 kN/m
    Direction 2 (0.35 x 0.3 x 24)................................= 2.52 kN/m
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  PE (Side  1) ..................................................= 16.29 kN/m
  PE (Side  2) ..................................................= 14.43 kN/m
  PE (Side  3) ..................................................= 16.29 kN/m
  PE (Side  4) ..................................................= 14.43 kN/m
-----------------------------------------------------------------------
Distributed internal load W (kPa)
  Internal walls  (50 x 0.5 x 2.7 / (20.11 x 8.45))..............= 0.40 kPa
  Slab self weight (0.1 x 24)....................................= 2.40 kPa
  Additional slab load ..........................................= 0.60 kPa
  Footing self weight:-
    Direction 1       ((1 x 0.3 x (0.45 - 0.1) x 24) / 8.45).....= 0.30 kPa
    Direction 2       ((5 x 0.3 x (0.45 - 0.1) x 24) / 20.11)....= 0.63 kPa
  Live load .....................................................= 1.50 kPa
  Sub Total (Omega) .............................................= 5.82 kPa
Longitudinal edge loads
  Direction 1       ((16.29 + 16.29) / 8.45).....................= 3.86 kPa
  Direction 2       ((14.43 + 14.43) / 20.11)....................= 1.43 kPa
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  W (Direction 1) ...............................................= 9.68 kPa
  W (Direction 2) ...............................................= 7.26 kPa
-----------------------------------------------------------------------
Total distributed load Q (kPa)
  Omega .........................................................= 5.82 kPa
  Line loads
    Direction 1       ((16.29 + 16.29) x 20.11) / (20.11 x 8.45) = 3.86 kPa
    Direction 2       ((14.43 + 14.43) x 8.45) / (8.45 x 20.11) .= 1.43 kPa
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Q .............................................................= 11.11 kPa
-----------------------------------------------------------------------
```

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:10)

Code Oriented Raft Design (Version 8.0)
****

Rectangle 1 of 3	DIRECTION 1	DIRECTION 2
L(m)	25.81	16.48
B(m)	16.48	25.81
P Edge (kN/m)	18.10	14.41
P Centre (kN/m)	0.00	0.00
W(kPa)	8.31	7.23
k(kPa/m)	1000.00	1000.00
Delta(mm)	30.0	30.0
No. of Beams	6	9
	CENTRE HEAVE	
Delta > Ymc ?	YES	YES
Edge Dist. (m)	1.278	1.278
M work (kNm/m)	10.50	15.14
I req(x10^6 mm4/m)	81.00	158.13
	EDGE HEAVE	
Delta > Yme ?	YES	YES
Edge Dist. (m)	1.000	1.000
M work (kNm/m)	0.12	0.49
I req(x10^6 mm4/m)	0.11	0.16

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:10)

Code Oriented Raft Design (Version 8.0)
****

Rectangle 2 of 3	DIRECTION 1	DIRECTION 2
L(m)	16.48	8.91
B(m)	8.91	16.48
P Edge (kN/m)	16.39	14.43
P Centre (kN/m)	0.00	0.00
W(kPa)	9.82	7.89
k(kPa/m)	1156.79	1156.79
Delta(mm)	30.0	22.3
No. of Beams	4	6
	CENTRE HEAVE	
Delta > Ymc ?	YES	NO
Edge Dist. (m)	1.278	1.278
M work (kNm/m)	9.68	20.51
I req(x10^6 mm4/m)	61.27	423.32
	EDGE HEAVE	
Delta > Yme ?	YES	YES
Edge Dist. (m)	1.000	1.000
M work (kNm/m)	0.46	0.30
I req(x10^6 mm4/m)	0.24	0.10

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:10)

Code Oriented Raft Design (Version 8.0)
****

Rectangle 3 of 3	DIRECTION 1	DIRECTION 2
L(m)	20.11	8.45
B(m)	8.45	20.11
P Edge (kN/m)	16.29	14.43
P Centre (kN/m)	0.00	0.00
W(kPa)	9.68	7.26
k(kPa/m)	1111.29	1111.29
Delta(mm)	30.0	21.1
No. of Beams	3	7
	CENTRE HEAVE	
Delta > Ymc ?	YES	NO
Edge Dist. (m)	1.278	1.278
M work (kNm/m)	9.63	22.24
I req(x10^6 mm4/m)	65.35	448.75
	EDGE HEAVE	
Delta > Yme ?	YES	YES
Edge Dist. (m)	1.000	1.000
M work (kNm/m)	0.37	0.29
I req(x10^6 mm4/m)	0.21	0.08

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:10)

Code Oriented Raft Design (Version 8.0)
****

TRIAL FOOTING PROPERTIES :-

Edge Beams:
Beam Width = 300 mm
Beam Depth = 450 mm
Reinforcement
- top = 4 x N12 bars, 40 mm cover
- bottom = 4 x N12 bars, 65 mm cover

Internal Beams:
Beam Width = 300 mm
Beam Depth = 450 mm
Reinforcement
- top = 3 x N12 bars, 40 mm cover
- bottom = 3 x N12 bars, 65 mm cover

Slab:
Thickness = 100 mm
Reinforcement
- layer 1 = 179 mm^2/m in both directions, 20 mm cover

Material Properties:
Fsy = 500 MPa
F'c = 32 MPa

A COMPARISON OF THE REQUIRED DESIGN PROPERTIES AND THOSE OBTAINED FOR THE ABOVE FOOTING SYSTEM IS TABULATED BELOW

- Note that where relevant, the properties are expressed in units per metre width of total footing cross section
- The I required values have been factored up to take account of the variation in the long term creep factor for concrete, refer to AS3600, clause 8.5.3.3

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:10)

Code Oriented Raft Design (Version 8.0)
****

RECTANGLE 1 of 3 (25.81m x 16.48m)

BEAM DEFLECTED SHAPE	CENTRE HEAVE		EDGE HEAVE	
	REQUIRED	ACTUAL	REQUIRED	ACTUAL
DIRECTION 1				
Moment of Inertia (x 10^9 mm^4/m)	0.081 (Ireq)	1.846 (Ieff)	0.000 (Ireq)	1.846 (Ieff)
Flexural Strength (kNm/m)	10.5 (M*)	49.4 (øMu)	0.1 (M*)	23.3 (øMu)
Ductility Check (kNm/m)	55.6 (1.5Mcr)	61.7 (Mu)	28.1 (1.5Mcr)	29.1 (Mu)
Flange Width (m)	External 1.648	Internal 3.296		
DIRECTION 2				
Moment of Inertia (x 10^9 mm^4/m)	0.158 (Ireq)	1.794 (Ieff)	0.000 (Ireq)	1.794 (Ieff)
Flexural Strength (kNm/m)	15.1 (M*)	47.8 (øMu)	0.5 (M*)	21.7 (øMu)
Ductility Check (kNm/m)	55.0 (1.5Mcr)	59.8 (Mu)	27.1 (1.5Mcr)	27.1 (Mu)
Flange Width (m)	External 1.613125	Internal 3.22625		

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:10)

Code Oriented Raft Design (Version 8.0)
****

RECTANGLE 2 of 3 (16.48m x 8.91m)

BEAM DEFLECTED SHAPE	CENTRE HEAVE		EDGE HEAVE	
	REQUIRED	ACTUAL	REQUIRED	ACTUAL
DIRECTION 1				
Moment of Inertia (x 10^9 mm^4/m)	0.061 (Ireq)	2.145 (Ieff)	0.000 (Ireq)	2.145 (Ieff)
Flexural Strength (kNm/m)	9.7 (M*)	55.8 (øMu)	0.5 (M*)	29.6 (øMu)
Ductility Check (kNm/m)	59.5 (1.5Mcr)	69.8 (Mu)	33.7 (1.5Mcr)	37.0 (Mu)
Flange Width (m)	External 1.485	Internal 2.97		
DIRECTION 2				
Moment of Inertia (x 10^9 mm^4/m)	0.423 (Ireq)	1.645 (Ieff)	0.000 (Ireq)	1.645 (Ieff)
Flexural Strength (kNm/m)	20.5 (M*)	40.0 (øMu)	0.3 (M*)	22.7 (øMu)
Ductility Check (kNm/m)	41.9 (1.5Mcr)	50.0 (Mu)	26.6 (1.5Mcr)	28.3 (Mu)
Flange Width (m)	External 1.191	Internal 2.082		

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:10)

Code Oriented Raft Design (Version 8.0)
****

RECTANGLE 3 of 3 (20.11m x 8.45m)

BEAM DEFLECTED SHAPE	CENTRE HEAVE		EDGE HEAVE	
	REQUIRED	ACTUAL	REQUIRED	ACTUAL
DIRECTION 1				
Moment of Inertia (x 10^9 mm^4/m)	0.065 (Ireq)	1.808 (Ieff)	0.000 (Ireq)	1.808 (Ieff)
Flexural Strength (kNm/m)	9.6 (M*)	50.6 (øMu)	0.4 (M*)	24.8 (øMu)
Ductility Check (kNm/m)	54.8 (1.5Mcr)	63.3 (Mu)	27.5 (1.5Mcr)	31.0 (Mu)
Flange Width (m)	External 2.1125	Internal 4.225		
DIRECTION 2				
Moment of Inertia (x 10^9 mm^4/m)	0.449 (Ireq)	1.565 (Ieff)	0.000 (Ireq)	1.565 (Ieff)
Flexural Strength (kNm/m)	22.2 (M*)	37.6 (øMu)	0.3 (M*)	21.4 (øMu)
Ductility Check (kNm/m)	39.5 (1.5Mcr)	47.1 (Mu)	25.4 (1.5Mcr)	26.7 (Mu)
Flange Width (m)	External 1.145	Internal 1.99		

FOR FOOTINGS USE :-

EXTERNALLY:- 300 mm (Wide) x 450 mm (Deep)
- With 8 /N12 Bars - 4 Top And 4 Bottom

INTERNALLY:- 300 mm (Wide) x 450 mm (Deep)
- With 6 /N12 Bars - 3 Top And 3 Bottom

WARNING:
In the following case(s), the analysis was NOT a reactive soils analysis because soil mound height was less than the allowable beam deflection:
Rectangle 1, Centre Heave, Direction 1
Rectangle 1, Centre Heave, Direction 2
Rectangle 1, Edge Heave, Direction 1
Rectangle 1, Edge Heave, Direction 2
Rectangle 2, Centre Heave, Direction 1
Rectangle 2, Edge Heave, Direction 1
Rectangle 2, Edge Heave, Direction 2
Rectangle 3, Centre Heave, Direction 1
Rectangle 3, Edge Heave, Direction 1
Rectangle 3, Edge Heave, Direction 2

Licensed User: FMG
Job Number: S42166/262926 – Strip footing. Date: 24/01/2019 (15:09)

Code Oriented Raft Design (Version 8.0)
****

FOOTING DESIGN TO AS2870 - 2011
-- Strip Footing --

****
RECTANGLE 1 of 3 (25.81m x 16.48m)

THE FOLLOWING VALUES WILL BE USED:

External Wall Weight
- Side 1 .....= 2 kPa
- Side 2 .....= 2 kPa
- Side 3 .....= 2 kPa
- Side 4 .....= 2 kPa

Wall Height Externally
- Side 1 .....= 5.8 m
- Side 2 .....= 5.8 m
- Side 3 .....= 5.8 m
- Side 4 .....= 5.8 m

Roof Eaves Overhang
- Side 1 .....= 0.6 m
- Side 2 .....= 0.6 m
- Side 3 .....= 0.6 m
- Side 4 .....= 0.6 m

Internal Wall Weight .....= 0.5 kPa
Roof Type - Trussed
Roof Weight .....= 0.45 kPa
Wall Height Internally .....= 2.7 m
Internal Wall Length .....= 100 m
Slab Live Load .....= 1.5 kPa
Deflection Ratio .....= 1 / 400
E conc. long term (max) .....= 19.581 GPa
Hs .....= 4 m
Footing design modified for tree effects - Yes

Ys .....= 20 mm

Yt .....= 14 mm

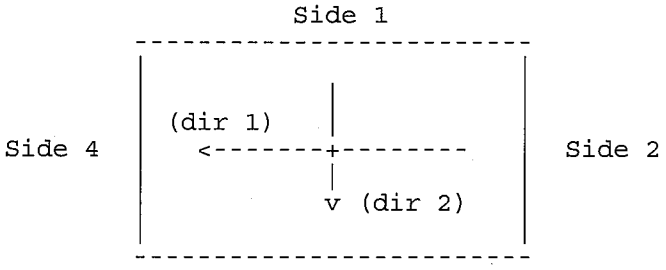
Ym tree (centre) --> 0.7Ys + Yt = 28 mm

Ym (edge) --> 0.5Ys .....= 10 mm

Footing design accounts for tree removal - No

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:09)

Code Oriented Raft Design (Version 8.0)
****



****
LOAD CALCULATION (Note: Footing self-weight is generated automatically)

External line load PE (kN/m)
Wall load
Side 1 (5.8 x 2) = 11.60 kN/m
Side 2 (5.8 x 2) = 11.60 kN/m
Side 3 (5.8 x 2) = 11.60 kN/m
Side 4 (5.8 x 2) = 11.60 kN/m
Roof eaves load
Side 1 (0.6 x (25.81 + 0.6 + 0.6) / 25.81 x 0.45) = 0.28 kN/m
Side 2 (0.6 x (16.48 + 0.6 + 0.6) / 16.48 x 0.45) = 0.29 kN/m
Side 3 (0.6 x (25.81 + 0.6 + 0.6) / 25.81 x 0.45) = 0.28 kN/m
Side 4 (0.6 x (16.48 + 0.6 + 0.6) / 16.48 x 0.45) = 0.29 kN/m
NOTE: Roof load (excluding eaves overhang) is borne only by sides 1 & 3.
Roof load
side 1 (0.45 x (16.48 / 2 + 0.6) = 3.98 kN/m
side 2 0.45 x 0.6 x (16.48 + 0.6 + 0.6) / 16.48 = 0.29 kN/m
side 3 (0.45 x (16.48 / 2 + 0.6) = 3.98 kN/m
side 4 0.45 x 0.6 x (16.48 + 0.6 + 0.6) / 16.48 = 0.29 kN/m
Footing self weight:-
Direction 1 (0.61 x 0.3 x 24) = 4.38 kN/m
Direction 2 (0.61 x 0.3 x 24) = 4.38 kN/m
- -
PE (Side 1) = 19.96 kN/m
PE (Side 2) = 16.27 kN/m
PE (Side 3) = 19.96 kN/m
PE (Side 4) = 16.27 kN/m

Distributed internal load W (kPa)
Internal walls (100 x 0.5 x 2.7 / (25.81 x 16.48)) = 0.32 kPa
Additional slab load = 0.60 kPa
Footing self weight:-
Direction 1 ((4 x 0.3 x 0.61 x 24) / 16.48) = 1.06 kPa
Direction 2 ((7 x 0.3 x 0.61 x 24) / 25.81) = 1.19 kPa
Live load = 1.50 kPa
Sub Total (Omega) = 4.69 kPa
Longitudinal edge loads
Direction 1 ((19.96 + 19.96) / 16.48) = 2.42 kPa
Direction 2 ((16.27 + 16.27) / 25.81) = 1.26 kPa
- -
W (Direction 1) = 7.12 kPa
W (Direction 2) = 5.96 kPa

Total distributed load Q (kPa)
Omega = 4.69 kPa
Line loads
Direction 1 ((19.96 + 19.96) x 25.81) / (25.81 x 16.48) = 2.42 kPa
Direction 2 ((16.27 + 16.27) x 16.48) / (16.48 x 25.81) = 1.26 kPa
- -
Q = 8.38 kPa

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:09)

Code Oriented Raft Design (Version 8.0)
****

****
RECTANGLE 2 of 3 (16.48m x 8.91m)

THE FOLLOWING VALUES WILL BE USED:

External Wall Weight
- Side 1 .....= 2 kPa
- Side 2 .....= 2 kPa
- Side 3 .....= 2 kPa
- Side 4 .....= 2 kPa

Wall Height Externally
- Side 1 .....= 5.8 m
- Side 2 .....= 5.8 m
- Side 3 .....= 5.8 m
- Side 4 .....= 5.8 m

Roof Eaves Overhang
- Side 1 .....= 0.6 m
- Side 2 .....= 0.6 m
- Side 3 .....= 0.6 m
- Side 4 .....= 0.6 m

Internal Wall Weight .....= 0.5 kPa
Roof Type - Trussed
Roof Weight .....= 0.45 kPa
Wall Height Internally .....= 2.7 m
Internal Wall Length .....= 50 m
Slab Live Load .....= 1.5 kPa
Deflection Ratio .....= 1 / 400
E conc. long term (max) .....= 19.581 GPa
Hs .....= 4 m
Footing design modified for tree effects - Yes

Ys .....= 20 mm

Yt .....= 14 mm

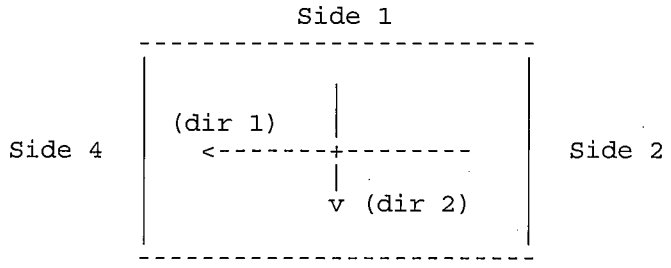
Ym tree (centre) --> 0.7Ys + Yt = 28 mm

Ym (edge) --> 0.5Ys .....= 10 mm

Footing design accounts for tree removal - No

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:09)

Code Oriented Raft Design (Version 8.0)
****



****
LOAD CALCULATION (Note: Footing self-weight is generated automatically)

External line load PE (kN/m)
Wall load
Side 1 (5.8 x 2) = 11.60 kN/m
Side 2 (5.8 x 2) = 11.60 kN/m
Side 3 (5.8 x 2) = 11.60 kN/m
Side 4 (5.8 x 2) = 11.60 kN/m
Roof eaves load
Side 1 (0.6 x (16.48 + 0.6 + 0.6) / 16.48 x 0.45) = 0.29 kN/m
Side 2 (0.6 x (8.91 + 0.6 + 0.6) / 8.91 x 0.45) = 0.31 kN/m
Side 3 (0.6 x (16.48 + 0.6 + 0.6) / 16.48 x 0.45) = 0.29 kN/m
Side 4 (0.6 x (8.91 + 0.6 + 0.6) / 8.91 x 0.45) = 0.31 kN/m
NOTE: Roof load (excluding eaves overhang) is borne only by sides 1 & 3.
Roof load
side 1 (0.45 x (8.91 / 2 + 0.6) = 2.27 kN/m
side 2 0.45 x 0.6 x (8.91 + 0.6 + 0.6) / 8.91 = 0.31 kN/m
side 3 (0.45 x (8.91 / 2 + 0.6) = 2.27 kN/m
side 4 0.45 x 0.6 x (8.91 + 0.6 + 0.6) / 8.91 = 0.31 kN/m
Footing self weight:-
Direction 1 (0.61 x 0.3 x 24) = 4.38 kN/m
Direction 2 (0.61 x 0.3 x 24) = 4.38 kN/m
- -
PE (Side 1) = 18.26 kN/m
PE (Side 2) = 16.29 kN/m
PE (Side 3) = 18.26 kN/m
PE (Side 4) = 16.29 kN/m

Distributed internal load W (kPa)
Internal walls (50 x 0.5 x 2.7 / (16.48 x 8.91)) = 0.46 kPa
Additional slab load = 0.60 kPa
Footing self weight:-
Direction 1 ((2 x 0.3 x 0.61 x 24) / 8.91) = 0.98 kPa
Direction 2 ((4 x 0.3 x 0.61 x 24) / 16.48) = 1.06 kPa
Live load = 1.50 kPa
Sub Total (Omega) = 4.63 kPa
Longitudinal edge loads
Direction 1 ((18.26 + 18.26) / 8.91) = 4.10 kPa
Direction 2 ((16.29 + 16.29) / 16.48) = 1.98 kPa
- -
W (Direction 1) = 8.73 kPa
W (Direction 2) = 6.61 kPa

Total distributed load Q (kPa)
Omega = 4.63 kPa
Line loads
Direction 1 ((18.26 + 18.26) x 16.48) / (16.48 x 8.91) = 4.10 kPa
Direction 2 ((16.29 + 16.29) x 8.91) / (8.91 x 16.48) .= 1.98 kPa
- -
Q = 10.71 kPa

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:09)

Code Oriented Raft Design (Version 8.0)
****

****
RECTANGLE 3 of 3 (20.11m x 8.45m)

THE FOLLOWING VALUES WILL BE USED:

External Wall Weight
- Side 1 .....= 2 kPa
- Side 2 .....= 2 kPa
- Side 3 .....= 2 kPa
- Side 4 .....= 2 kPa

Wall Height Externally
- Side 1 .....= 5.8 m
- Side 2 .....= 5.8 m
- Side 3 .....= 5.8 m
- Side 4 .....= 5.8 m

Roof Eaves Overhang
- Side 1 .....= 0.6 m
- Side 2 .....= 0.6 m
- Side 3 .....= 0.6 m
- Side 4 .....= 0.6 m

Internal Wall Weight .....= 0.5 kPa
Roof Type - Trussed
Roof Weight .....= 0.45 kPa
Wall Height Internally .....= 2.7 m
Internal Wall Length .....= 50 m
Slab Live Load .....= 1.5 kPa
Deflection Ratio .....= 1 / 400
E conc. long term (max) .....= 19.581 GPa
Hs .....= 4 m
Footing design modified for tree effects - Yes

Ys .....= 20 mm

Yt .....= 14 mm

Ym tree (centre) --> 0.7Ys + Yt = 28 mm

Ym (edge) --> 0.5Ys .....= 10 mm

Footing design accounts for tree removal - No

```
                               Side 1
                      -------------------------
                     |                         |
                     |            |            |
                     |  (dir 1)   |            |
           Side 4    |    <-------+--------    |    Side 2
                     |            |            |
                     |            v (dir 2)    |
                     |                         |
                      -------------------------
                               Side 3
***********************************************************************
LOAD CALCULATION (Note: Footing self-weight is generated automatically)
-----------------------------------------------------------------------
External line load PE (kN/m)
  Wall load
    Side 1  (5.8 x 2)............................................= 11.60 kN/m
    Side 2  (5.8 x 2)............................................= 11.60 kN/m
    Side 3  (5.8 x 2)............................................= 11.60 kN/m
    Side 4  (5.8 x 2)............................................= 11.60 kN/m
  Roof eaves load
    Side 1  (0.6 x (20.11 + 0.6 + 0.6) / 20.11 x 0.45)...........= 0.29 kN/m
    Side 2  (0.6 x (8.45 + 0.6 + 0.6) / 8.45 x 0.45).............= 0.31 kN/m
    Side 3  (0.6 x (20.11 + 0.6 + 0.6) / 20.11 x 0.45)...........= 0.29 kN/m
    Side 4  (0.6 x (8.45 + 0.6 + 0.6) / 8.45 x 0.45).............= 0.31 kN/m
NOTE: Roof load (excluding eaves overhang) is borne only by sides 1 & 3.
  Roof load
    side 1  (0.45 x (8.45 / 2 + 0.6) ............................= 2.17 kN/m
    side 2  0.45 x 0.6 x (8.45 + 0.6 + 0.6) / 8.45 ..............= 0.31 kN/m
    side 3  (0.45 x (8.45 / 2 + 0.6) ............................= 2.17 kN/m
    side 4  0.45 x 0.6 x (8.45 + 0.6 + 0.6) / 8.45 ..............= 0.31 kN/m
  Footing self weight:-
    Direction 1 (0.61 x 0.3 x 24)................................= 4.38 kN/m
    Direction 2 (0.61 x 0.3 x 24)................................= 4.38 kN/m
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  PE (Side  1) ..................................................= 18.16 kN/m
  PE (Side  2) ..................................................= 16.29 kN/m
  PE (Side  3) ..................................................= 18.16 kN/m
  PE (Side  4) ..................................................= 16.29 kN/m
-----------------------------------------------------------------------
Distributed internal load W (kPa)
  Internal walls  (50 x 0.5 x 2.7 / (20.11 x 8.45))..............= 0.40 kPa
  Additional slab load ..........................................= 0.60 kPa
  Footing self weight:-
    Direction 1       ((1 x 0.3 x 0.61 x 24) / 8.45).............= 0.52 kPa
    Direction 2       ((5 x 0.3 x 0.61 x 24) / 20.11)............= 1.09 kPa
  Live load .....................................................= 1.50 kPa
  Sub Total (Omega) .............................................= 4.13 kPa
Longitudinal edge loads
  Direction 1      ((18.16 + 18.16) / 8.45)......................= 4.30 kPa
  Direction 2      ((16.29 + 16.29) / 20.11).....................= 1.62 kPa
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  W (Direction 1) ...............................................= 8.43 kPa
  W (Direction 2) ...............................................= 5.75 kPa
-----------------------------------------------------------------------
Total distributed load Q (kPa)
  Omega .........................................................= 4.13 kPa
  Line loads
    Direction 1       ((18.16 + 18.16) x 20.11) / (20.11 x 8.45) = 4.30 kPa
    Direction 2       ((16.29 + 16.29) x 8.45) / (8.45 x 20.11) .= 1.62 kPa
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Q .............................................................= 10.05 kPa
-----------------------------------------------------------------------
```

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:09)

Code Oriented Raft Design (Version 8.0)
****

Rectangle 1 of 3	DIRECTION 1	DIRECTION 2
L(m)	25.81	16.48
B(m)	16.48	25.81
P Edge (kN/m)	19.96	16.27
P Centre (kN/m)	0.00	0.00
W(kPa)	7.12	5.96
k(kPa/m)	1000.00	1000.00
Delta(mm)	30.0	30.0
No. of Beams	6	9
	CENTRE HEAVE	
Delta > Ymc ?	YES	YES
Edge Dist. (m)	1.278	1.278
M work (kNm/m)	12.84	18.01
I req(x10^6 mm4/m)	120.23	219.41
	EDGE HEAVE	
Delta > Yme ?	YES	YES
Edge Dist. (m)	1.000	1.000
M work (kNm/m)	0.16	1.21
I req(x10^6 mm4/m)	0.13	0.59

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:09)

Code Oriented Raft Design (Version 8.0)
****

Rectangle 2 of 3	DIRECTION 1	DIRECTION 2
L(m)	16.48	8.91
B(m)	8.91	16.48
P Edge (kN/m)	18.26	16.29
P Centre (kN/m)	0.00	0.00
W(kPa)	8.73	6.61
k(kPa/m)	1070.80	1070.80
Delta(mm)	30.0	22.3
No. of Beams	4	6
	CENTRE HEAVE	
Delta > Ymc ?	YES	NO
Edge Dist. (m)	1.278	1.278
M work (kNm/m)	12.16	24.17
I req(x10^6 mm4/m)	101.98	513.22
	EDGE HEAVE	
Delta > Yme ?	YES	YES
Edge Dist. (m)	1.000	1.000
M work (kNm/m)	0.63	0.34
I req(x10^6 mm4/m)	0.29	0.13

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:09)

Code Oriented Raft Design (Version 8.0)
****

Rectangle 3 of 3	DIRECTION 1	DIRECTION 2
L(m)	20.11	8.45
B(m)	8.45	20.11
P Edge (kN/m)	18.16	16.29
P Centre (kN/m)	0.00	0.00
W(kPa)	8.43	5.75
k(kPa/m)	1004.80	1004.80
Delta(mm)	30.0	21.1
No. of Beams	3	7
	CENTRE HEAVE	
Delta > Ymc ?	YES	NO
Edge Dist. (m)	1.278	1.278
M work (kNm/m)	12.67	26.32
I req(x10^6 mm4/m)	113.85	527.73
	EDGE HEAVE	
Delta > Yme ?	YES	YES
Edge Dist. (m)	1.000	1.000
M work (kNm/m)	0.51	0.33
I req(x10^6 mm4/m)	0.25	0.10

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:09)

Code Oriented Raft Design (Version 8.0)
****

TRIAL FOOTING PROPERTIES :-

Edge Beams:
- Beam Width = 300 mm
- Beam Depth = 610 mm
- Reinforcement
  - top = 4 x N12 bars, 50 mm cover
  - bottom = 4 x N12 bars, 65 mm cover

Internal Beams:
- Beam Width = 300 mm
- Beam Depth = 610 mm
- Reinforcement
  - top = 3 x N12 bars, 50 mm cover
  - bottom = 3 x N12 bars, 65 mm cover

Material Properties:
- Fsy = 500 MPa
- F'c = 32 MPa

A COMPARISON OF THE REQUIRED DESIGN PROPERTIES AND THOSE OBTAINED FOR THE ABOVE FOOTING SYSTEM IS TABULATED BELOW

- Note that where relevant, the properties are expressed in units per metre width of total footing cross section
- The I required values have been factored up to take account of the variation in the long term creep factor for concrete, refer to AS3600, clause 8.5.3.3

RECTANGLE 1 of 3 (25.81m x 16.48m)

BEAM DEFLECTED SHAPE	CENTRE HEAVE		EDGE HEAVE	
	REQUIRED	ACTUAL	REQUIRED	ACTUAL
DIRECTION 1				
Moment of Inertia (x 10^9 mm^4/m)	0.120 (Ireq)	2.147 (Ieff)	0.000 (Ireq)	2.147 (Ieff)
Flexural Strength (kNm/m)	12.8 (M*)	30.6 (øMu)	0.2 (M*)	29.8 (øMu)
Ductility Check (kNm/m)	24.2 (1.5Mcr)	38.3 (Mu)	35.4 (1.5Mcr)	37.2 (Mu)
Flange Width (m)	External 0	Internal 0		
DIRECTION 2				
Moment of Inertia (x 10^9 mm^4/m)	0.219 (Ireq)	1.388 (Ieff)	0.001 (Ireq)	2.061 (Ieff)
Flexural Strength (kNm/m)	18.0 (M*)	28.5 (øMu)	1.2 (M*)	27.7 (øMu)
Ductility Check (kNm/m)	23.3 (1.5Mcr)	35.6 (Mu)	33.9 (1.5Mcr)	34.6 (Mu)
Flange Width (m)	External 0	Internal 0		

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:09)

Code Oriented Raft Design (Version 8.0)
****

RECTANGLE 2 of 3 (16.48m x 8.91m)

BEAM DEFLECTED SHAPE	CENTRE HEAVE		EDGE HEAVE	
	REQUIRED	ACTUAL	REQUIRED	ACTUAL
DIRECTION 1				
Moment of Inertia (x 10^9 mm^4/m)	0.102 (Ireq)	2.627 (Ieff)	0.000 (Ireq)	2.627 (Ieff)
Flexural Strength (kNm/m)	12.2 (M*)	39.4 (øMu)	0.6 (M*)	38.2 (øMu)
Ductility Check (kNm/m)	29.6 (1.5Mcr)	49.3 (Mu)	43.4 (1.5Mcr)	47.7 (Mu)
Flange Width (m)	External 0	Internal 0		
DIRECTION 2				
Moment of Inertia (x 10^9 mm^4/m)	0.513 (Ireq)	0.749 (Ieff)	0.000 (Ireq)	2.116 (Ieff)
Flexural Strength (kNm/m)	24.2 (M*)	30.6 (øMu)	0.3 (M*)	29.4 (øMu)
Ductility Check (kNm/m)	23.7 (1.5Mcr)	38.2 (Mu)	35.0 (1.5Mcr)	36.8 (Mu)
Flange Width (m)	External 0	Internal 0		

Licensed User: FMG
Job Number: S42166/262926 Date: 24/01/2019 (15:09)

Code Oriented Raft Design (Version 8.0)
****

RECTANGLE 3 of 3 (20.11m x 8.45m)

BEAM DEFLECTED SHAPE	CENTRE HEAVE		EDGE HEAVE	
	REQUIRED	ACTUAL	REQUIRED	ACTUAL
DIRECTION 1				
Moment of Inertia (x 10^9 mm^4/m)	0.114 (Ireq)	2.096 (Ieff)	0.000 (Ireq)	2.096 (Ieff)
Flexural Strength (kNm/m)	12.7 (M*)	32.6 (øMu)	0.5 (M*)	31.7 (øMu)
Ductility Check (kNm/m)	23.7 (1.5Mcr)	40.7 (Mu)	34.5 (1.5Mcr)	39.6 (Mu)
Flange Width (m)	External 0	Internal 0		
DIRECTION 2				
Moment of Inertia (x 10^9 mm^4/m)	0.528 (Ireq)	0.548 (Ieff)	0.000 (Ireq)	2.022 (Ieff)
Flexural Strength (kNm/m)	26.3 (M*)	28.8 (øMu)	0.3 (M*)	27.8 (øMu)
Ductility Check (kNm/m)	22.7 (1.5Mcr)	36.1 (Mu)	33.5 (1.5Mcr)	34.7 (Mu)
Flange Width (m)	External 0	Internal 0		

FOR FOOTINGS USE :-

EXTERNALLY:- 300 mm (Wide) x 610 mm (Deep)
- With 8 /N12 Bars - 4 Top And 4 Bottom

INTERNALLY:- 300 mm (Wide) x 610 mm (Deep)
- With 6 /N12 Bars - 3 Top And 3 Bottom

WARNING:
In the following case(s), the analysis was NOT a reactive soils analysis because soil mound height was less than the allowable beam deflection:
Rectangle 1, Centre Heave, Direction 1
Rectangle 1, Centre Heave, Direction 2
Rectangle 1, Edge Heave, Direction 1
Rectangle 1, Edge Heave, Direction 2
Rectangle 2, Centre Heave, Direction 1
Rectangle 2, Edge Heave, Direction 1
Rectangle 2, Edge Heave, Direction 2
Rectangle 3, Centre Heave, Direction 1
Rectangle 3, Edge Heave, Direction 1
Rectangle 3, Edge Heave, Direction 2

REVISED 12 DECEMBER 2012

APPENDIX A

IMPORTANT NOTES TO THE OWNER(S)

These introductory notes have been prepared for the purpose of explaining IMPORTANT ASPECTS of the soil report document. They are to be kept in a safe place and passed on to future Owners.

It is imperative that you READ AND UNDERSTAND ALL SECTIONS OF THE REPORT and if you have any queries arising therefrom, that you telephone us during normal business hours for further discussion and explanation.

A1.0 FOOTING PERFORMANCE

A1.1 The footings for this building have been designed using the Australian Standard 2870-2011, *"Residential Slabs and Footings - Construction"* in accordance with the Performance Requirements of Volume Two of the National Construction Code Series, the Building Code of Australia (2012 Edition).

A1.2 The Building Code and Australian Standard AS2870-2011 embrace the philosophy that optimum performance of rational, economical footing designs can only be achieved with the co-operation of informed owners who pay attention to maintaining a reactive clay site. (Refer CSIRO Division of Building Research "Guide to Home Owners on Foundation Maintenance and Footing Performance" by P F Walsh - copy attached.)

A1.3 THE OWNER'S ATTENTION IS DIRECTED TO THE CSIRO DOCUMENT REFERRED TO IN ITEM A1.2 IMMEDIATELY ABOVE. **Your footing design has been based upon the assumption that you, the owner(s), will observe the requirements for proper site maintenance as set out in this reference**. If you do not heed this advice, then building damage may result as a consequence of your neglect. **Neither FMG nor your builder can accept any responsibility for the performance of your footing system where site maintenance requirements have not been met, or where instructions given elsewhere in this report document have been disregarded or otherwise ignored for whatever reason.**

A1.4 Your footing design has been prepared with the aim of achieving a level of structural performance in the range from Category 0 to 2 (i.e. no damage to a low incidence of damage category 1 and an occasional incidence of damage category 2) as set out in Appendix C of AS2870-2011. Footing systems complying with the standard, on a *normal* site are intended to achieve acceptable probabilities of serviceability and safety of a building during its design life of 50 years.

Your documentation contains a site drainage and paving plan. This plan plus Section B5.0 in Appendix B of this soil report sets out the requirements for the construction of future paving and drainage works around your house.

Gardens must be watered but not soaked for long periods which would constitute overwatering and the recommended site drainage and paving works must be constructed within a reasonable time frame after taking possession. Much of the site management that contributes to the maintenance of "*Normal*" soil moisture conditions must be carried out by the home owner. For example garden watering, planting of trees, repair of leaks, etc. and as set out below.

Normal sites are defined as those sites which are classified as one of the soil site classes, A, S, M, H1, H2 and E, where the soil (foundation) moisture variations are caused by seasonal and regular climatic effects including the effect of the building on the site with normal garden conditions. This means gardens must be watered but not soaked for long periods which would constitute overwatering and *abnormal* soil moisture conditions.

AS2870 sets out that: where *abnormal* environmental or moisture changes are present, or were present, footings will have a higher probability of damage. *Abnormal* site conditions can include,

(a) Recent removal of an existing building or structure likely to have significantly modified the soil moisture conditions under the proposed footprint of the new building.
(b) Unusual moisture conditions caused by leaking or overflowing drains, channels, ponds, dams, swimming pools, effluent disposal or tanks which must be maintained.

(c) Recent removal of large trees prior to construction.

(d) Growth of trees too close to a footing (considering mature tree height/s not necessarily existing height).

(e) Excessive or irregular watering of gardens adjacent to the house.

(f) Lack of maintenance of site drainage.

(g) Failure to repair plumbing leaks.

(h) Reduction in, or neglect of, garden and lawn watering.

(i) Failure to provide adequate site drainage

(j) Failure to detail or construct drainage in accordance with AS2870-2011

(k) The effects of trees too close to a footing

(l) Failure to maintain site drainage

(m) Loss of vegetation from near a building

The footing design may not achieve the level of structural performance in A1.4 if these factors are present or have occurred because they create *abnormal* soil moisture conditions.

Special Note Regarding Existing Trees

A traditional design method to allow for the potential effects of trees on a footing system is provided in Appendix H of AS2870-2011. The method is essentially the one that has been used with apparent success since July 1990 in South Australia. This method does not separately assess all characteristics that affect a tree's ability to draw moisture. However, when combined with engineering judgement, this method has been found to be sufficient to model tree impact on foundation behaviour in South Australia.

The AS2870-2011 Appendix H approach to design of footing systems for the presence of tree effects will not necessarily result in a footing system that achieves the performance requirements of Appendix B. The risk of any lack of performance arises from factors that include the particular environment as well as imperfections in the method of rationally modelling the effects of trees. An increased risk of

underperformance is understood by designers and the existence of the increased risk and the potential effects of any underperformance are hereby communicated to you as the owner/s of the building. Should you wish to discuss footing design options for tree effects you must advise your builder and either you or your builder must discuss any such concerns with FMG Engineering prior to commencement of footing construction.

A1.5 As set out in AS2870, it is neither possible nor economical to design for extreme conditions that could occur in the foundation if a site is not properly maintained. Refer clause A1.9 for a summary of foundation maintenance and clause A1.2.

Be advised that the design of your footing system does not take account of:

(a) leakage or loss of water from any pipe, drain or sewer;

(b) leakage or loss of water from a water tank, swimming pool, fountain, ornamental pool, duct, drain, fish pond or any other like container of water;

(c) surface water or water from a roof of any building that is allowed to flow onto, over, or lie upon, areas of the site that are adjacent to the footings;

(d) the planting of a tree or shrub within the distance limits defined in the attached CSIRO notes;

(e) excessive watering of lawns, trees, shrubs, flowers or other plants; or

(f) a reduction in, or neglect of, garden and lawn watering;

(g) failure to provide pavements to drain water away from the building perimeter (refer to B5.5 for details)

(h) any other activity carried on beyond the boundaries of the site that may affect the moisture content of the foundation.

These are ongoing maintenance items that you (the homeowner) will need to address.

Problems relating to these matters are discussed in the CSIRO document referred to in Item A1.2 above.

The design of footing systems shall consider control of cracking that may be caused by soil movement but not the prevention of cracking due to materials related shrinkage cracking (AS2870-2011, Section 1.4.3).

A1.6 If you intend to utilise brittle floor coverings for example large areas of tiling (or unusually large sized tiles) you should consult your builder (or designer) so that consideration can be given to specifying an increase in the slab reinforcing mesh to be used in concrete floors (AS5870-2011, Section 5.3.7). This is to provide more stringent control of concrete shrinkage cracking and reduce the potential for reflective cracking in tiles.

If after construction of your slab you choose to install large areas of tiles (or to use unusually large sized tiles) the placement of tiles or brittle floor coverings must be delayed for not less than 3 months (BCA 3.2.5.3). Tiles should be fixed to the floor using flexible adhesive applied in accordance with the manufacturer's instructions. Tile movement joints should be included around all fixed objects, around room perimeters and otherwise at maximum 4.5mc/c in both directions (AS2870-2011, Section 5.3.7 and BCA 3.2.5.3)

A1.7 Should you wish to have a stronger and stiffer footing designed to achieve a higher confidence level with respect to structural performance, we would be pleased to amend our design upon receiving your further instructions. A fee will be charged for any amendments forthcoming from such instructions. Such fee will be determined at the time of your communication with this office and at a time prior to the commencement of any work on the amendment.

A1.8 Be advised that it is sometimes not possible (on a statistical basis) to determine any and all sub-surface anomalies which may exist at a site by the borehole sampling technique which is in common use for geotechnical investigations of building sites.

Current state-of-the-art site investigation procedure involves the sinking of up to three 40 mm diameter boreholes. Be advised that the chance of discovering buried anomalies such as old wells, filled cellars, rock outcrops, soil filling and/or any other sub-surface intrusions increases only marginally with an increase in the frequency of sampling.

If a more comprehensive site investigation is desired, PRIOR TO THE COMMENCEMENT OF CONSTRUCTION, then this office should be notified and we will be pleased to act upon your further instructions in this regard.

Any additional site investigation work requested will incur an additional fee which will be negotiated at the time of your issuing such instructions.

Any distinct variations or discrepancies in soil type, colour, texture, composition or horizon depth observed by the client, the builder, or any of his servants or agents must be referred to the Engineer immediately upon discovery. Further advice may be necessary from the Engineer as a result of such discovery. A site visit may also be necessary.

In accordance with current state-of-the-art practice, this office uses the push tube or percussion tube method of retrieving soil core samples. These methods have been found to be the most cost effective means of site investigation currently available.

For notes and details concerning footing and site preparation including earthworks, concrete and steel reinforcement, service trenching, paving requirements, site drainage, retaining walls and articulation of superstructure walls, the owner is advised to read this report and its appendices in their entirety.

A1.9 **FOUNDATION MAINTENANCE** (Extract from Appendix B Section B.2.1 AS2870-2011)

Foundation soils All soils are affected by water. Silts are weakened by water and some sands can settle if heavily watered, but most problems arise on clay foundations. Clays swell and shrink due to changes in moisture content and the potential amount of the movement is implied in the site classifications in the Standard, which are designated as follows:

(a) A means Stable (Non-reactive).
(b) S means Slightly Reactive.
(c) M means Moderately Reactive.
(d) H1 and H2 means Highly Reactive.
(e) E means Extremely Reactive.
(f) D - subscript, added to M, H and E, eg (M-D), represents selected sites where deep seated clays and arid climatic conditions prevail.
(g) P - problem sites, eg collapsing soils, uncontrolled fill, trees, reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.

Sites classified Class A and S may be treated as non-reactive sites. Sites classified otherwise should comply with the recommendations given below.

Class A and S sites Sands, silts and clays shall be protected from becoming extremely wet by adequate attention to paving, site drainage and prompt repair of plumbing leaks.

Class M, H and E Sites classified as M, H1, H2 or E shall be maintained at essentially stable moisture conditions and extremes of wetting and drying prevented in so far as this is practically possible. This will require attention to the following:

(a) *Drainage of the site* The area surrounding the building footprint shall be graded or drained so that water cannot pond against or near the building. The ground immediately adjacent to the building shall be graded to a fall to suit paving requirements (refer B5.5). The subfloor space for houses with suspended floors shall be graded or drained to prevent ponding.

The site drainage requirements shall be maintained for the life of the building.

NOTE: On some low and flat sites surface stormwater drainage is not always possible without either building the site up to achieve gravity flow of the drainage system or by installing a sump and pump system. The Owner is advised to discuss with their Builder the consequences of building the site up or the installation of a sump and pump disposal system.

The Owner should be aware that surface stormwater disposal shall be in accordance with the Building Code of Australia and AS3500.3.

(b) *Limitations on gardens* The development of gardens shall not interfere with drainage requirements or the subfloor ventilation and weephole drainage systems. Garden beds adjacent to the building should be avoided. Care should be taken to avoid overwatering of gardens close to footings. Watering must be maintained during droughts and summer-autumn seasons to prevent excessive drying out of the soil.

(c) *Restrictions on trees and shrubs* Planting of trees should be avoided near building footings or neighbouring buildings on reactive sites as they can cause damage due to drying of the clay over substantial distances. To reduce, but not necessarily eliminate, the possibility of damage tree planting should be restricted to a distance from the house of:

(i) 1 x mature height for a single tree

(ii) 1.5 x mature height for a group of trees

(iii) 2.0 x mature height for four or more trees in a row

Removal of trees from a site prior to building construction can also cause damage.

(d) *Repair of leaks* Leaks in plumbing, including water supply, stormwater and sewerage should be repaired promptly.

(e) *Perimeter Paving* An apron of paving should be installed around the entire building perimeter in accordance with AS2870-2011 B5.5

The level to which these measures are implemented depends on the reactivity of the site. The measures apply particularly to masonry houses and masonry veneer houses. For frame of houses clad with timber or sheeting, lesser precautions may be appropriate.

A2.0 CONDITIONS OF ACCEPTANCE OF THIS REPORT

A2.1 Neither the Engineer nor the builder shall be liable for any defect in, or damage to, the building (which includes the footing) arising from footing inadequacy or movement of the building, including its footing caused by, or contributed to, by any breach of this agreement committed, permitted or allowed by the Client.

A2.2 Where more than one person is named as the Client on the Report, every provision hereof shall bind all such persons jointly and each such person severally, and any instructions or information given to the Engineer or builder by any one such person shall be deemed to be given by an agent of the Client.

A2.3 Any Builder or Supervisor (and any of their respective servants or agents) engaged in the construction of the building shall be deemed to be an agent of the Client.

A2.4 The Client will, at all times after receiving a Construction Footing Report from the Engineer or builder, comply and procure compliance in all respects with <u>all</u> recommendations and directions contained in such Construction Footing Report, including Appendices.

REVISED 30 November 2011

APPENDIX B

IMPORTANT NOTES TO THE BUILDER/LICENSED WORKS SUPERVISOR

B1.0 GENERAL

B1.1 At all times it shall remain the Builder's and/or Licensed Works Supervisor's responsibility to ensure compliance during construction with this soil report document and with any and all other constructional requirements as set out in The Building Code of Australia (2012) Volume 2 and AS2870-2011 *"Residential Slabs and Footings - Construction"*. (Note in particular Section 6 of that document.)

B1.2 The Builder and/or any Licensed Works Supervisor associated with the construction of the building is instructed to read this report carefully in conjunction with any architectural working drawings, contour plans, site drainage plans and structural calculations or drawings. Any discrepancy, error or omission found therein must be reported to this office immediately upon discovery and at a time prior to the commencement of any related work. Where such discrepancy, error or omission is not related to any act or omission on the part of this company, a fee will be charged for any additional information required of this company as a consequence of such discrepancy, error or omission.

B1.3 Where construction work in relation to site drainage does not fall within the scope and extent of the building contract, it shall be the Builder's responsibility to give notice in writing to the owners instructing them that all site drainage work, as set out in the Council approved documents, inclusive of the requirements and recommendations set out in this report should be completed by the time the building contract is completed (refer AS2870-2011 cl.5.6.3(a).

B1.4 It shall at all times remain the responsibility of the Builder to present to the owners an original and unabridged copy of this soil/footings report document titled, *"Owner's Copy"*, including any and all amendments made thereto for the period of the building contract at, or prior to, the completion of that building contract.

In so doing, the Builder shall furthermore instruct the owner(s) to read the soil report document carefully and in its entirety so that they may act upon matters directed to their specific attention and which pertain to the maintenance of their site after handover. The copy needs to be kept in a safe place and passed on to any future Owner(s). Ensure care and maintenance of the site is maintained in compliance with advice given in this Report.

B1.5 The finished floor level (FFL) for construction may, in some cases, be dictated by Local Council requirements or by statutory requirements giving the relationship between finished floor level, external pavement level and/or the sewer flood gully level. The Local Council approved FFL or platform level must be clearly established on site and checked by the Builder/Licensed Works Supervisor prior to the commencement of earthworks at the site. (Refer also Clause B6.2).

Any errors, omissions or discrepancies in contour levels, platform levels or FFL's discovered at this time must be reported to this office immediately so that corrective action can be advised.

B2.0 CUT/FILL SITES - CLASSIFICATION OF SITE

The classification of a site shall take into account the effect of site works when these are known at the time of classification, i.e. where a cut is deeper than 500 mm and/or where depth of uncontrolled fill is deeper than 800mm for sand, and 400mm for other material. (Clause 2.5.3 AS2870-2011)

SITE PREPARATION - EARTHWORKS & FOUNDATION PREPARATION

Be advised that the notes in this section dealing with cut/fill sites are additional to requirements set out in AS2870-2011 Rule 6.4.4. These notes are to be read in conjunction with Rule 6.4.4 and under no circumstances must any matter raised be construed to take precedence over any specific requirements of Rule 6.4.4.

B2.1 Footings may be constructed on either:

(a) controlled fill, OR

(b) "clean" site excavated fill derived from a cut and fill earthworks operation, and rolled fill.

All foundations shall have a level layer of clean quarry sand placed below slab panels to a depth of not less than 20 mm, BCA 3.2.2.2(c).

Site filling shall be compacted in accordance with the following specification:

B2.1.1 Controlled Fill

All footing types may be founded into or upon controlled fill. For the purposes of this note "controlled fill" is defined as clean filling soil, not containing organic matter, topsoil, rock fragments, boulders or other deleterious matter, including general refuse and building debris, which has been compacted to provide the allowable bearing pressure required to adequately support the footing system without excessive settlement. Controlled fill must be compacted to a standard not less than that set out in AS2870-2011 Rule 6.4.2(a). Density tests and "certification of controlled fill" are required where controlled fill is deeper than 400 mm.

The number of density tests required on a site is specified under Section 8.2 of "Guidelines on earthworks for commercial and residential developments" AS3798. The level of supervision or quality assurance that the owner may expect is set out in Appendix B of AS3798. This should be decided before commencement of any earthworks compaction.

On sand sites, compaction by flooding of the site with water and then surface rolling will require density test certification.

If fill is present and where scaffolding support is required during construction the ground surface shall be prepared as *"controlled fill"*.

B2.1.2 "Clean" Site Excavated Fill and Rolled Fill

"Clean" site excavated fill for the purposes of this note is defined as filling soil derived from the site which does not contain deleterious matter, organic matter, topsoil, refuse, building debris and/or rock fragments or boulders of a size or frequency of inclusion so as to create an obstructive and/or otherwise impenetrable medium through which a conventional auger drilling rig could not pass without occasioning damage to its drive mechanism.

Note: Where site excavated materials are unsuitable because of their nature or moisture content, quarry sand/rubble or other approved granular materials may be imported to the site as a substitute for reject site material.

Clean site excavated *rolled* fill is most suited to the construction of pier-and-beam or pier-and-slab footing systems where the founding horizon for piers is given under the "Site Preparation" section of this report. For piered constructions there shall be no specific compaction requirement for underfloor fill, however, a compactive effort of not less than six passes, in at least two orthogonal directions, of the earthmoving plant used in the cut/fill operation is recommended for each layer of filling placed. The filling soil shall be placed in layers not exceeding 300 mm "loose" thickness for this purpose.

Rolled fill consists of material compacted in layers by repeated rolling with an excavator (either wheel or track), in maximum 300 mm thick layers for sand material and 150 mm thick layers for other material (Clause 6.4.2 AS2870-2011).

Such compaction is to be carried out over the full area of the site bench (platform level) and shall continue past the edge of the principal building structure by at least a minimum of 1 metre and any and all trafficked pavements (e.g. patios, garages, carports, driveways and footpaths). The fill shall be retained or battered beyond this point by a slope protected from erosion and not steeper than 2 horizontal to one vertical (AS2870-2011, 6.4.4). The Builder shall be responsible for providing suitable compaction of clean, site excavated rolled filling to ensure that subsidence of patios, driveways, footpaths, carport, garage floors and support of scaffolding or formwork will not be excessive.

B2.1.3 Where the depth of clay fill does not exceed 300 mm or the depth of sand or gravel fill does not exceed 600 mm and where these are placed in two approximately equal layers and rolled by the excavator, defined as "rolled fill", there shall be no requirement to increase the slab specification for slab-on-ground constructions.

B2.1.4 Where the depth of clay fill exceeds 300 mm and the depth of sand or gravel fill exceeds 600 mm, the slab panels for slab-on-ground construction shall be either:

(a) constructed on "controlled fill" as treated in Item B2.1.1 above, OR

(b) designed by engineering principles. (For A and S sites the concrete slab shall be reinforced with an additional bottom layer of SL72 and shall be 125 mm thick for 4 m x 4 m slab panels).

B2.1.5 Wherever clean site excavated fill is used (i.e. for cut/fill sites), the Builder shall use a support method for the installation of service pipe runs in fill, or the Builder shall construct same in or upon natural soil. At all times minimum grade requirements shall be achieved and the installation shall be in accordance with AS/NZS3500 to the approval of the relevant authority.

B2.1.6 On steep sites where filling is to be placed on a slope of 1 vertical to 8 horizontal or steeper, a series of parallel benched terraces shall be excavated into the natural surface contours over the whole of the area to be filled. This will provide stability against translational downhill slip of the filling after placement.

B2.1.7 For some sites with a slope exceeding 1 vertical to 5 horizontal an assessment of slope stability will be required. This shall be carried out by a Geotechnical Engineer prior to the commencement of site works and footing design. Such Geotechnical assessment and analysis is expensive and may require additional deep soil testing. The Engineer will discuss fees for same at an interview with the Builder and his/her client.

B3.0 RECOMMENDED EMBANKMENT SLOPES

B3.1 The following recommended embankment slopes are appropriate where the natural ground surface slope does not exceed 1 vertical (V) to 5 horizontal (H).

MATERIAL	**SURFACE SLOPE** (V:H)
Firm stiff clay	1:1
Soft clay	1:1.5
Loose sands (cohesionless)	1:2
Friable and sandy mostly cohesionless soils	1:1.5
Weathered rock in stable condition	1:0.5
Sound and solid rock	Nearly Vertical

B3.2 Embankments shall be protected from stormwater erosion by the construction of suitable drains above the embankment and at its toe.

(a) In sands, it may be necessary to construct a french (agricultural type) drain or strip drain at the top of the embankment to divert downhill flow away from the building area during the construction phase.

(b) In clays and generally for cohesive soil types, a slope of 50 mm per metre is required away from the building platform area towards the toe of cut banks. At the toe it may be necessary for the builder to excavate an unlined earth drain to collect water and divert it away from the principal building area where the natural ground slope would otherwise prevent drainage.

B3.3 Any vertical or near vertical permanent excavation within 2 metres of the building and deeper than 0.6 m in material other than rock shall be adequately retained or battered (AS2870-2011, 6.2).

B4.0 PLUMBING AND DRAINAGE DETAILS

B4.1 The sewer trench shall fall at a minimum rate of 1 vertical to 50 horizontal towards the connection point. The trench is to be ideally located at a distance of 1300 mm ±200 mm away from the footing. The trench shall otherwise conform in all respects with local authority requirements.

Temporary trench excavations for services parallel to the edge of a footing shall not extend below a line drawn at 30^{o} to the horizontal for SAND or 45^{o} to the horizontal for CLAY, from the outer bottom edge of the edge beam. Excavations below this level shall only be carried out after giving due consideration to the stability of the soil by way of an Engineer's inspection and the need to maintain support for the footing (by locally deepened footings or piers) and to the necessary strength and permeability of the backfill material (AS2870-2011, Rule 6.3).

B4.2 For sites of Class M, H1, H2 and E all plumbing trenches shall slope away from the footing. Such trenches shall be backfilled with compacted clay in the top 300 mm within 1.5 m of the dwelling. The clay used for backfilling shall be compacted. Plumbing and drainage under a slab shall be avoided where practical. Where pipes extend under the footing system, the trenches shall be backfilled with clay to prevent the ingress of water beneath the footing system. Alternatively, a plastic membrane across the cross-section of the trench, taped to the pipe and keyed into the sides and base of the trench may be used. (AS2870-2011, Rule 5.6.3)

B4.3 Closed-cell polyethylene lagging shall be used around all sewer and stormwater plumbing penetrations through external footings. The lagging shall be 20 mm thickness on Class H1 sites and 40 mm thickness on Class H2 and E sites. Lagging is not required around vertical penetrations up through slab panels and it is not required at the bases of vertical uPVC stacks in multi-storey construction. In this case, the junction or bend shall be encased in a minimum thickness of 100 mm of concrete.

For Class A, S and M sites, lagging is required however it may be open cellular polyethylene or hessian lagging (e.g. "foamlag") of 10 mm thickness.

Service penetrations shall be permitted through the middle third zone of the footing. If penetrations are to be made outside this zone, the strength and stiffness of the footing shall be restored by making provision for extra beam depth and additional steel reinforcement. Contact this office for details where this occurs (AS2870-2011, Rule 5.4.2(e)).

B4.4 On sites where sewer plumbing needs flexible connections, expansion couplings shall be fitted to all vertical and/or inclined risers and also at their point of connection to the main run for 100 mm diameter uPVC sewer plumbing. Such flexible couplings are to be positioned outside the footing, within 1m of the building perimeter, in the manner shown on the enclosed detail sheet DD1. This requirement is for soil classes H1, H2 and E.

For stormwater drains flexibility with respect to soil/footing interaction can be achieved using flexible pipe for bends. This company advises that the standard rectangular - circular transition spigot for rectangular downpipes, or an oversized circular sleeve of 150 mm length for circular downpipes may be used in conjunction with PVC expansion/repair couplings of suitable diameter (e.g. Storm Plastics repair coupling) for sites requiring flexible connections.

Plumbing penetrations through any external concrete paving shall be suitably lagged to accommodate soil movement. This office recommends encasement of such penetrations using 10 mm "foamlag" or similar approved lagging material (e.g. "compriband", "aeroform" or "abelflex").

B4.5 It is desirable that sub-surface drains (i.e. agricultural or strip drain) be laid upon polythene when positioned close to footings for soil classes H1, H2 and E. It is essential, where such drains have been called up on drawings, or as otherwise specified in this report, to install same so that the invert level of the pipe is founded below finished floor level and furthermore that such drain is laid to a minimum fall of 1 vertical to 80 horizontal away from its origin.

Subsurface drains shall be protected by gravel filters and a geotextile wrapping to prevent clogging during service. It is further recommended that an L-shaped polythene sheet be used to line the subsurface trench to form an impervious channel in the event of the drain becoming blocked. The upstand "leg" of polythene so formed shall be placed on the side of the trench closest to the building element being protected from moisture flow.

For split levels, the ground behind the step shall be properly drained by formation of a surface drain or installation of a strip drain or agricultural drain.

The ground surface beneath suspended floors must be graded to prevent water ponding beneath the building. Suitable outlets shall be provided in the building exterior to allow below-floor moisture to escape.

B4.6 Cold water pipes and heated or hot water pipes shall not be installed under a slab, unless the pipes are installed within a conduit. (AS2870-2011 Rule 5.6.4)

Water service pipes installed under concrete slabs shall comply with the relevant requirements of AS3500.1. Heated water service pipes installed under concrete slabs shall comply with the relevant requirements of AS3500.4.

B4.7 Drainage requirements will be satisfied if drainage is designed and constructed in accordance with AS3500.3 "Stormwater drainage installations" (BCA 3.1.2).

Refer also to National Plumbing and Drainage Part 3.2 Stormwater drainage - Acceptable Solutions (AS3500.3.2).

B4.8 Temporary site drainage. Builders shall control surface drainage of the site from the commencement of construction and throughout the entire site preparation, construction and practical completion phases of the works (refer AS2870-2011 cl.5.6.3). This shall involve but not necessarily be limited to, at least the following scope of temporary works;

(a) As soon as practically possible after footing placement grade the site to drain stormwater away from footing edges.

(b) As soon as the roof and roof gutters are installed provide temporary downpipes to discharge roof stormwater a minimum of 3m away from footing edges.

(c) Put in place temporary unlined earth drains to convey surface stormwater at least 3m away from footing edges and to the low side of the allotment.

(d) Any other works of a temporary (or permanent) nature to prevent all forms of stormwater from ponding against or within 3m of footing edges around the full building perimeter.

B5.0 PAVING REQUIREMENTS

B5.1 Reference is made to AS3727 *"Guide to Residential Pavements"*.

B5.2 Concrete pavements for foot and bicycle traffic **for A, S and M classified sites** shall have a minimum thickness of 75 mm and may be unreinforced. However, this office recommends that shrinkage cracking can be better controlled if a light gauge reinforcing

mesh, such as SL52 is placed centrally even though this is discretionary and not mandatory per AS3727, Table 2. Concrete pavements for driveways **for A, S and M sites** shall have a minimum thickness of 100 mm and be reinforced with steel mesh not less than size SL52, located with 30 mm clear cover to the top face.

For site classifications H1, H2 and E we recommend the use of 75 mm pavement thickness reinforced with SL52 mesh for foot and bicycle traffic only and for driveways 100 mm minimum thickness, reinforced with SL62 mesh placed with 30 mm clear cover to top face.

B5.3 Control joints in concrete pavements shall be provided at maximum 2 m centres and at all changes in direction of the slab edges.

B5.4 For sites with deep filling or of Class H2 or E, it is recommended that Builders and Owners give consideration to the use of segmental brick or block paving which may be re-levelled with comparative ease in the post construction period should local areas of settlement or heave cause ponding of stormwater.

B5.5 Pavements shall be not less than 900 mm width and preferably 1.0m in width and shall have a crossfall of not less than 25 mm per 1 m width for site classes A, S and M-D (see B5.6 below) for class H2 sites not less than 35 mm per 1 m width and for class H2-D and E sites not less than 50 mm per 1 m width.

B5.6 Where the estimated free soil swell (*y*s) is in excess of 35 mm (refer borelog) it is recommended that paving be constructed at the end of winter, when the site soils are wet, so that crossfalls constructed in the paving will not reduce. It is important, however, if the house is occupied during the winter period and no paving is provided, that the soil surface around the perimeter of the house is protected and maintained in a well drained state until such time as paving is installed (refer item B4.8 above). (Note also that excessive garden watering has been known to lead to this problem of reversal of fall on perimeter paving.) Protection of the ground surrounding a dwelling can be initially (temporarily) achieved by using 0.2 mm polythene sheeting and a gravel covering until permanent paving is placed.

B5.7 Paving shall be constructed on a firm clean base. Ensure that all building debris is removed from the perimeter of the house and that a vertical damp proof course (dpc) barrier is placed against the footing (refer detail sheet CD5-1). Provide a compacted quarry rubble base if necessary to elevate paving and achieve the necessary crossfall. Ensure the dpc vertical barrier also separates the basecourse rubble or sand from the concrete edge footing and not just the paving medium.

B5.8 The paving shall not be constructed above any horizontal damp-proof course or built-in damp-proof membrane. Refer to standard detail sheet CD5-1 for a typical detail of the junction between the pavement and the footing.

The height of paving relative to the lowest horizontal dpc in an external wall shall be as follows.

(a) Where a perimeter termite management treatment is installed and;

- there is either a *raft slab without an edge rebate* (e.g. for non masonry/Powerpanel walls) or a strip footing the paved areas shall be a minimum of 35 mm below the finished concrete level of the footing or raft slab, measured at the footing edge, exclusive of any toppings, tiling and floor coverings.

- there is a raft *with an edge rebate*, the paved areas shall be a minimum of 15 mm below the finished concrete level of the edge rebate, except for class H2, E and P sites and filled sites the minimum shall be 75 mm.

(b) Whether there may be or may not be a perimeter termite treatment, where *no paving* is installed and;

- there is either a raft slab without rebate or a strip footing, the external finished ground level shall be a minimum of 100 mm below the finished concrete level of the raft slab or strip footing measured at the slab edge or footing beam, exclusive of any toppings, tiling and floor coverings.

- there is a raft slab with an edge rebate, the external finished ground level shall be a minimum of 75 mm below the finished concrete level of the rebate.

B5.9 On sites with reactive soils, paving may separate horizontally from the perimeter of the building due to soil drying. Gaps which occur between the pavement and footing may be sealed with a flexible mastic sealant, or expanding foam type purpose-made joint backing material.

B5.10 Refer to note B2.1.2 for special paving requirements on filled sites.

B6.0 CONSTRUCTION REQUIREMENTS - TERMITE RISK MANAGEMENT, CONCRETE & REINFORCING

B6.1 Termite risk management shall be in accordance with Part 3.1.3 Termite Risk Management (BCA 1996), with reference to AS3660.1 *"Protection of Buildings from Subterranean Termites Part 1 New Buildings"*. If the ground surface is to be chemically treated then it shall be done following the excavation of any and all trenches.

B6.2 The minimum height of the floor slab above finished ground level shall be 150 mm except in sandy well drained areas where the minimum height shall be 100 mm. The minimum clearance from top of flood gully to finished floor level shall be taken into account. (This clearance is set by the sewerage authority.) The height may be affected by Termite Risk Management requirements.

B6.3 For slab on ground construction (raft footings), including habitable slabs and garage slabs, a damp proofing membrane film branded continuously *"AS2870 Concrete underlay, 0.2 mm high impact resistance"* together with the manufacturer's or distributor's name, trade mark or code, shall be placed so that the bottom surface of the slab and sub-beams, including internal beams are entirely underlaid (Clause 5.3.2 AS2870-2011).

The membrane must be lapped 200 mm minimum and all plumbing penetrations shall be taped or sealed using 50 mm minimum width pressure sensitive plastic tape or close fitting sleeve.

B6.4 Edge rebates in footings for masonry cavity or veneer construction shall be in multiples of masonry units and in any case not less than 20 mm depth. Edge rebates are not required for single leaf masonry, double leaf retaining walls, or for strip footings.

The external masonry leaf may overhang the outer edge of the footing by not more than 15 mm.

The edge rebate shall be flashed continuously and drained by weepholes at not greater than 1.2 metre c/c spacing. Weepholes shall be located above the finished ground and/or pavement level. Any portion of a deep rebate that cannot be drained shall be mortar filled).

B6.5 Hot water heating pipes may be embedded in a slab provided the slab thickness is increased by 25 mm and the steel reinforcing mesh is increased by one grade up (e.g.

SL72 to SL82; SL82 to SL92, etc.). The steel mesh may be placed at a suitable level to accommodate the pipes (AS2870-2011, Rule 5.3.6).

Electric heating cables may be embedded in the slab without increasing the slab thickness or providing extra reinforcement.

B6.6 Where brittle floor coverings are to be used extra measures shall be taken to control the effect of shrinkage cracking. Specific recommendations are made in AS2870-2011, Section 5.3.7 for the treatment of slabs to accept brittle floor coverings. The most practical options are the following:

> *"Where brittle floor coverings are to be used, e.g. large tiled areas, the reinforcement in the slab should be increased to SL92 in accordance with AS2870-2011 Section 5.3.7(a), or use a flexible adhesive grout bed to accommodate shrinkage movement associated with concrete and screeds or the placement of floor covering must be delayed for not less than 3 months"*

Reference to movement joints in tiles and other construction requirements can be found in *"Guide to the installation of ceramic tiles",* AS3958.1.

B6.7 Where a potential shrinkage crack may develop in a slab e.g in some re-entrant corners, fix three 2 metre long N12 bars tied to the mesh diagonally across the potential crack position.

B6.8 Unless otherwise noted in the Footing Construction Report, Concrete shall be not less than Grade N20 with slump of 100mm in accordance with AS1379, with 20 mm nominal maximum aggregate size (AS2870-2011, Rule 5.3.1).

Water must not be added to the mix to increase the slump to a value in excess of that specified (BCA 3.2.3.1).

Concrete pours shall be continuous up to construction joints and/or expansion joints where these have been specified. Where this is not practical due to plant breakdown or unforeseen circumstances, this office must be contacted for advice on a suitable construction joint.

Complete discharge of the concrete from the truck should be made within one and a half hours of initial mixing with water unless a suitable set retarder has been specified. (BCA 3.2.3.1)

All concrete shall be placed and compacted with a suitably sized mechanical vibrator and with good building practice.

In South Australia BCA 2012, section 3.2.3.1(d)(e)(f)(g). The following clauses apply:

- Concrete in slabs must be adequately compacted, and slab surfaces, including edges, moist cured for 7 days.

- After vertical surfaces are stripped of formwork, slab edges must be finished prior to curing.

- Loading of concrete slabs with stacked materials or building plant must not occur for a minimum of 7 days after pouring although construction of wall frames and setting out brickwork may be undertaken during this period.

The finishing and curing of slab edges provides an improved edge finish which mitigates edge dampness (also refer to paving requirements (B5.6)). Any excess concrete spillage under edge formwork boards is to be trimmed off while concrete remains at

plastic hardening stage of hydration.

All slab surfaces shall be adequately and properly cured using an approved treatment (refer AS3600 - Concrete Structures Code.) Care should be taken using chemical curing methods, because some products may not be compatible with adhesives used to fix surface finishes to the slab.

Piers of depth greater than 1 metre are to be poured separately from footing beams to allow shrinkage to occur prior to continuing with the juxtaposed footing preparation for pier-and-beam or pier-and-slab constructions.

For raft footings with beams embedded deeper than 1 m below the natural ground surface or with connected piers >1 m in depth and for strip footings where depth excavation is deeper than 700 mm, provide 2 layers of plastic sheeting to the sides of excavations.

In hot weather (above 32°C) concrete must not be poured without written instruction from a professional engineer. Concrete must be cured by water spray and covering with plastic sheeting, spraying with a liquid membrane curing compound, or ponding of water on the top surface, BCA (2012) 3.2.3.1(d). The plastic sheeting and ponding needs to be for a minimum period of 7 days.

Extreme caution must be exercised when temperatures in the shade in excess of 34^{o}C are likely to occur during the time of finishing the slab. Where the forecast temperature is higher than this level, it is permissible to pour the footing but the following conditions shall be satisfied:

(a) The concrete must be mixed using chilled mixing water.

(b) The steel reinforcement must be kept cool by light water spray.

(c) The use of the vibrator for slab panels must be supervised by a Licensed Works Supervisor or the Builders.

(d) Concrete shall be placed and finished early in the day, well before the maximum temperature is likely to be reached.

(e) A continuous polythene membrane with minimum 300 mm laps must be placed over the slab immediately it becomes "walk dry". The polythene membrane must be held down and secured in position so as to remain for a period of 10 days following the pour. A covering of 50-75 mm of sand kept damp will satisfy this requirement.

All slab surfaces shall be adequately and properly cured using an approved treatment. (Refer AS3600 – Concrete Structures Code).

B6.9 Design cover to the outer most edge of steel reinforcement shall be:

(a) For concrete slab footings protected by polythene vapour barrier ..... 30 mm

(b) For all concrete footings (slabs, strip and piers) in contact with soil ..... 40 mm

(c) For internal slab surfaces clear cover from top face generally, except as in (d) below ..... 20 mm

(d) For exposure, upper slab surfaces (patios, pavements, etc.) ..... 40 mm

Raft or slab fabric shall be lapped by one full panel of fabric so that the two outermost transverse wires of one sheet must overlap the two outermost transverse wires of the sheet being lapped.

Note that permitted tolerances in (a) to (d) above are ±10 mm except that the +ve tolerance may be increased where the design strength of the section is not reduced.

B6.10 Principal steel bar reinforcement in sub-beams shall be lapped so that transverse bars are cut flush with the outer circumference of longitudinal bars at T- and L-junctions. Reinforcing bars shall have a lap length at splices not less than 500 mm. At T and L intersections, the bars shall be continued across the full width of the intersection. At L intersections one outer bar top and bottom shall be bent and continued 500 mm or a bent lap bar 500 mm long on each leg shall be provided top and bottom (AS2870-2011 Rule 5.3.2(e)).

This requirement shall not apply to waffle raft footings.

B6.11 **Reinforcement Splices**

Provided the spacing between parallel bars is not less than 50 mm, splices to reinforcement may be taken from the following table:

BAR SIZE	TOP REO*	BOTTOM REO
N12	500	500
N16	750	700
N20	1200	950
N24	1650	1300
N28	2150	1700
N32	2400	2000

**Applies when 300 mm or more of concrete is placed below the bar(s) at the time of pouring.*

B6.12 **Fixing of Reinforcement**

Prior to the placement of concrete, the cover to the location of reinforcement shall be maintained by using appropriate spacers and bar chairs with bases. Reinforcement shall not be placed or located after concreting except for piers shallower than 1 metre. All other reinforcement including splices and laps need to be wire tied and fixed. Wire chairs must be spaced at not more than 800 mm centres for steel fabric.

B6.13 Reinforcement must be cleaned of mud, paints and oils immediately prior to the concrete pour (BCA 3.2.3.2).

B7.0 SITE INSPECTIONS

B7.1 A fee, additional to that already charged for the preparation of this Report will be levied for each inspection carried out. The onus for notification of each inspection, in accordance with the terms set out in Clause B7.4, immediately below, shall at all times remain with the owner and/or his/her builder, servant or agent.

B7.2 Subject to the Client complying with Clause B7.4, immediately below, the Engineer shall be engaged to carry out site inspections as follows:

(a) If, upon completion of preparatory earthworks and/or any trenching operations undertaken at the site, the Works Supervisor or Builder observe any discrepancy between the actual foundation soil conditions existing at the site and our soil borelog description forming part of this report.

This is not a mandatory inspection, however, the Works Supervisor or Builder should pay close attention during construction to identify matters such as any non-uniformity of soil texture or colour, any "foreign" inclusions and the degree of difficulty of excavation. In this regard filling soil usually varies in colour and texture, it can contain "foreign" matter such as brick, asphalt, glass, etc. and it is usually "easier" to dig than naturally occurring soil.

(b) Upon excavation of trenches and piers as specified in the Report prior to the placement of any vapour proof membrane or concrete.

(c) Upon completion of fixing of reinforcement and at, or prior to, the commencement of the concrete pour.

It shall remain the Builder's responsibility to ensure that:

- The correct cover to reinforcement, the concrete grade and quality of workmanship are met.
- Vapour-proof membranes are not punctured.
- The concrete is finished to correct levels and tolerances as set out in Clauses B6.8 and B6.9 of Appendix B of AS2870-2011.

B7.3 Site inspections specifically exclude the checking of levels, layout dimensions, squareness, relationship to boundaries and any and all other matters which will not affect the structural integrity of the footing and that are the responsibility of the builder.

B7.4 The Client shall ensure that the Engineer is advised at least 24 hours in advance of the time that he should attend for each of the site inspections set out above.

CSIRO

Improving the Built Environment
information sheet

Sheet No. 10–91 Revised August 1996

Guide to home owners on foundation maintenance and footing performance (updated for AS 2870–1996)

Introduction

This guide was prepared by Dr P.F. Walsh, formerly of CSIRO and now with the University of Newcastle, with advice from the Standards Australia Committee on Residential Slabs and Footings, to provide guidance to home owners on their responsibilities for the care of clay foundations, and to discuss the performance that can be expected from a footing system. (The ground that supports a house is called a foundation, and the concrete structure that transfers the load to this foundation is the footing system.)

The best information about the design and construction of footing systems is contained in the Australian Standard AS 2870 'Residential Slabs and Footings'. The Standard gives a system of site classification, prescribed footing and slab designs, and construction methods that provide an excellent footing system for Australian houses. However, a warning is given that the chance of a footing failure is higher if extreme site conditions are permitted to occur, viz.:

- growth of trees too close to a footing;
- excessive or irregular watering of gardens adjacent to the house;
- lack of maintenance of site drainage; and
- failure to repair plumbing leaks.

The Standard further states that compliance with this guide is a way to avoid extreme site conditions.

Clay foundations are the cause of major problems for houses. Clays are very fine-grained soils that are plastic and sticky when wet, and hard and strong when dry. All clays swell or shrink to some degree as they become wet or dry out. 'Reactive' clays swell or shrink to such an extent that foundation movements can damage houses.

All house sites are classified. Reactive-clay sites are classified as S, M, H or E, in order of increasing reactivity. Proper maintenance of such clay sites requires that the moisture content of the clay should be kept reasonably constant.

Some minor cracking of masonry walls on reactive clay sites is almost inevitable despite proper design, construction and maintenance. Very slight cracks (up to 1 mm wide) could be expected in most houses. Larger cracks (up to 5 mm) may occur in some houses with properly designed and constructed footings if reactive clay sites have been subject to large changes of moisture. Cracks larger than 5 mm are regarded as significant damage.

Non-reactive sites – sands, silts and certain clays of class A or S – need only be protected from becoming extremely wet. This requires adequate attention to site drainage and prompt repair of plumbing leaks.

Further information on these topics is given in the following sections. The guide has been updated to be consistent with the revised edition of AS 2870 (1996).

Site classification

AS 2870 requires all sites to be classified. The emphasis has been placed on reactive clays that swell and shrink with changes of moisture content, because these are the most common cause of problems. The classification system is fairly complicated but, as a general guide, the following may be helpful in understanding the system for clay sites.

S Clays that have not given trouble in the past.

M Moderately reactive clays that may cause minor damage to brick houses on old-style light strip footings. Moderately reactive clays are common.

H Highly reactive clays that often damage houses, paths and fences.

E Extremely reactive clays that frequently damage houses even with strong footings. Generally rare in major cities except Adelaide. Other occurrences include outback NSW, Darling Downs, Geelong and Horsham.

Since the precautions necessary depend on the reactivity of the site, the owner should check the classification that is shown on the house plans.

The maintenance of the building and the site is the responsibility of the owner, and so the owner should be familiar with the requirements of this guide.

Care of clay foundations

All clays move with changes of moisture content, so the aim is to minimise such changes in the clay by:

- draining the site;
- keeping gardens and trees away from the house;
- adequate but moderate garden watering; and
- repairing plumbing leaks.

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On a reactive-clay site there are some restrictions on the way the owner can safely develop the garden around the house. These restrictions apply mainly to brick houses. In most cases, only minimal precautions are justified for framed houses clad with timber or sheeting.

The site must be well drained. Under no circumstances should water be allowed to lie against the house or even near the house. The ground immediately next to the house should be graded away with a slope of about 50 mm over the first metre. Suitable surface drains should be provided to take the surface water away from the house. Where topsoil is brought in, it should not interfere with the site drainage, nor should it raise the ground level enough to block the weepholes in the brick walls or any subfloor vents. Even the subfloor of houses with timber floors should be drained so that water does not collect under the house.

Large garden beds are best not located near the house. This will avoid the possibility of introducing too much moisture to the foundation clay by overwatering. The zone near the house should be planned for paths or covered with gravel and plastic sheeting. Small shrubs may be planted at reasonable spacings.

Gardens and lawns should be watered adequately but not excessively. Uniform, consistent watering can be important to prevent damage to the foundation during dry spells such as droughts or dry summers.

Trees and large shrubs require substantial amounts of water, and if the soil near the tree dries out, the roots will extend in search of soil moisture. Tree watering is important in late summer and in drought. The use of slow-drip watering systems may be appropriate. It has also been found useful to drill holes near trees and fill them with gravel to allow water better access to the tree roots. Otherwise, clays will shrink as they dry, and a house may settle as shown below.

Removal of large trees creates the opposite problem. As soil moisture is gradually restored, clays swell and may lift shallow footings.

Many factors determine the extent of clay drying by trees. The more important include soil type, and the size, number and species of trees. Trees obtain moisture from roots that spread sideways, and the drying zone is influenced by the extent of these roots. For single trees, the drying zone is usually half to twice the tree height, but the zone may be larger for groups or rows of trees. Although it is known that the species can influence the extent and severity of the drying zone, little definite information is available. Some Australian trees are particularly efficient in extracting water from very dry soils and can be more dangerous than non-Australian species that use large amounts of water in normal conditions. The effect of tree drying on the amount of movement is also related to the reactivity of the clay. To minimise the risk of damage, trees (especially groups of trees) should not be planted near the house on a reactive clay site, and the following limits are recommended:

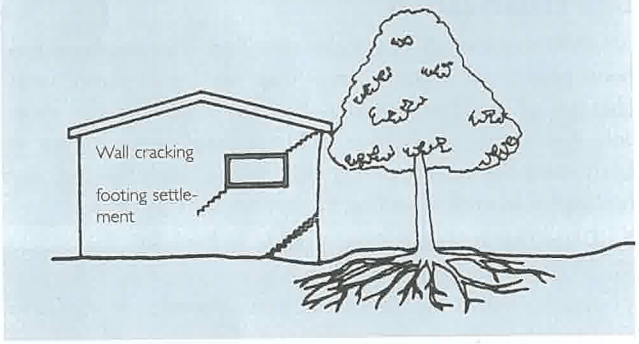
$d = 1.5\,h$ for Class E sites
$d = 1\,h$ for Class H sites
$d = 0.75\,h$ for Class M sites

where d is the distance of the tree from the house, and h is the eventual mature height of the tree. These values should be increased by 50% if the trees are in a dense group. These rules mean that on the average suburban block, trees that grow higher than 8–9 m are often impractical unless the owner accepts the risk of some damage to the house. If large trees are desired, it may be practical to adopt a specially designed footing system, e.g. a piled footing system.

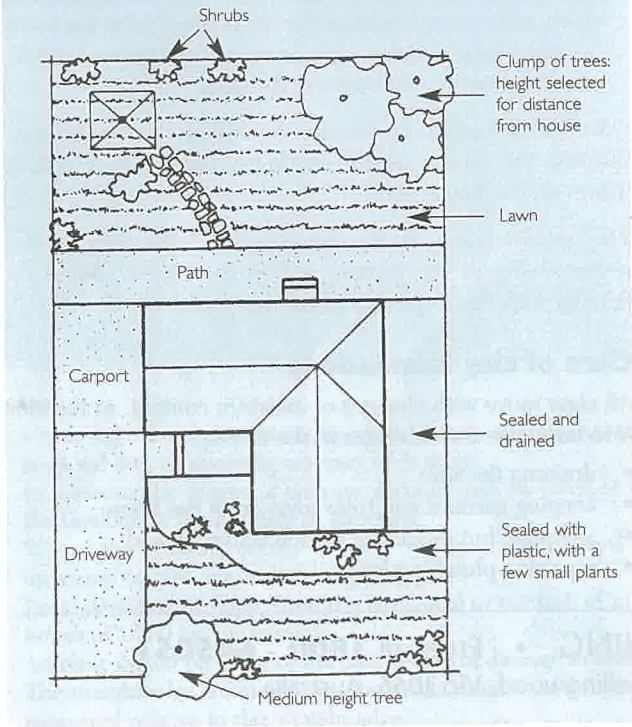
A leak in the plumbing can cause the footings of a house on a reactive clay to move. The water seeps into the clay causing it to swell and push the footing system upwards. Any obvious leaks in stormwater, drainage or sewerage pipes should be investigated. Leaking water pipes can be detected by turning off all the taps and checking if the water meter records any flow.

The above restrictions may seem onerous for new home owners, but lack of site maintenance on a reactive clay can cause damage to the house. The whole issue should be kept in some perspective. The damage to houses caused by reactive clays is mostly unsightly cracks in the brickwork. In the typical Australian brick-veneer house, the brickwork does not support the structure. It is the timber frame that

Trees cause shrinkage and damage



Gardens for reactive site



carries the walls and roof loads, so brick cracks do not affect the structural safety of the house.

If owners choose to disregard some of the above restrictions and, say, plant large trees all around the house, they should not blame the builder, the engineer or the Council if the house suffers some cracking.

Performance of footing systems

All building materials move. Concrete and timber shrink, bricks grow, and so on. Many building practices have been evolved to reduce the damage that such movements cause, and the minor difficulties that arise are usually repaired without significant problems.

Where footings are designed by an engineer, the basis of the design is the limitation of any vertical movement that might occur between the centre of the wall and a line joining the ends of the wall. This is termed the differential movement and limits are given in AS 2870 for various forms of house construction. For example, a masonry veneer house with articulation joints is designed for a movement limit of 30 mm. The amount of this movement at a house can be checked using a level or even a string line along a brick course in the wall. If the vertical differential movement is less than the prescribed limit then the footing system has performed up to standard.

Masonry wall cracking can have many causes other than footing movement, including bricks growing as they absorb moisture, the structural or shrinkage movements of the frame within the veneer skin or even accidental damage during construction. If the cracking is less than a few millimetres it is virtually impossible to determine the cause. Certainly if there is no evidence of excessive differential movement then footings should not be regarded as the cause of the cracking.

However, it must be accepted that on reactive clay sites, particularly Class H and E, some movement is likely and for some sensitive houses cracking may occur even for footings performing within expectations. In order to set realistic expectations, AS 2870 contains Appendix C which is included in this report.

The performance requirement of AS 2870 suggests that Category 0 to 1 damage may be expected for houses on a reactive-clay site, but that the damage is of little consequence. Category 2 damage (isolated cracks up to 5 mm wide) is clearly not satisfactory, but it still does not constitute significant failure and could be expected to occur under adverse environmental conditions.

For these categories of damage, it is the intention of AS 2870 that consequent repairs are part of the normal house maintenance, although during the warranty period this may be the responsibility of the builder.

Nonetheless, to ensure that the damage does not proceed to a more serious state, the owner should take some action.

- Check that the recommendations on site treatment, drainage, garden arrangement, trees etc., have been observed.
- Keep a record of the crack width against the time of the year. If the damage is as high as Category 2 and seems to be increasing, the owner should consult the builder who may be able to offer more specific advice. If this does not prove satisfactory, the owner should engage a consulting engineer who specialises in house footings.
- Engage a plumber to check for leaks if this is suspected to be the cause.
- Replace soil moisture in dry spells by watering. Such watering can be more effective if holes or trenches are dug into the clay. The holes or trenches should be filled with compacted crushed rock or gravel and moderately watered. Some trees may need to be removed or kept pruned.

Complete stability is difficult to achieve, so repairs to damaged walls should include methods that will disguise further movements. Extra joints should be included in external masonry walls and further cracking in internal walls can be concealed by flexible paints, wall paper or panelling. Repairing of cracks with brittle fillers should be avoided unless the cracks have stabilised.

For the more serious categories of damage, the steps to be taken are similar, but there should be little delay in seeking advice. Remedial action for significant failure may still only include attention to stabilising moisture conditions as described above, but could also involve constructing a concrete path or a wall in the ground to stop drying of the foundation clay. Walls may even be designed to span over sagging footings or to cantilever beyond sagging footings. Underpinning is usually not satisfactory in reactive clays.

Experience indicates that lack of maintenance is responsible for many failures. Even with proper design and site maintenance the occasional failure may still occur because footing behaviour is so complex.

Shrinkage of concrete floors

Concrete needs water. Firstly to allow the fresh concrete to flow, and secondly to develop strength during its first few weeks. As a slab starts to dry, it shrinks and tries to contract. Some of this movement is restrained or resisted by friction on the bottom of the slab and by the beams in the ground. This restraint causes tension or stretching forces in the slab and these forces are often large enough to crack the slab.

Shrinkage cracking is almost inevitable and does not represent failure. Most owners never notice the cracks because they often do not occur until after the carpets are laid. Cracks under brittle or sensitive floor coverings are of concern, but the risk of damage can be reduced by using flexible mortars and glues for fixing slate and tiles etc. Also it helps to delay installing the floor covering until after the shrinkage has occurred. The length of delay should be at least three months after the slab has started to dry (i.e. from the time the slab is last wet from rain or during construction).

Adhesive-fixed floor coverings

A concrete slab takes a long time to dry. For example, under temperate condidons a slab will take about three months to dry. Moisture in the concrete can interfere with the bond or break down the adhesive used to attach floor coverings. However, a range of adhesives is available for various floor coverings and these should perform quite well on slabs that have been allowed to dry sufficiently. If there is any doubt, the moisture condition of the slab should be assessed before coverings are placed.

Conclusion

This guide has been prepared to advise owners on how to care for the foundation of their houses and what to expect from a well-designed footing system. The main concern with foundation maintenance is to prevent the foundation soil becoming too wet or too dry, and a variety of recommendations are given to achieve this.

Further information

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Disclaimer

Appendix C of As 2870

Table C1 Classification of damage with reference to walls

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depends on number of cracks	4

Table C2 Classification of damage with reference to concrete floors

Description of typical damage	Approximate crack width limit in floor	Change in offset from a 3 m straight edge centred over defect (see Note 5)	Damage category
Hairline cracks, insignificant movement of slab from level	<0.3 mm	<8 mm	0
Fine but noticeable cracks. Slab reasonably level	<1.0 mm	<10 mm	1
Distinct cracks. Slab noticeably curved or changed in level	<2.0 mm	<15 mm	2
Wide cracks. Obvious curvature or change in level	2–4 mm	15–25 mm	3
Gaps in slab. Disturbing curvature or change in level	4–10 mm	>25 mm	4

Notes:

1 Crack width is the main factor by which damage to walls is categorised. The width may be supplemented by other factors, including serviceability, in assessing category of damage.

2 In assessing the degree of damage, account shall be taken of the location in the building or structure where it occurs, and also of the function of the building or structure.

3 Where the cracking occurs in easily repaired plasterboard or similar clad-framed partitions, the crack width limits may be increased by 50% for each damage category.

4 Local deviation of slope, from the horizontal or vertical, of more than 1/100 will normally be clearly visible. Overall deviations in excess of 1/150 are undesirable.

5 Account should be taken of the past history of damage in order to assess whether it is stable or likely to increase.

6 The straight edge is centred over the defect, usually, and supported at its ends by equal height spacers. The change in offset is then measured relative to this straight edge.