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CONSTRUCTION REPORT AND FOOTING RECOMMENDATIONS ADDENDUM (CR1A)

Builder / Agent:	82 JOHNS ROAD PTY LTD	**Job Number:**	1806063
Owner:	CIFIFY GROUP	**Date:**	3/06/2020
Project:	PROPOSED TRIPLE STOREY TOWNHOUSES (LOTS 1-8)	**Order No.**	
Project Location:	82 - 90 JOHNS ROAD, PROSPECT		
Original Report Date:	21/05/2019		
Previous Addendum Date(s):	NIL		

This Addendum is an integral part of a Construction Report giving specific recommendations for the above mentioned building. The addendum must be read in conjunction with the original report, previous Addenda and all listed attachments. Changes to the design or construction must not be made without further written advice from the Engineer. The Engineer will not be liable for any problems or defects, or damage to the building that may arise on the site as a result of non-compliance to the recommendations contained in this report. This report is valid for a period of 24 months based on current standards, regulations, etc.

ATTACHMENTS: CRC, CR2, CR2-1 (2 pages), CR2-2, CR4, CR5, CR5-1, CR6, CR9, CD1, CD3, CD5, CRS, CRG, SDN, FC111-FC115, SC2, (A1 DRAWING NO. S102/A), CSIRO BTF 18 Bulletin - Owner's copy only.

FOOTING TYPE:
1. Reinforced concrete strip footings founded at a minimum of 200 mm into natural ground.
2. Reinforced concrete raft footings founded at a minimum of 200 mm into natural ground.

FOOTING DETAILS (*Unless noted otherwise*)**:**

Designation		**Width x Depth**	**Reinforcement / Ligatures**
Major External	E		
Major Internal	M		REFER TO S102/A
Minor	m		

RECOMMENDED SITE INSPECTIONS:
1. After excavation for the footing beams and piers, prior to placement of the damp proof membrane.
2. After preparation of the reinforcement prior to pouring of any concrete.
3. As otherwise required by the engineer, or required by the client / contractor.

NOTE: 1. These inspections will incur additional fees.
2. We require 24 hours notice when booking inspections.

ADDITIONAL NOTES / REQUIREMENTS:
1. If trenched piers are to be utilised in lieu of continuous trenching, they are to be 1000 mm long by the width of the footings trenched 200 mm into natural ground. The piers are to be provided at 2.5 m c/c maximum and at each footing beam intersection. Ligature spacing is to be reduced to 300 mm c/c between piers.
2. Where the depth of fill beneath the slab panel exceeds 400 mm increase the slab thickness to 125 mm with one layer of SL92T & one layer of SL72B.
3. Footing sizes adopted have taken into account the effect of existing tree(s) in the vicinity of the proposed works. However, the owner must note that a precise design for the effects of trees was not possible due to the complexity of tree root geometry, variable moisture extraction by tree(s) and the difficulty in predicting future tree growth. Therefore some distortion in the building must be expected. The tree(s) must be kept well watered so that excessive desiccation of the subsurface soils does not occur.
4. This is a Class 'H2-D' site, with a Y_s value of approximately 65 mm. Refer to sheet CR5-1 for corner reinforcement and lagging requirements.
5. Flexible connections for sewer and stormwater pipes are required on this site.
6. **Reason for addendum: Lots 1- 8 Townhouses provided.**

For and on behalf of
TMK Consulting Engineers

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1. GENERAL

1.1 This is a Construction Report giving specific recommendations for the aforementioned building. This report must be read in conjunction with all listed attachments. Changes to the design or construction must not be made without further written advice from the Engineer.

The Owner and or his / her Agent[1] will comply and procure compliance in all respects and at all times with all terms, conditions and recommendations contained in, or attached to, this Construction Report.

1.1.1 List of Possible Attachments.

CRC - Conditions for Use of the Footing Construction Report
CR2 - Surface Soil Borehole Log
CR2-1 - Surface Borehole Location Plan
CR2-2 - Surface Soil Borehole Log Explanatory Notes
CR3 - Footing Layout Plan
CRL - Level Plan
CRD - Drainage Plan
CR4 - Typical Footing Details - Grillage Raft
CR5 - Typical Footing Details - Strip
CR5-1 - Typical Footing Details - Corner Reinforcement and Service Penetration
CR6 - Typical Footing Details - Steps
CR9 - Typical Footing Details – Cut and Fill Sites
CD1 - Control Joint Details in Masonry Walls & Construction Details between New & Existing Buildings
CD2 - Standard Articulation Details for Existing Walling
CD3 - Typical Details for Perimeter Paving
CD4 - Domestic-Sealed Drainage System (Pressurized)
CD5 - Flexible Service Connection Details for Class H, E Sites
CD6-1 - Reinforced Brick Arch 2. "Hesbia" Lintel
CD7 - Stormwater Soakage Pit Detail
CD8 - Earthquake Connection Detail Roof to Solid Masonry Wall
CD9 - Gravel Filled Soakage Pit Detail
CRS - Specifications for Footings
CRG - General Notes
SD1 - Structural Details
SDN - General Construction Notes
FC1 - Footing Calculations
SC1 - Structural Calculations
SW1 - Stormwater Calculations
RC1 - Retaining Wall Details and Calculations
RW1 - Retaining Wall Details
RWN - Retaining Wall Notes
R1 - Retaining Wall Details
SRW - Sleeper Retaining Wall Details and Calculations
PT1 - Dynamic Cone Penetrometer Test
RT1 - Roof Tiedown Details
SPS - Swimming Pool Specifications
SPG - Swimming Pool General Notes
A1 - Appendix A, B, etc.

1.2 The details in this report contain advice designed to minimize distress to the building. It is an important document and should be kept in a safe place. It is essential that this report be supplied to subsequent owner / Agents so that they are aware of the consequences of making changes to the building, garden and adjacent areas. Without this information, they may institute changes to site management that could jeopardize the long term serviceability of the building. In addition the Owner / Agent's attention is drawn to the CSIRO BTF 18 Information Sheet entitled “Foundation Maintenance and Footing Performance: A Homeowners Guide", attached.

[1] *Agent refers to architect, builder, project manager, contractor, supervisor or any other such person that has authority to act on the Owner's behalf.*

1.3 This Construction Report has been prepared at the request of the Owner / Agent. It is a condition of the use of this report that the Owner / Agent accepts the basis on which the footing design has been prepared (refer to Clause 2) and that the Owner / Agent ensures that the Engineer is advised with sufficient notice of the time to attend each of the recommended site inspections (refer to Clause 4).

1.3.1 It is essential that the Owner / Agent reads the entire Footing Construction Report carefully as it contains important information, relating not only to the construction of the footings, but also to the obligations, liabilities and requirements for site management.

1.3.2 If the Owner / Agent requires a different type of footing to that recommended, or stiffer footings to reduce expected movement, our office must be notified prior to the commencement of construction, and advice will be provided accordingly.

1.3.3 If there are any aspects of the report that are not understood, the Owner / Agent should contact the Engineer.

1.4 The Engineer may (and the Owner hereby authorizes the Engineer to):

1.4.1 Issue instructions (including an instruction to cease construction) on behalf of the Owner to any person engaged in the construction of the building, or any part thereof, to ensure that the construction of the building is in accordance with this Construction Report and any modification thereof. If any modification as aforesaid may be likely to result in additional construction costs exceeding $3,500.00 (plus GST) the Engineer may issue an instruction to cease construction in order to obtain the approval of the Owner for such modification.

1.4.2 Make such modifications to the Construction Report as the Engineer may deem necessary during the course of construction.

1.5 The Owner shall be responsible for, and indemnify the Engineer against, all and any costs and charges and all claims and demands made for any additional costs incurred by reason of any act, requirement or instruction of the Engineer made or given pursuant to Clause 1.4.

1.6 The Engineer shall not be liable for any defect in or damage to the building arising from footing inadequacy or movement of the building, including its footing, caused by or contributed to by any breach of the terms, conditions and recommendations committed, permitted or allowed by the Owner / Agent.

1.7 Where more than one person is named as the Owner, all these terms, conditions and recommendations shall bind all such persons jointly and each such person severally, and any instruction or information given to the Engineer by any one such person shall be deemed to be given by all other such persons.

1.8 For the purposes of these conditions 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 Owner.

2. FOOTING PERFORMANCE

2.1 The following information represents the basis on which the Construction Report has been prepared.

2.1.1 It is important for the Owner to understand that reactive clays move because of moisture changes. Even relatively stable clays will move significantly if subjected to extreme moisture changes, for example, too much or too little garden watering. It is neither possible nor economical to design for extreme changes in soil moisture conditions. The Owner is the person responsible for maintaining acceptably uniform moisture conditions on the site.

2.1.2 Generally, the footings specified in an engineered system will be reasonably economical to construct, will fully comply with all relevant building codes and industry practice and will provide acceptable levels of performance into the future.

2.1.3 The Owner should appreciate that it is impossible to design a footing system that will totally prevent structural movement, unless of course there is no limit on expenditure. Some minor aesthetic (non-structural) cracking, whilst undesirable, will occur in almost all buildings.

2.1.4 Any movement, damage, cracking, collapse or other condition which reduces the safety, aesthetics or serviceability of the structure is usually referred to as “distress”. Engineered footings are designed to reduce the risk of foundation (ie, soil or rock) movements causing distress to the structure and are not designed to completely eliminate all cracking or other distress.

2.1.5 Limits on the expected performance of engineered footings are set out in Tables C1 and C2 of AS 2870, reproduced below. While occasional Category 2 behaviour may occur, Category 0 and 1 should be the limit for most situations.

2.1.6 Masonry exhibiting crack widths of more than 5 mm (Category 3) usually perform well in practice. In most cases, the cracking of the structure only presents an aesthetic problem.

2.1.7 The generally accepted probability of Category 3 damage occurring is of the order of 5%. This equates to the probability that 1 in 20 buildings will experience a crack of 5 mm width sometime during their design life and is a community-based level of risk adopted in AS 2870. If the Owner desires a lower risk of distress, this can be achieved but at increased expense. The Owner must specifically request a lower risk design, if desired.

2.1.8 The risk of distress is affected by various environment factors. The risk levels adopted in AS 2870 are based on normal site and environmental conditions. Abnormal conditions such as leaking water or sewer pipes or a departure from the site management regime described in this report will increase the risk of significant distress occurring during the life of the building. Many of these abnormal conditions are directly under the control of the Owner.

2.1.9 Just as it is impossible to design an immovable footing system, it is almost impossible to provide remedial measures that will prevent further movements if distress does occur. Therefore, extreme remedial measures should not be undertaken for minor problems.

2.2 Ideally, the planting of trees should be avoided on reactive clay sites in order to protect the structure from possible damage. However, this is not always practicable. Therefore the planting of trees must be carried out strictly in accordance with recommendations set out elsewhere in this report.

In the case where one or more trees already exist in the vicinity of the proposed structure, the engineering design of the footings takes account of their anticipated effects by allowing for greater soil movements than would be expected if the tree or trees were not present.

The Owner should understand that, because the effects of trees and their roots on a structure cannot be predicted precisely due to the complex geometry of tree roots and the variability inherent in the soil material, some level of structural movement must be expected due to the presence of trees.

2.4 When additions are made to an existing building, special considerations will apply. The footings of the existing building and the footings of the addition are always separate structures. Even though some connection may be made between the footings, the footings will move differentially, meaning that cracking may occur at the junction of the two footings and control joints will open and / or close. The presence of the addition should not be expected to stabilize any pre-existing movements in the existing building.

2.5 The attachment of floor surfacing to concrete slabs that have not fully dried can cause problems due to moisture reactions with glues or normal concrete shrinkage. Drying times vary and up to 6 months may be required. Concrete shrinks as it dries resulting in some cracking, often of the order of 1 mm width. This has little effect on structural performance of the slab but could affect some brittle floor coverings if installed too soon (Refer to CRS Clause 3.8).

TABLE C1 (AS 2870): 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. Weather tightness often impaired.	5 mm to 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 with some loss of bearing in beams. Service pipes disrupted.	15 mm to 25 mm but also depends on number of cracks	4

TABLE C2 (AS 2870): 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 CENTERED OVER DEFECT (see Note 6)	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. Slabs noticeably curved or changed in level.	< 2.0 mm	< 15 mm	2
Wide cracks. Obvious curvature or change in level.	2 mm to 4 mm	15 mm to 25 mm	3
Gaps in slab. Disturbing curvature or change in level.	4 mm to 10 mm	> 25 mm	4

NOTES:

1. Crack width is the main factor by which damage to walls is categorized. 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, or 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 centered over the defect, usually, and supported at its ends by equal height spacers. The change in offset is then measured relative to the straight edge.

3. SOIL BOREHOLE LOGS

3.1 The soil profiles as indicated by the test bores, form the basis of the footing recommendations. The soil profile is only particular to the test location and the soil samples obtained may not disclose all the soil variations on the site.

3.2 Assessment of subsurface soils apart from the determination of the 'soil heave' value, is excluded from our scope.

3.3 It is not economically possible or practical to determine every subsurface feature on a site. Because of this any variations or discrepancies in soil type, colour, or horizon depth, as compared to the test bores shall be referred to the Engineer immediately. One must not place sole reliance on the surface soil borehole logs as a means of being an absolute representation of all sub-surface features existing on the site. Nor can the density and difficulty of excavation be estimated by interpretation of the surface soil borehole logs.

3.4 The footings have been selected on the basis of the recognized characteristics of the soil profile. Unless otherwise stated, these characteristics have been visually assessed and related to known performance of the soils under normally-expected conditions of site development and use. It has been assumed that aspects of site drainage, paving and landscaping which are described in the report have been, or will be, implemented. Where any or all of these aspects do not form part of the building contract, it is a mandatory requirement that they be carried out within a period of 4 months from date of completion of the building provided always that adequate temporary stormwater drainage is installed.

4. SITE INSPECTIONS

4.1 General

Inspections specifically exclude particular architectural details, the checking of levels, layout dimensions, squareness and relationship to site boundaries.

4.1.1 The Owner / Agent shall ensure that the Engineer is advised at least 1 full working day in advance of the time to attend each of the inspections, and shall ensure that construction of the building is not allowed to proceed beyond any stage at which an inspection is required, unless the Engineer has approved the work at that stage.

4.1.2 The Owner / Agent shall ensure that any work request given by the Engineer is undertaken.

4.1.3 Site inspections have not been included in the initial design fees, and hence will incur additional fees.

The inspections listed below are strongly recommended. It is stressed that incorrect construction, detected at a later stage, may result in increased costs for remedial work.

4.2 Stages for Inspections

4.2.1 Prior to the commencement of earthworks to determine the impact of such works on adjacent structures.

4.2.2 Upon completion of primary earthworks, where the depth of excavation and/or filling exceeds 600 mm. Alternatively, this inspection may be carried out at the same time as Clause 4.2.3 provided the Owner / Agent accepts the consequences of any changes to the footing construction that may be required as a result of the primary earthworks. The inspection shall be limited to a visual assessment of the earthworks and any approval shall be conditional upon the Owner / Agent completing the final earthworks to the correct levels and slopes at a later stage. Where the Engineer considers that additional testing or investigation is required as a result of the earthworks, work shall not proceed until the additional services have been completed. Any such additional testing, investigation and reporting shall incur additional fees.

4.2.3 After completion of excavation for footings and prior to the placement of any vapour barrier (if required) or reinforcement. Where footing construction is staged, an inspection must be carried out at each stage.

4.2.4 After placement of the reinforcement prior to pouring any concrete. It shall remain the Owner / Agent's responsibility to ensure that the correct cover to reinforcement, concrete quality and quality of workmanship are maintained, vapour barriers are not punctured, and that the concrete is finished to the correct levels.

4.2.5 After completion of excavation for main sewers to ensure that the trenches, as constructed, do not affect the footing as designed. Checking sewers for compliance with the requirements of statutory authorities is excluded. This inspection is only required when the depth of any sewer trench exceeds the distance from the trench to the building. This does not apply to trenches up to 1000 mm deep running perpendicular to the building.

4.2.6 After completion of brickwork or similar to ensure that the articulation joints have been placed at the specified locations. Checking construction details which are not visible is excluded and no responsibility is taken for any problem arising from such.

4.2.7 Upon completion of the installation of paving, stormwater drains, pipes and structures. The checking of sections which are not visible is excluded and no responsibility is taken for any problem arising from such sections. Maintenance of ground slopes to ensure continued proper drainage will be required subsequent to the inspection, and shall remain the Owner / Agent's responsibility. If inspection Clause 4.2.6 has not been carried out, any control joints will be checked at this stage. The work must have been completed, and inspected, within 4 months of the date of practical completion.

5. TERMS OF ENGAGEMENT

All work will be carried out in accordance with TMK's 'Terms and Conditions of Engagement for Consulting Services'.

TECHNICAL SERVICES
Soil Sampling and Logging * Engineering Level Surveys
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STS Technical Services, 8 Duncan Road, Dry Creek SA 5094
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email: stssa@stssa.com.au ABN 68 007 952 203

SURFACE BOREHOLE LOG	**DATE:** 28/08/2018 **JOB NO:** 1806063 **STS REF:**	**CR2** **1 OF 2**
DATE DRILLED: 27/08/2018	TO BE READ IN CONJUNCTION WITH CR2-1 & CR2-2	
SITE: 82 - 90 JOHNS ROAD PROSPECT SA		

DEPTH IN METRES				**VISUAL ASSESSMENT OF PROPERTIES**						
BORE 1	BORE 2	BORE 3	BORE 4	COLOUR	CONSISTENCY, TEXTURE & STRUCTURE	SOIL DESCRIPTION	U.S.C.	M.C.	BEARING	EST Ips (AVE)
0.00 - 0.02	0.00 - 0.02	0.00 - 0.02	0.00 - 0.02	Dark Grey	Firm, Granular	(FILL) BITUMEN NP	SM-GM	B	H	0.000
0.02 - 0.30	0.02 - 0.20	0.02 - 0.30	0.02 - 0.30	Cream, Orange, Brown	Friable, Granular	(FILL) Clayey SAND with Gravel VLP	SC-GM	B	M	0.002
0.30 - 0.40	0.20 - 0.30		0.30 - 0.40	Dark Brown	Friable, Granular	Clayey SAND VLP	SC	B	M	0.005
0.40 - 0.75	0.30 - 0.70	0.30 - 0.70	0.40 - 0.80	Red Brown	Firm, Granular	Sandy CLAY HP	CH	B	M	0.030
0.75 - 1.40	0.70 - 1.20	0.70 - 1.30	0.80 - 1.60	Cream, Orange, Red, Brown	Friable - Firm, Granular	Sandy CLAY, Limey with Calcrete Nodules MP	CL	B/N	M*	0.020
1.40 - 2.00	1.20 - 2.00	1.30 - 1.80	1.60 - 2.20	Cream Brown	Friable, Granular	Silty Sandy CLAY, Limey LMP	CL-ML	A/WA	M	0.015
2.00 - 2.40	2.00 - 2.40	1.80 - 2.00	2.20 - 2.50	Cream, Red, Brown	Firm, Granular	Sandy Limey CLAY MHP	CL-CH	N/A	M	0.025
2.40 - 3.00	2.40 - 3.00	2.00 - 2.50	2.50 - 3.00	Orange, Brown	Stiff, Granular	Sandy CLAY HP	CH	B/N	M	0.035

REMARKS	CLASSIFICATION: H2-D	TYPE: BS	CLASSIFIER: TMK

1 The classification nominated on this borehole log relates to the site soil profile at the time of testing. It does not allow for future earthworks and does not incorporate any possible effects from trees, either existing or future.
2 The calcareous clay soils present within the soil profile may lose strength upon wetting. Adequate site drainage is essential.
3 The soil profile possesses a VERY HIGH potential of surface movement (swelling and shrinking due to soil moisture variations).
4 In this area the soil profile, as indicated by the borehole log, is possibly underlain by reactive clay soils with a Ips in the order of 0.055.

REFERENCES USED:

SOIL MAPS: Soil Association Map of the Adelaide Region

NEARBY BORELOGS:

SAMPLE METHOD: Driven push tube using high pressure hydraulic hammer

Drilled & Logged By: STS Technical Services **Checked By:** VENKY

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DATE DRILLED: 27/08/2018	TO BE READ IN CONJUNCTION WITH CR2-1 & CR2-2	
SITE: 82 - 90 JOHNS ROAD PROSPECT SA		

DEPTH IN METRES				**VISUAL ASSESSMENT OF PROPERTIES**						
BORE 1	BORE 2	BORE 3	BORE 4	COLOUR	CONSISTENCY, TEXTURE & STRUCTURE	SOIL DESCRIPTION	U.S.C.	M.C.	BEARING	EST Ips (AVE)
		2.50 - 3.00		Orange, Green	Very Stiff Granular	CLAY VHP	CH	B	M	0.050

REMARKS	CLASSIFICATION: H2-D	TYPE: BS	CLASSIFIER: TMK

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SURFACE BOREHOLE LOG	**DATE:** 28/08/2018 **JOB NO:** 1806063 **STS REF:**	**CR2** **2 OF 2**
DATE DRILLED: 27/08/2018	TO BE READ IN CONJUNCTION WITH CR2-1 & CR2-2	
SITE: 82 - 90 JOHNS ROAD PROSPECT SA		

DEPTH IN METRES				VISUAL ASSESSMENT OF PROPERTIES						
BORE 5	BORE 6			COLOUR	CONSISTENCY, TEXTURE & STRUCTURE	SOIL DESCRIPTION	U.S.C.	M.C.	BEARING	EST Ips (AVE)
0.00 - 0.02	0.00 - 0.02			Dark Grey	Firm, Granular	(FILL) BITUMEN NP	SM-GM	B	H	0.000
0.02 - 0.30	0.02 - 0.30			Cream, Orange, Brown	Friable, Granular	(FILL) Clayey SAND with Gravel VLP	SC-GM	B	M	0.002
0.30 - 0.45	0.30 - 0.40			Dark Brown	Friable, Granular	Clayey SAND VLP	SC	B	M	0.005
0.45 - 1.00	0.40 - 0.80			Red Brown	Firm, Granular	Sandy CLAY HP	CH	B	M	0.030
1.00 - 1.60	0.80 - 1.40			Cream, Orange, Red, Brown	Friable - Firm, Granular	Sandy CLAY, Limey MP	CL	B/N	M	0.020
1.60 - 2.00	1.40 - 1.90			Cream Brown	Friable, Granular	Silty Sandy CLAY, Limey LMP	CL-ML	A/WA	M	0.015
2.00 - 2.20	1.90 - 2.40			Cream, Red, Brown	Firm, Granular	Sandy CLAY, Limey MHP	CL-CH	N/A	M	0.025
2.20 - 3.00	2.40 - 3.00			Orange, Brown	Stiff, Granular	Sandy CLAY HP	CH	B/N	M	0.035

REMARKS	CLASSIFICATION: H2-D	TYPE: BS	CLASSIFIER: TMK

1 The classification nominated on this borehole log relates to the site soil profile at the time of testing. It does not allow for future earthworks and does not incorporate any possible effects from trees, either existing or future.
2 The calcareous clay soils present within the soil profile may lose strength upon wetting. Adequate site drainage is essential.
3 The soil profile possesses a VERY HIGH potential of surface movement (swelling and shrinking due to soil moisture variations).
4 In this area the soil profile, as indicated by the borehole log, is possibly underlain by reactive clay soils with a Ips in the order of 0.055.

REFERENCES USED:

SOIL MAPS: Soil Association Map of the Adelaide Region

NEARBY BORELOGS:

SAMPLE METHOD: Driven push tube using high pressure hydraulic hammer

Drilled & Logged By: STS Technical Services **Checked By:** VENKY

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SITE: 82 - 90 JOHNS ROAD PROSPECT SA		

DEPTH IN METRES				**VISUAL ASSESSMENT OF PROPERTIES**						
BORE 5	BORE 6			COLOUR	CONSISTENCY, TEXTURE & STRUCTURE	SOIL DESCRIPTION	U.S.C.	M.C.	BEARING	EST Ips (AVE)
3.00 - 4.00	3.00 - 4.60			Red Brown	Stiff, Granular	CLAY VHP	CH	B	M	0.050
4.00 - 6.00	4.60 - 6.00			Khaki, Brown, Red	Stiff, Granular- Blocky	CLAY VHP	CH	B	M	0.060

REMARKS	CLASSIFICATION: H2-D	TYPE: BS	CLASSIFIER: TMK

1 The classification nominated on this borehole log relates to the site soil profile at the time of testing. It does not allow for future earthworks and does not incorporate any possible effects from trees, either existing or future.
2 The calcareous clay soils present within the soil profile may lose strength upon wetting. Adequate site drainage is essential.
3 The soil profile possesses a VERY HIGH potential of surface movement (swelling and shrinking due to soil moisture variations).
4 In this area the soil profile, as indicated by the borehole log, is possibly underlain by reactive clay soils with a Ips in the order of 0.055.

REFERENCES USED:

SOIL MAPS: Soil Association Map of the Adelaide Region

NEARBY BORELOGS:

SAMPLE METHOD: Driven push tube using high pressure hydraulic hammer

Drilled & Logged By: STS Technical Services **Checked By:** VENKY

K:\2018\06\1806063\Issue\Ready for Issue\1806063_CR2.PDF

JOB NO: 1806063.

TAT: .....

DATE: 27/8/18.

DUE DATE: .....

STS TECHNICAL SERVICES

Soil Sampling and Logging *Engineering Level Surveys
Percolation Tests * Environmental Soil Sampling * Groundwater Wells

AGENT: .....

OWNER: CHIFY Group

SOIL / PERCOLATION / PENETROMETER: .....

PLANS: (YES) / NO

SITE LOCATION: 82-90 Johns Road Prospect, S.A

NO. & DEPTH OF BORES REQUESTED: 2 x 6m & 4 x 3m.

CR2-1

DRILLER'S NOTES

Drillers Initials: T.B. & J.S. Date Drilled: 27/8/18.

Tick and /or make notes

GROUND SURFACE

Show location on Plan if relevant

Surface Moisture Content	✓ Dry	☐ Moist	☐ Wet	
Surface Vegetation	☐ Grass	☐ Trees	✓ Gravel	
Surface Cracks	☐ Yes	✓ No		
Surface Soil Strength	☐ Soft	☐ Loose	✓ Firm	☐ Hard

UNUSUAL FEATURES

Heap / even Filling	✓ Yes	☐ No
Rock Outcrops	☐ Yes	✓ No
Pits / Cellar / Underground Tank	☐ Yes	✓ No
Excavations	☐ Yes	✓ No
Drainage Channels	☐ Yes	✓ No
Trees	☐ Yes	✓ No
Cracks in existing Structures	☐ Yes	✓ No
Other (Specify)	☐ Yes	☐ No

SLOPE (Show on Plan)

(Level) ..... Fall .....

WATER TABLE

Water Struck ☐ Yes ☐ No

Depth of Water Table on Completion of Drilling

Bore No	1	2	3	4	5	6	7	8	9	10	11	12
Depth												

BOREHOLE INFORMATION

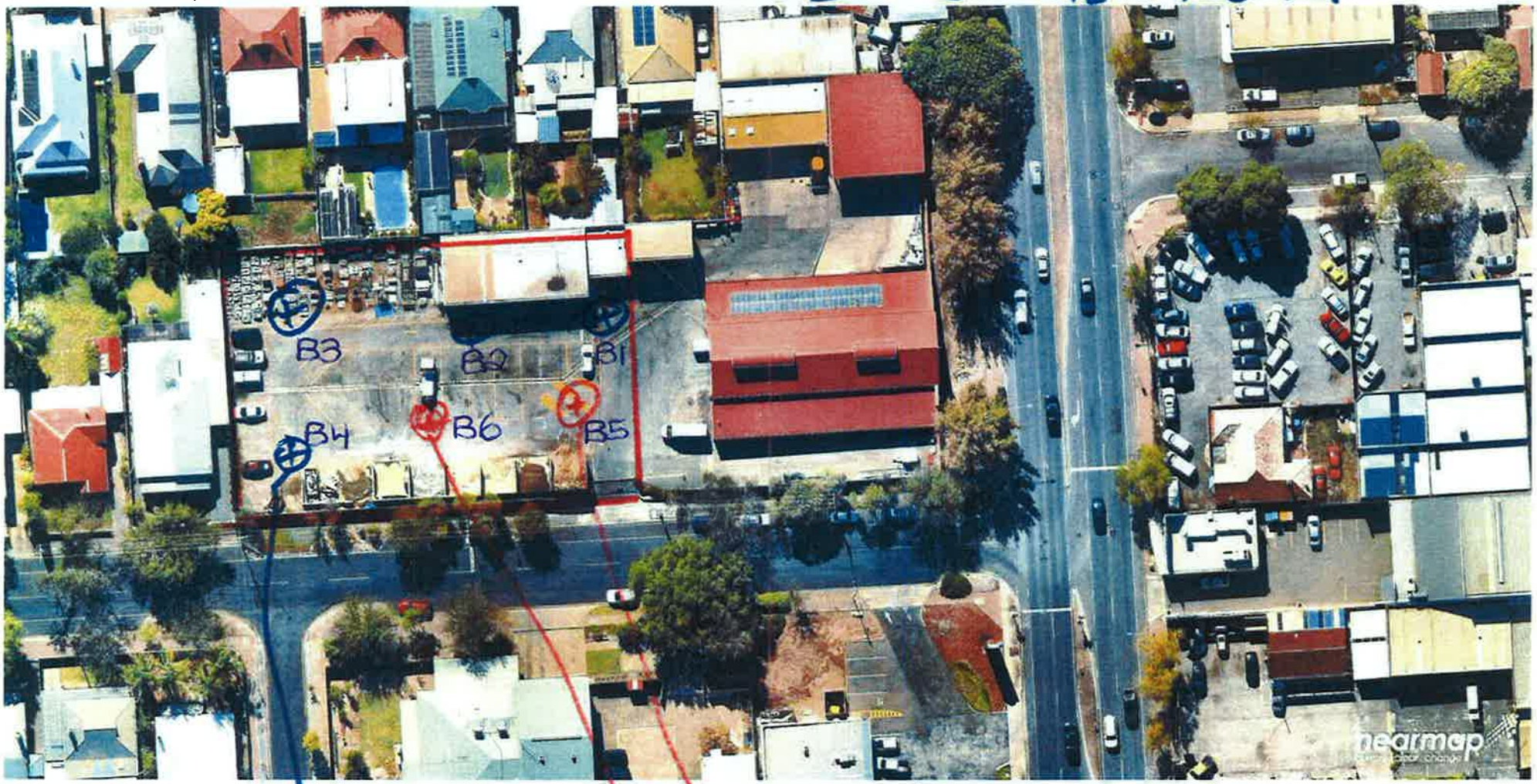
		1	2	3	4	5	6	7	8	9	10	11	12
Overall Resistance	Low												
	Medium	✓	✓	✓	✓	✓	✓						
	High												
Bottom Resistance	Low	✓	✓										
	Medium	✓		✓	✓	✓	✓						
	High												
Depth Drilled (in meters)		3	3	3	3	6	6						
Core Recovery	100%			✓		✓	✓						
	Stretched	150				550	650						
	Core Loss		800		400								

Auger

Comment: Approx 20mm Bitchem.

STS Technical Services, 8 Duncan Road, Dry Creek S.A. 5094
Tel: 08 8262 9580 / 08 8262 4755 Fax: 08 8262 9579
Email: stssa@stssa.com.au Web: www.stssa.com.au

Date: Thu, 19 Apr 2018 Notes: 1806063 82 Johns Road



4 cores to 3 metres.

2 cores to 6 metres.

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Email: sts_soils@stssa.com.au

SURFACE SOIL BOREHOLE LOG EXPLANATORY NOTES (CR2-2)

1. GENERAL

The surface soil borehole log is based on visual-tactile logging of the drilled core. The soil characteristics are generally estimated, however samples from 1 in 50 sites are subjected to shrink-swell tests conducted by a NATA accredited laboratory to verify estimated values.

One must not place sole reliance on the surface soil borehole logs as a means of being an absolute representation of all sub-surface features existing on the site. Nor can the density and difficulty of excavation be estimated by interpretation of the surface soil borehole log.

The soil borehole logs are usually based upon 40 mm diameter continuous core samples in one or more locations on the site in accordance with AS 2870 *Residential slabs and footings*. It is not possible by this means to detect all subsurface features which may exist and the Owner is advised to seek information from Local Council, Department of Health and other statutory Authorities regarding any unnatural features (e.g. wells, mineshafts, filled areas etc) land use (e.g. toxic waste, waste disposal etc), or other features typical to the area (e.g. landslip, springs etc).

This office uses not only the borehole log information but may take into account such matters as the known geology of the area taken from published soil maps, the known performance of existing structures in the general area and engineering judgment to make an assessment of soil classification for design purposes.

2. UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines.
	GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures.
	GC	Clayey gravels, gravel-sand-clay mixtures.
Clean sands	SW	Well graded sands and gravelly sands, little or no fines.
	SP	Poorly graded sands and gravelly sands, little or no fines.
Sands with Fines	SM	Silty sands, sand-silt mixtures.
	SC	Clayey sands, sand-clay mixtures.
Silts and Clays (Liquid Limit <50%)	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.
	CL	Inorganic clays of low to medium plasticity, gravelly/sandy/silty/lean clays.
	OL	Organic silts and organic silty clays of low plasticity.
Silts and Clays (Liquid Limit >50%)	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.
	CH	Inorganic clays or high plasticity, fat clays.
	OH	Organic clays of medium to high plasticity.
Highly Organic Soils	Pt	Peat, muck, and other highly organic soils.

3. MOISTURE CONTENT

MOISTURE CONTENT relative to the Plastic Limit (PL) of the soil for cohesive soils or relative to the optimum moisture content of the soil (OMC) for cohesionless soils, i.e. non plastic.

WB	Well below
B	Below
N	Near
A	Above
WA	Well above

4. BEARING STRENGTH

The descriptive term used relates to the in-situ strength at the time of logging.

It must be noted that site works and changes in soil moisture may significantly affect the bearing strength. It must also be noted that as the soils are disturbed in the drilling and sampling process the bearing strength in-situ may be different from that logged.

Term	Description	Allowable Bearing Capacity (kPa)
VL	Very low (loose granular material or soft, possibly collapsing soil)	< 50
L	Low (firm)	50 to 100
M	Medium (stiff)	100 to 200
H	High (very stiff to hard)	> 200

5. SITE CLASSIFICATION BASED ON SITE REACTIVITY

Class	Foundation	Character
A S	Most sand and rock sites with little or no ground movement from moisture changes Slightly reactive clay sites, which may experience only slight ground movement from moisture changes	Stable
M H1 H2 E	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes Highly reactive clay sites, which may experience high ground movement from moisture changes Highly reactive clay sites, which may experience very high ground movement from moisture changes Extremely reactive sites, which may experience extreme ground movement from moisture changes	Reactive
A A to P	Sand Material other than sand	Controlled Fill
P	Mine subsidence Uncontrolled fill Landslip Soft Collapsing soils	Problem

Note: For sites with deep seated moisture changes characteristic of dry climates and corresponding to a design depth of suction change equal to or greater than 4 m, the classification shall be M-D, H1-D, H2-D, H2-D or E-D as appropriate. For example, M represents a moderately reactive site with shallow moisture changes and M-D represents a moderately reactive site with deep moisture changes.

6. PLASTICITY

NP Non plastic.
VLP Very low plasticity.
LP Low plasticity.
MP Medium plasticity.
HP High plasticity.
VHP Very high plasticity.

7. REACTIVITY

The reactivity of the soil is defined as the potential for undergoing changes in volume with changes in the soil moisture content.

The reactivity is measured in terms of Shrinkage Index (I_{ps}).

Term	Description	Shrinkage Index (I_{ps})
VL	Very low	0.5% or less
L	Low	1%
M	Medium	2%
H	High	3% to 4%
VH	Very high	4.5% or greater

Characteristic surface movement (y_s) mm	Site classification in accordance with Table 2.3 AS2870-2011
$0 < y_s \leq 20$	S
$20 < y_s \leq 40$	M
$40 < y_s \leq 60$	H1
$60 < y_s \leq 75$	H2
$y_s > 75$	E

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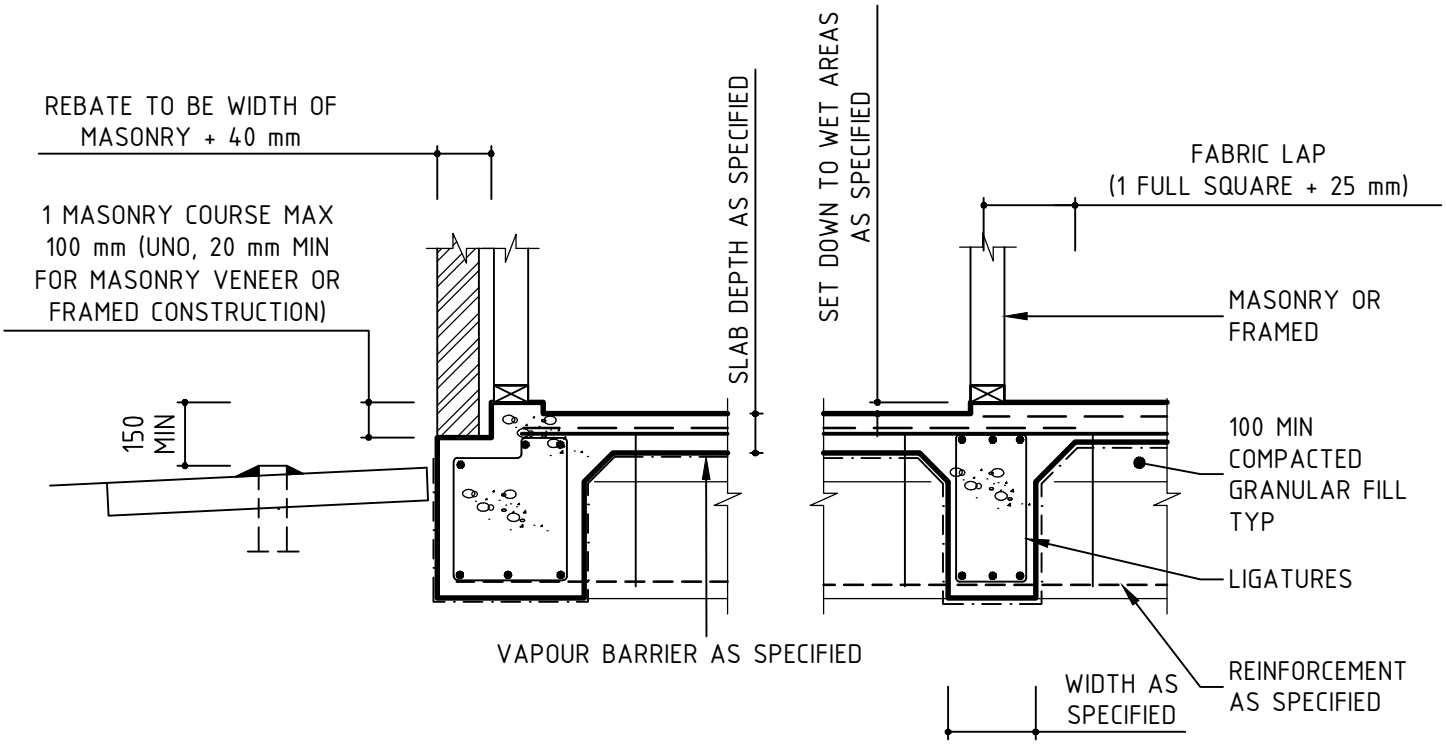
RAFT FOOTING DETAIL (CR4)

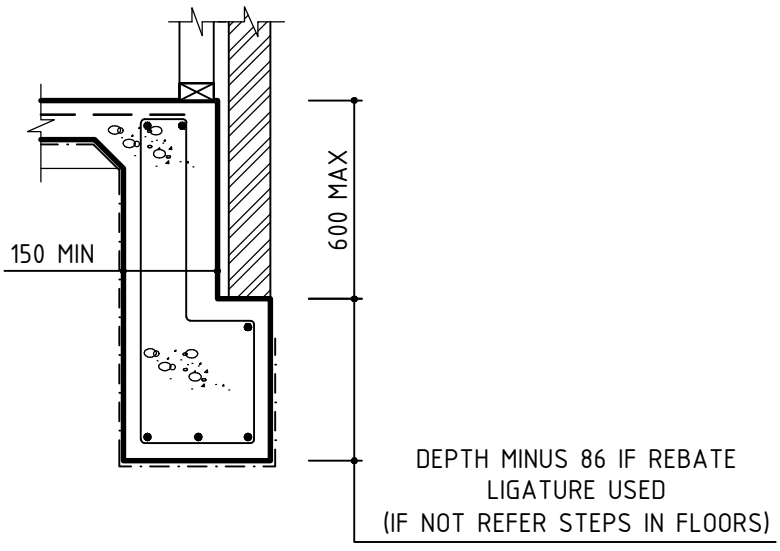
NOT TO SCALE



TYPE E TYPE M

NOTES:

1. WHEN DEPTH OF FOOTING BEAM EXCEEDS 800 mm CARRY VAPOUR BARRIER DOWN SIDES ONLY



DEEP EDGE REBATE

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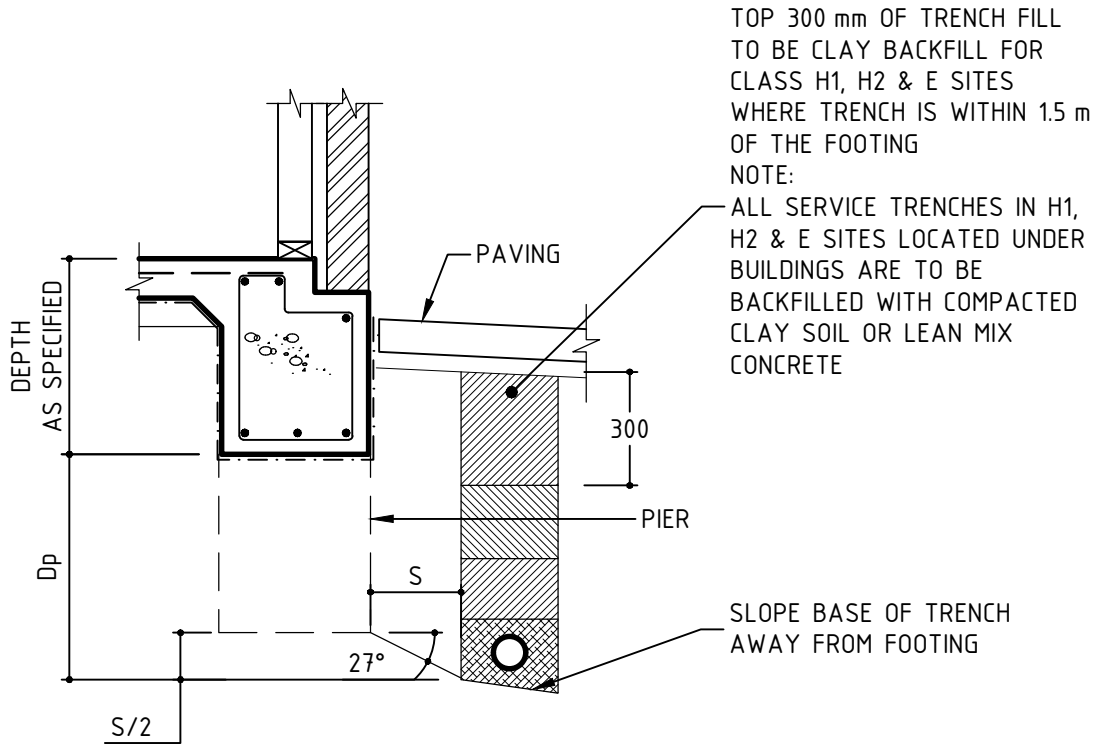
RAFT FOOTING DETAIL (CR4)

NOT TO SCALE



FOOTING REQUIREMENTS ADJACENT TO PIPE TRENCHES

NOTES:

1. WHEN THE DEPTH Dp IS GREATER THAN THE DISTANCE S/2, PROVIDE A MINIMUM OF 1000 LONG UNREINFORCED CONCRETE PIERS THE SAME WIDTH AS THE FOOTING BEAM AT MAXIMUM 3000 C/C TO THE DEPTH SHOWN
2. THE LIGATURE SPACING IN THE FOOTING BEAMS MUST BE REDUCED TO 300 C/C WHEN PROVIDING PIERS
3. ALTERNATIVELY: BACKFILL THE TRENCH WITH A GRANULAR MATERIAL (NON CLAY) IN LAYERS NOT EXCEEDING 150 mm EACH LAYER IS TO BE COMPACTED TO A DENSITY OF 95% IN ACCORDANCE WITH AS 1289 5.2.1 MODIFIED COMPACTION

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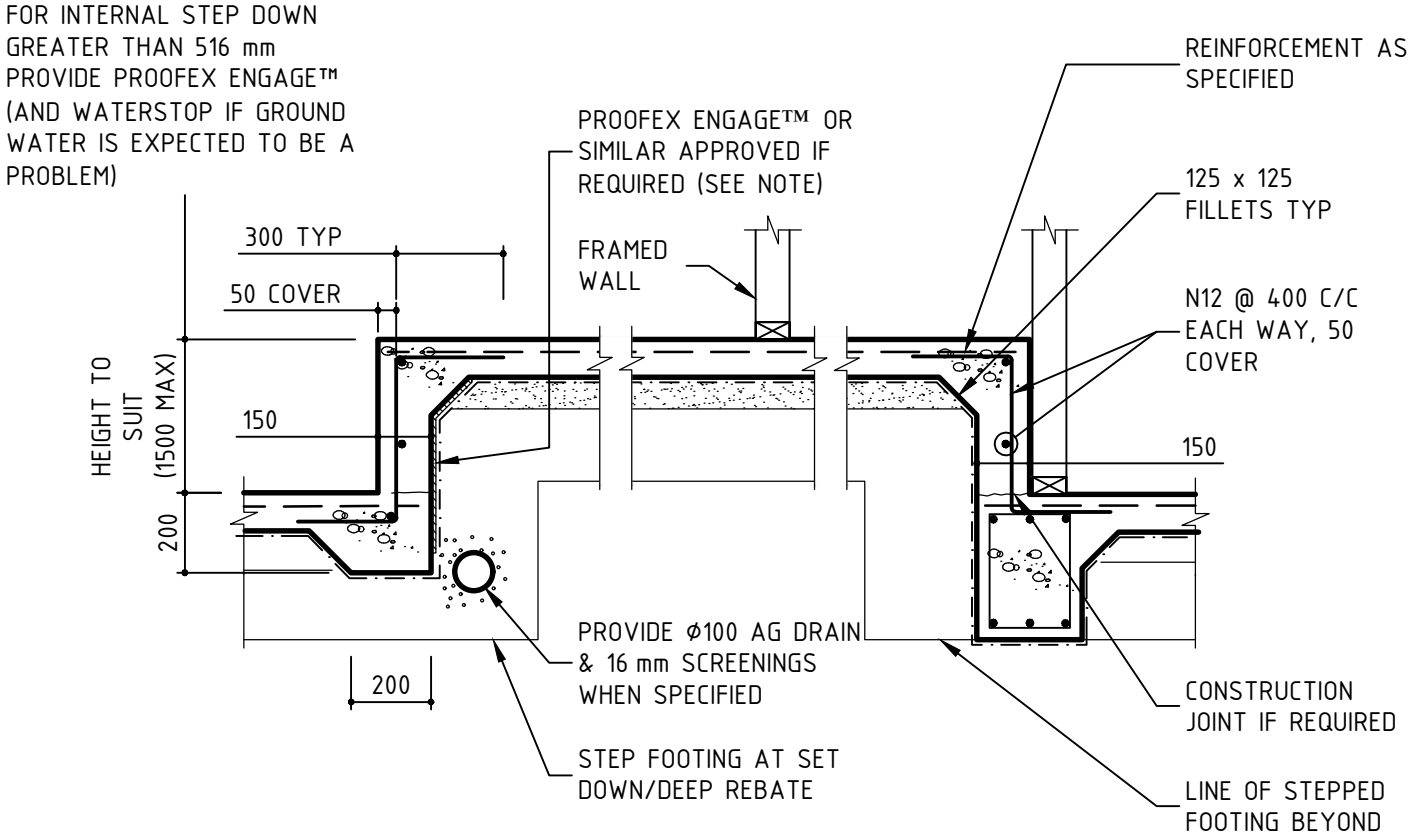
RAFT FOOTING DETAILS (CR4)

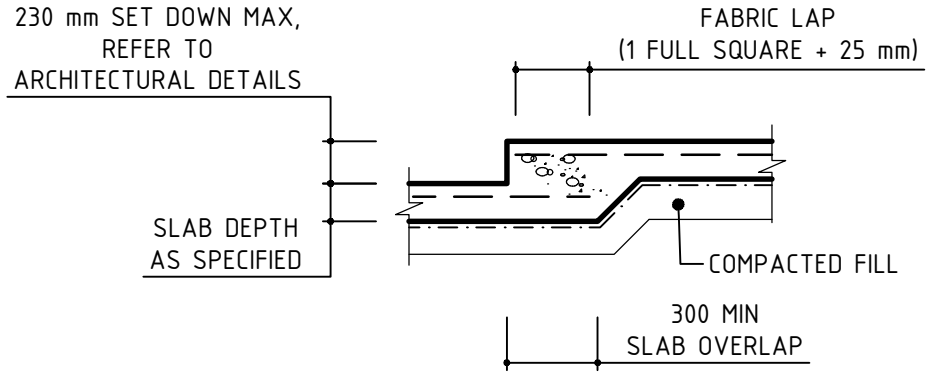
NOT TO SCALE



STEPS IN FLOORS (GREATER THAN 230 mm)

NOTES:

1. WHEN DEPTH OF FOOTING BEAM EXCEEDS 800 mm CARRY VAPOUR BARRIER DOWN SIDES ONLY



STEPS IN FLOORS (LESS THAN 230 mm)

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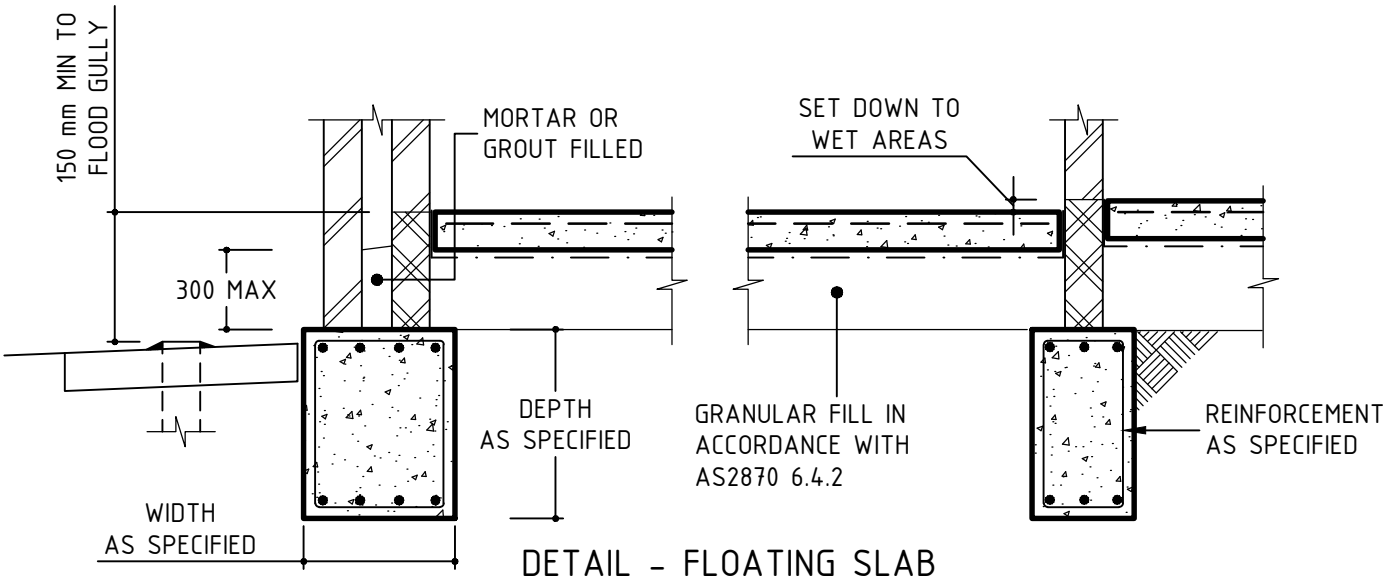
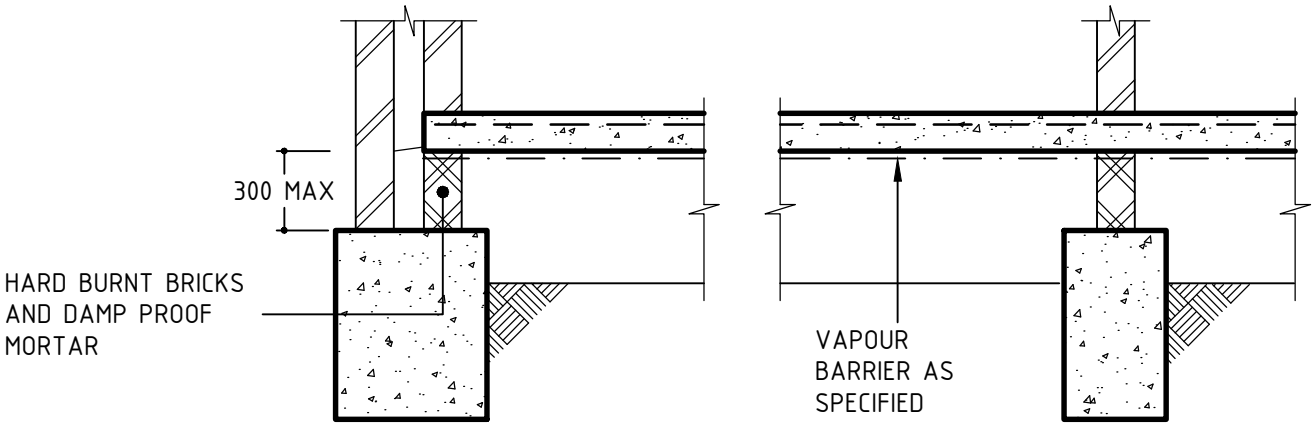
STRIP FOOTING DETAILS (CR5)

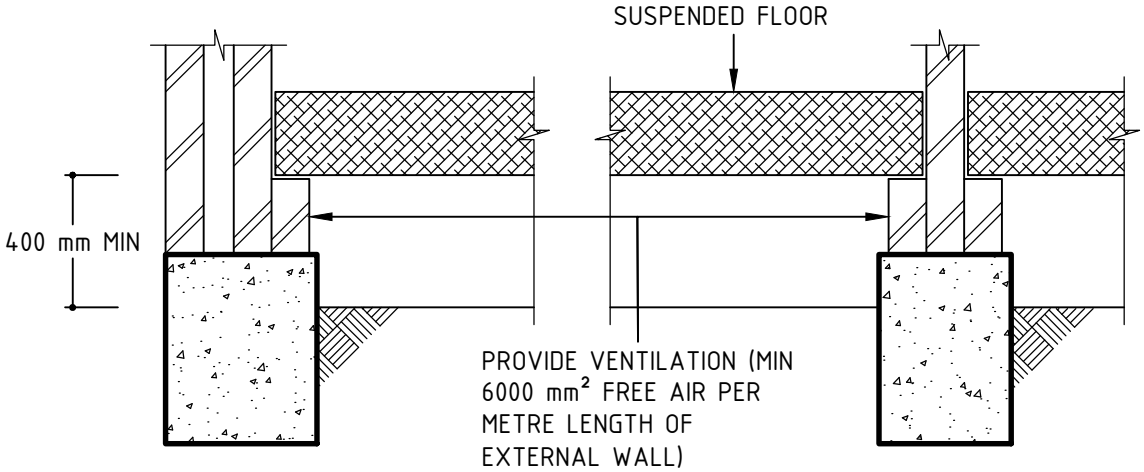
NOT TO SCALE



DETAIL - FLOATING SLAB
(CLASS A & S SITES ONLY)



DETAIL - SLAB POURED AFTER BRICK BUILD UP
(CLASS A & S SITES ONLY)



DETAIL - SUSPENDED FLOOR

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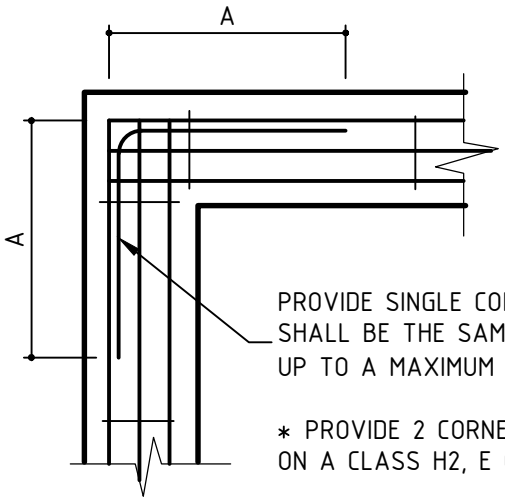
CORNER REINFORCEMENT AND SERVICE PIPE PENETRATION FOOTING DETAIL (CR5-1)

NOT TO SCALE

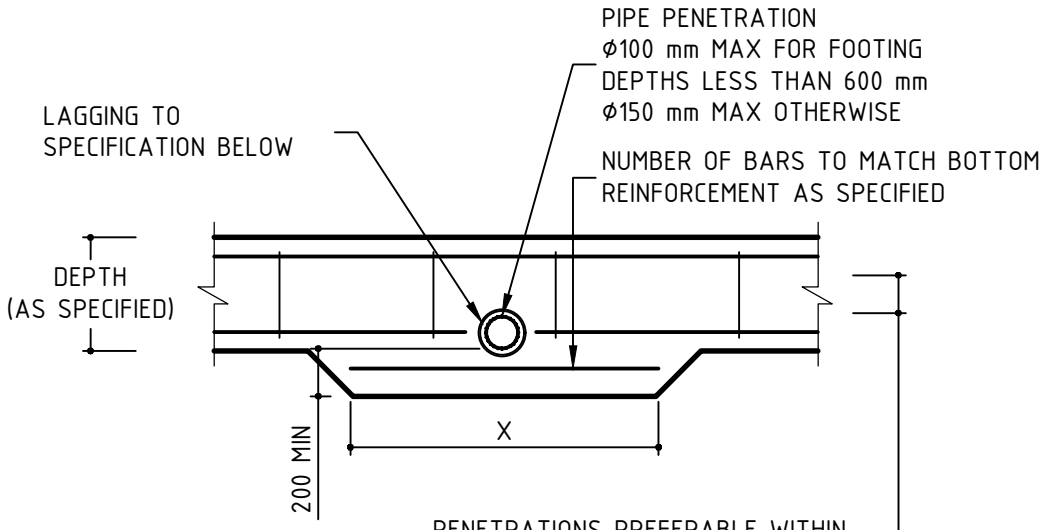


CORNER BAR LAP LENGTHS	
MAIN FOOTING REINF SIZE	DIMENSION A, mm
N12, N16, N20	500 MIN
N24, N28, N32	1000 MIN

PROVIDE SINGLE CORNER BAR TOP AND BOTTOM* (LAP BAR SIZE SHALL BE THE SAME AS THE MAIN REINFORCEMENT IN THE FOOTING UP TO A MAXIMUM OF N24)

* PROVIDE 2 CORNER BARS TOP AND BOTTOM FOR STRIP FOOTINGS ON A CLASS H2, E OR P SITE

ADDITIONAL CORNER REINFORCEMENT



LAP BAR IN DEEPENED FOOTING	
LAP BAR LENGTH X, mm	MAIN (& LAP) BAR REINF SIZE
1200	N12
1700	N16
2200	N20
3100	N24

SERVICE PIPE LAGGING	
SITE SOIL CLASSIFICATION	CLOSED CELL POLYETHYLENE LAGGING THICKNESS, mm
S	20**
M, H1	20
H2, E, P	40

** NEED NOT BE CLOSED CELL

FOOTING SERVICE PIPE PENETRATION DETAIL

NOTE:
FOOTING PENETRATIONS NOT COVERED BY THE ABOVE ARE NOT PERMITTED WITHOUT SPECIFIC ADVICE & APPROVAL FROM THIS OFFICE

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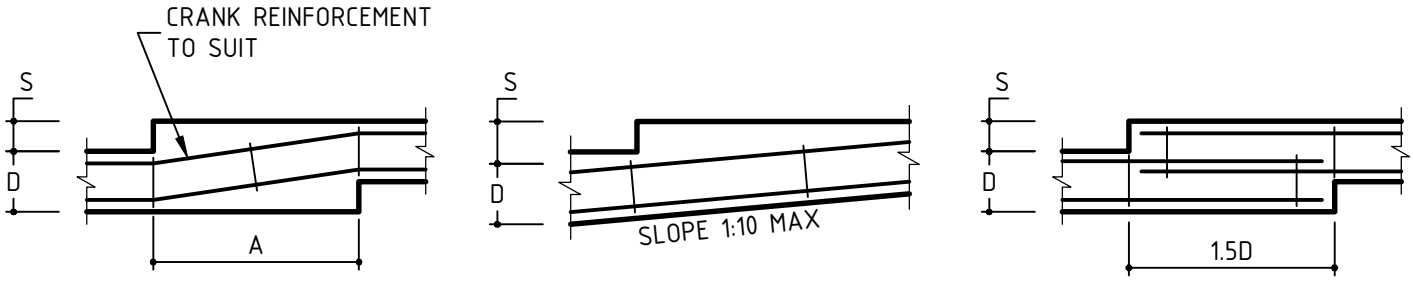
STEP FOOTING DETAILS (CR6)

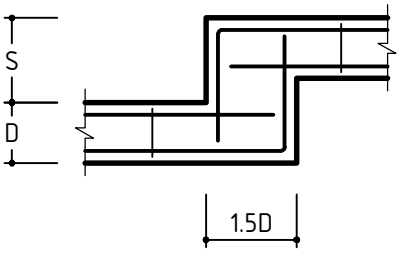
NOT TO SCALE

STEP LENGTH	
MAX STEP HEIGHT S, mm	DIMENSION A, mm
100 (1 COURSE)	600
200 (2 COURSES)	1200

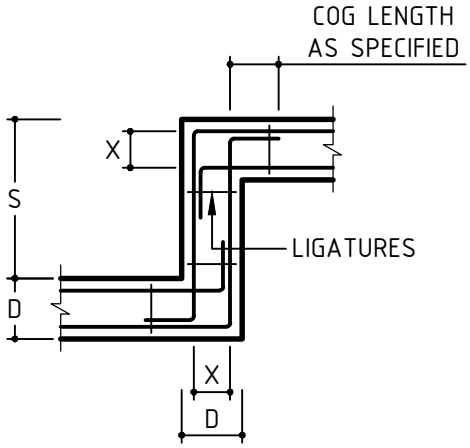


OPTION 1 OPTION 2 OPTION 3

STEP 'S' FOR 2 MASONRY COURSES (200 mm OR LESS)



STEP 'S' GREATER THAN 200, AND LESS THAN '2D'



STEP 'S' GREATER THAN '2D' (DROP PIER)

COGS MAY BE OMITTED IF 'X' IS GREATER THAN OR EQUAL TO SPECIFIED COG LENGTH

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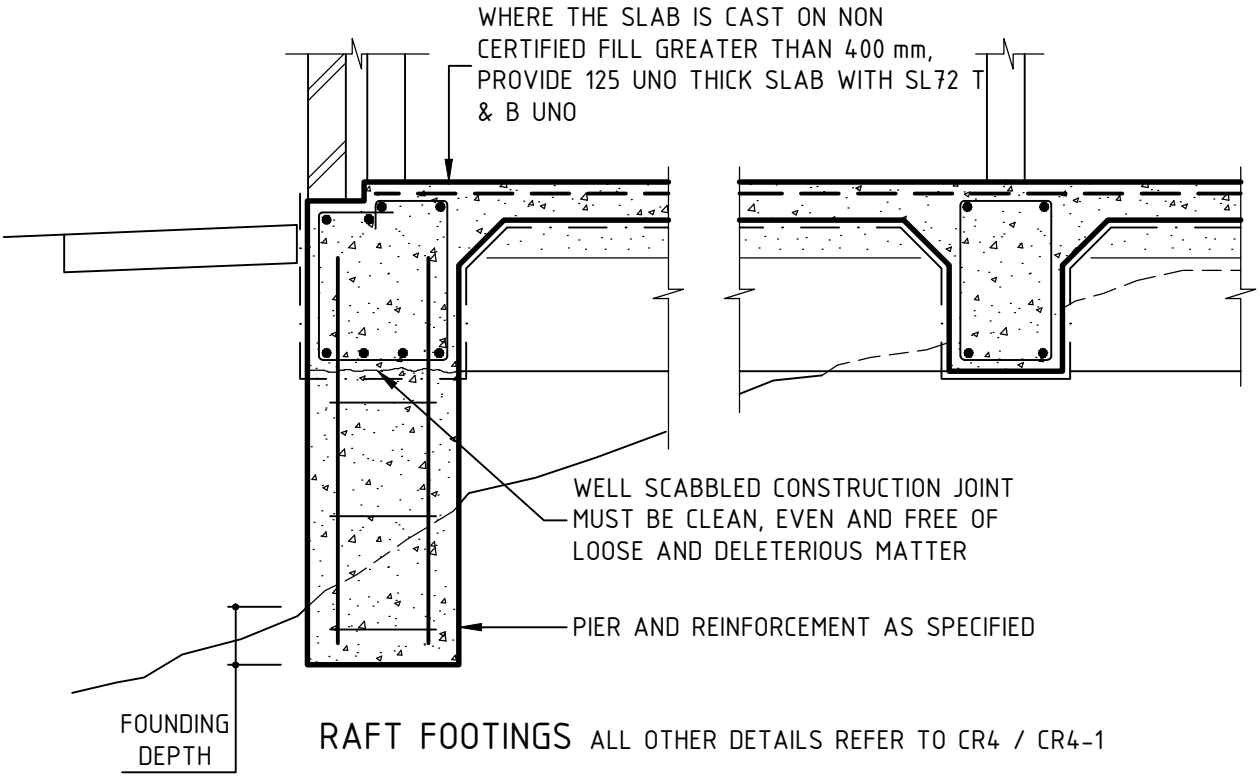
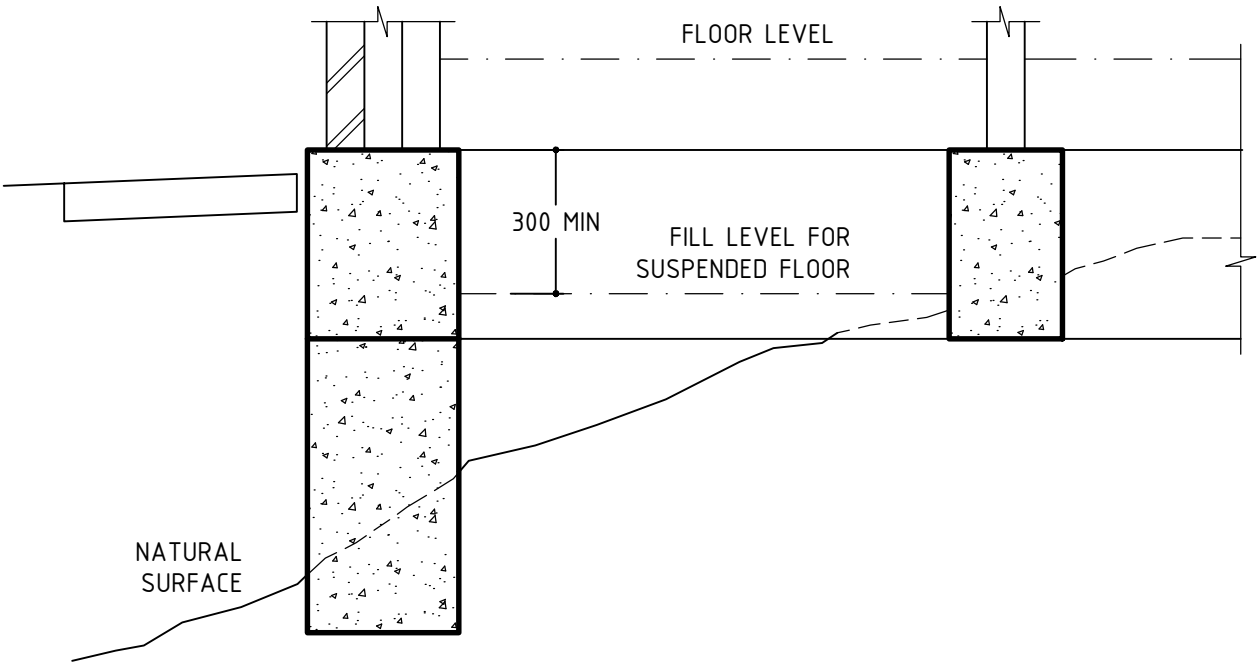
CUT AND FILL SITES FOOTING DETAIL (CR9)

NOT TO SCALE



RAFT FOOTINGS ALL OTHER DETAILS REFER TO CR4 / CR4-1



STRIP FOOTINGS ALL OTHER DETAILS REFER TO CR5

NOTES:

1. TRENCHED / BORED PIERS GREATER THAN 1000 DEEP BELOW FOOTING LEVEL TO BE POURED AT LEAST 24 HOURS PRIOR TO MAIN POUR.
2. TRENCHED / BORED PIERS GREATER THAN 1.0 m DEEP TO BE REINFORCED WITH 6-N12 VERTICAL BARS (UNO).
3. LIGATURE SPACING TO BE REDUCED TO 300 C/C BETWEEN PIERS (UNO).

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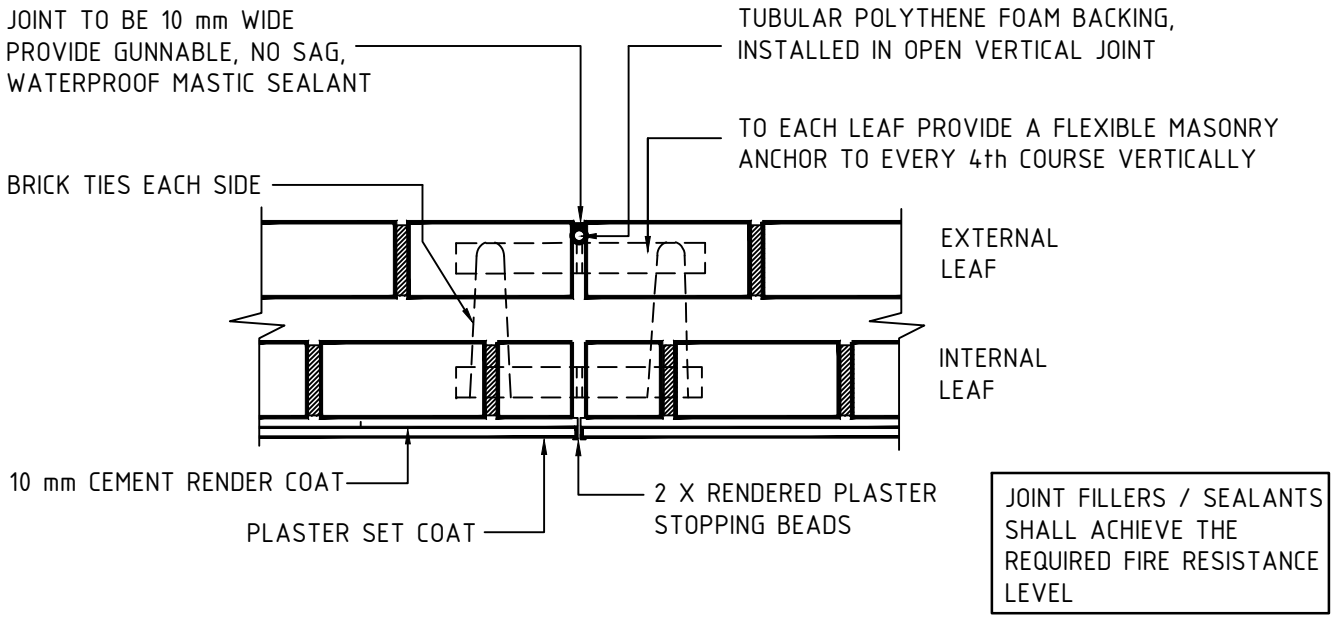
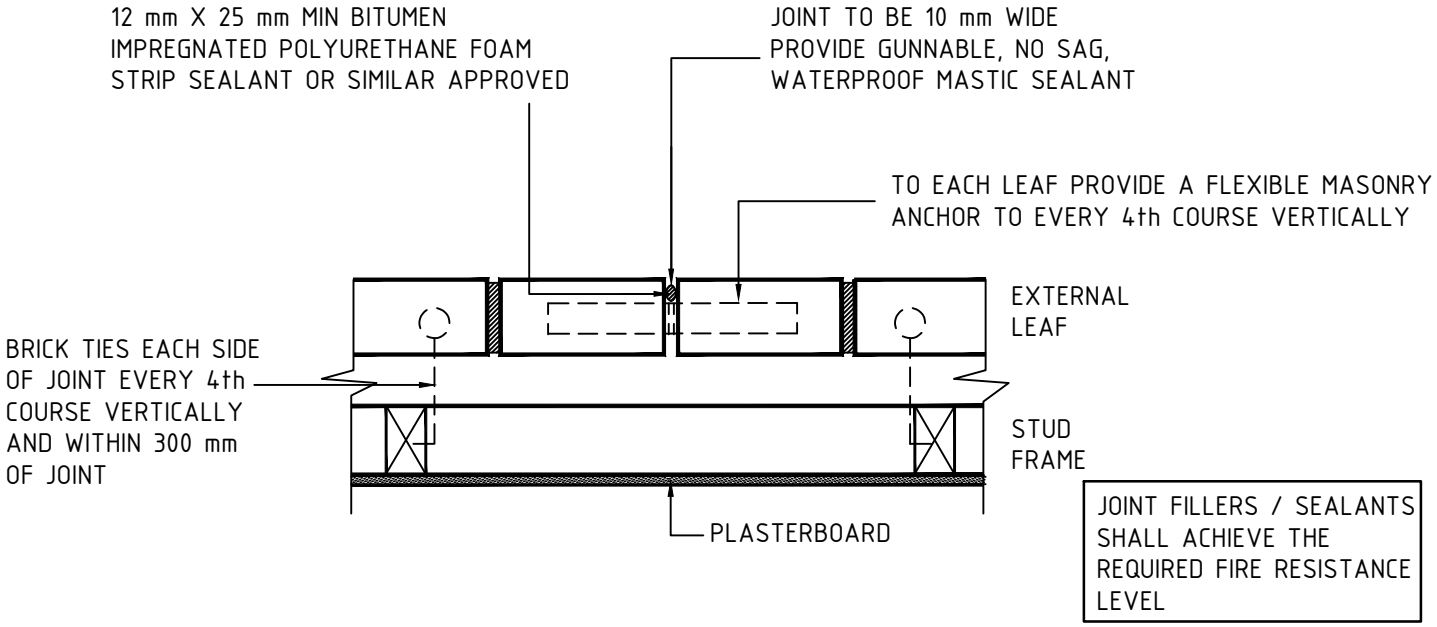
CONTROL JOINT DETAIL IN WALLING (CD1)

NOT TO SCALE



DETAIL 1: CAVITY SOLID MASONRY CONSTRUCTION



DETAIL 2: MASONRY VENEER CONSTRUCTION

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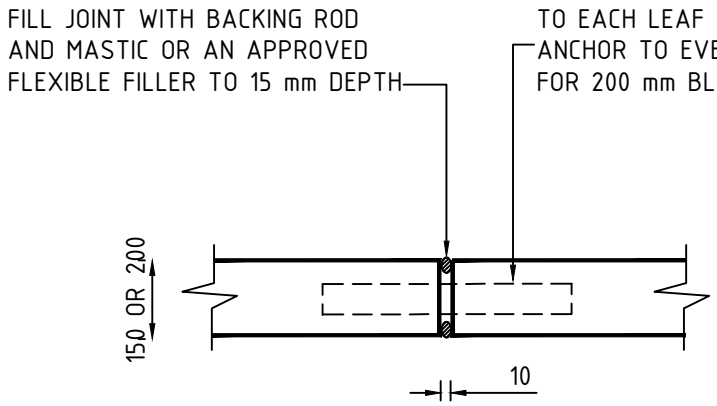
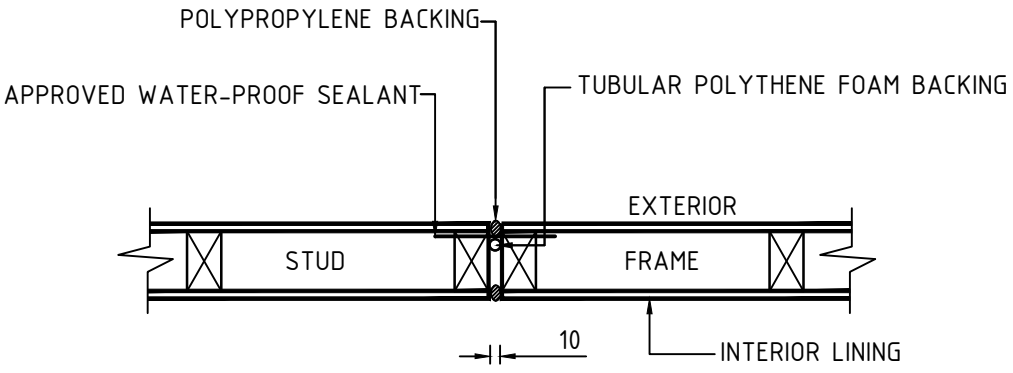
CONTROL JOINT DETAIL IN WALLING (CD1)

NOT TO SCALE



JOINT FILLERS / SEALANTS SHALL ACHIEVE THE REQUIRED FIRE RESISTANCE LEVEL

DETAIL 3: CONTROL JOINT DETAIL IN AAC BLOCK WALL



JOINT FILLERS / SEALANTS SHALL ACHIEVE THE REQUIRED FIRE RESISTANCE LEVEL

DETAIL 4: LIGHT FRAMED WALL CONSTRUCTION

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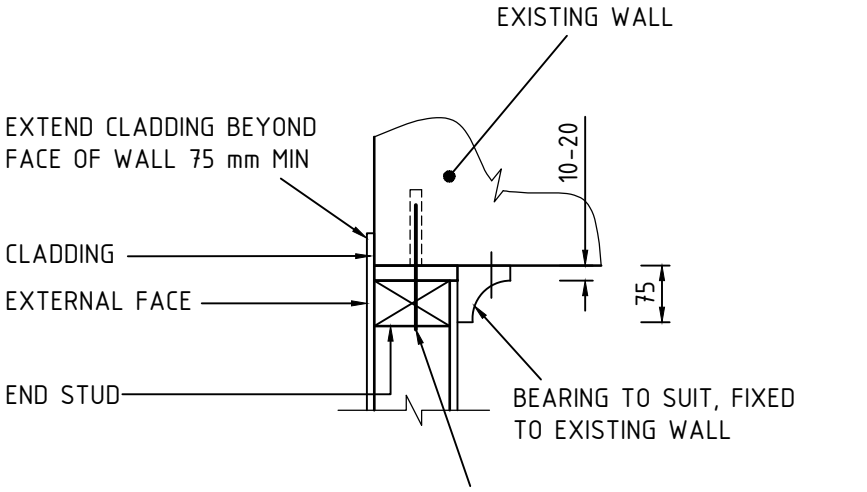
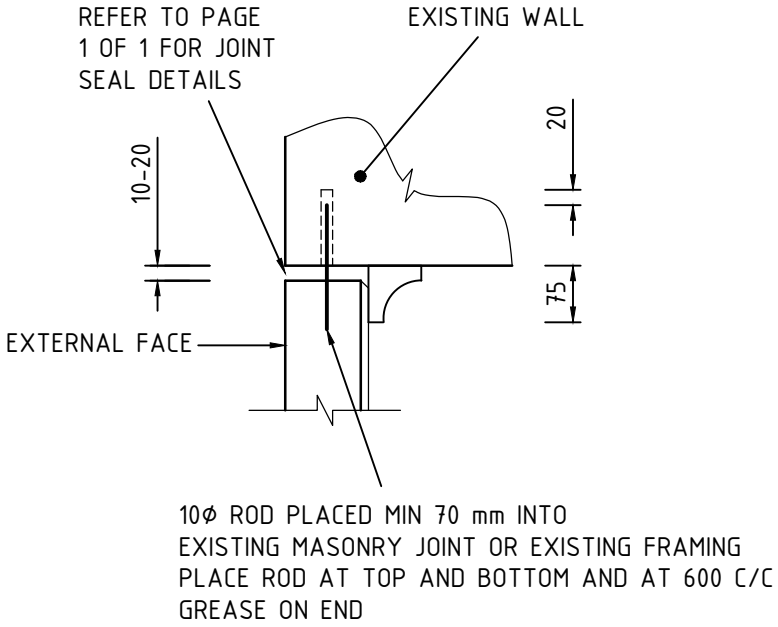
NOT TO SCALE



DETAIL 5: LIGHT FRAMING DETAIL



DETAIL 6: MASONRY WALLING DETAIL

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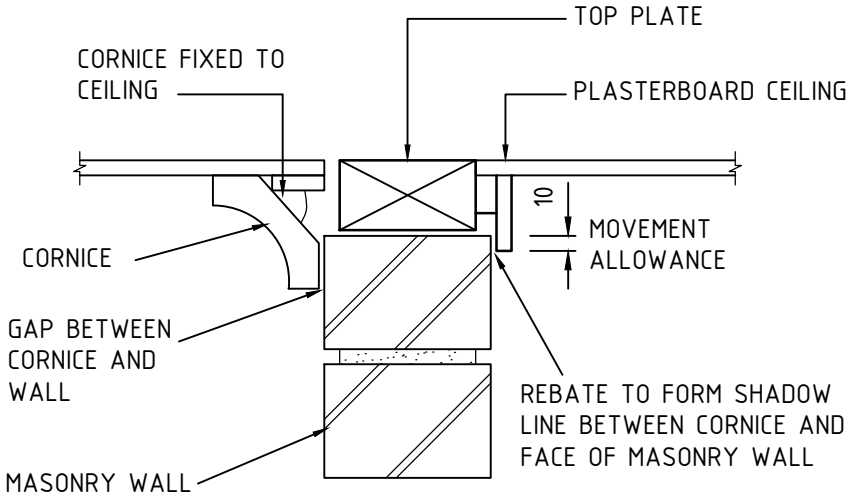
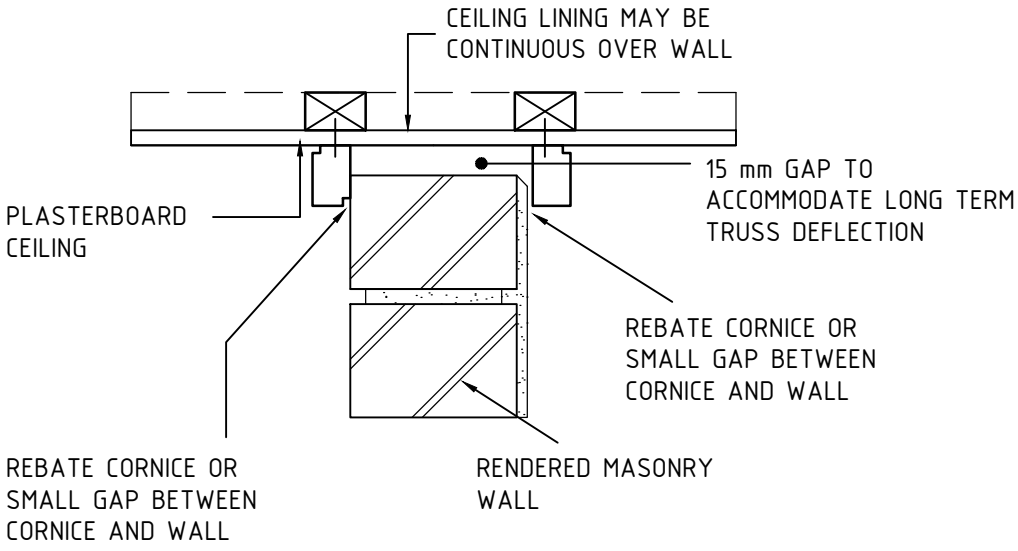
CONTROL JOINT DETAIL IN WALLING (CD1)

NOT TO SCALE





DETAIL 7: WALL / CEILING JUNCTION DETAIL

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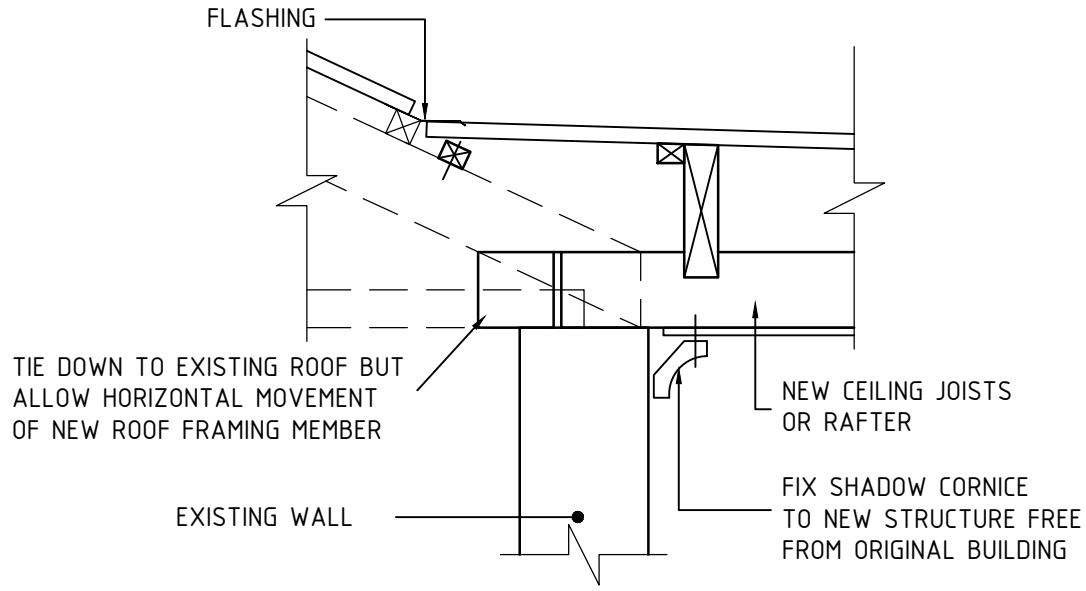
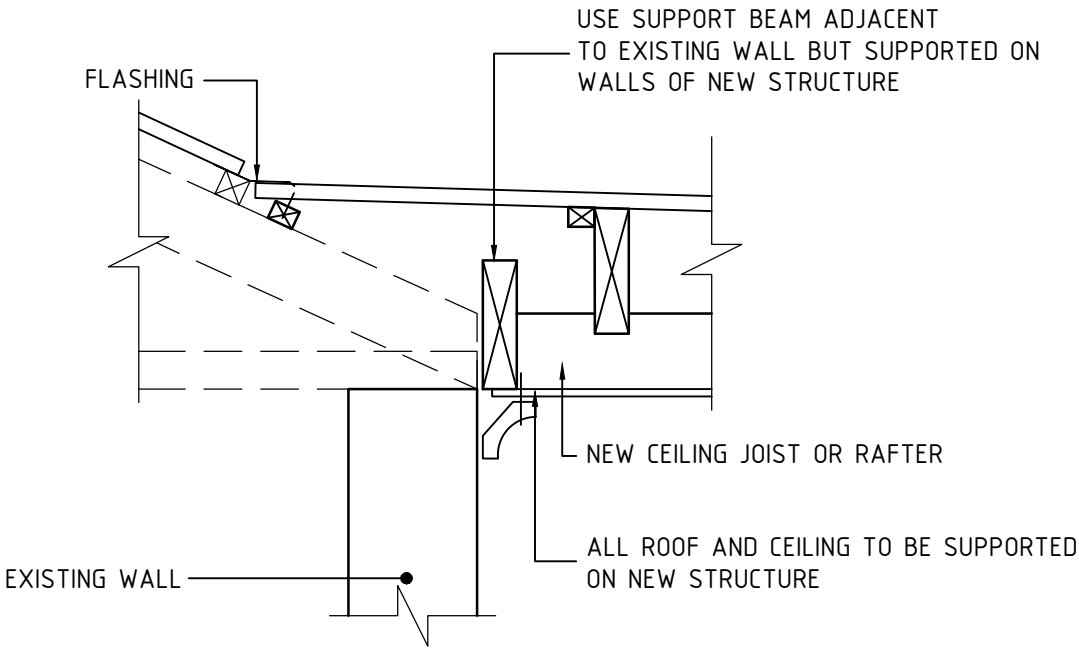


DETAIL 8: SUGGESTED ROOF JUNCTION DETAIL



DETAIL 9: ALTERNATIVE ROOF JUNCTION DETAIL

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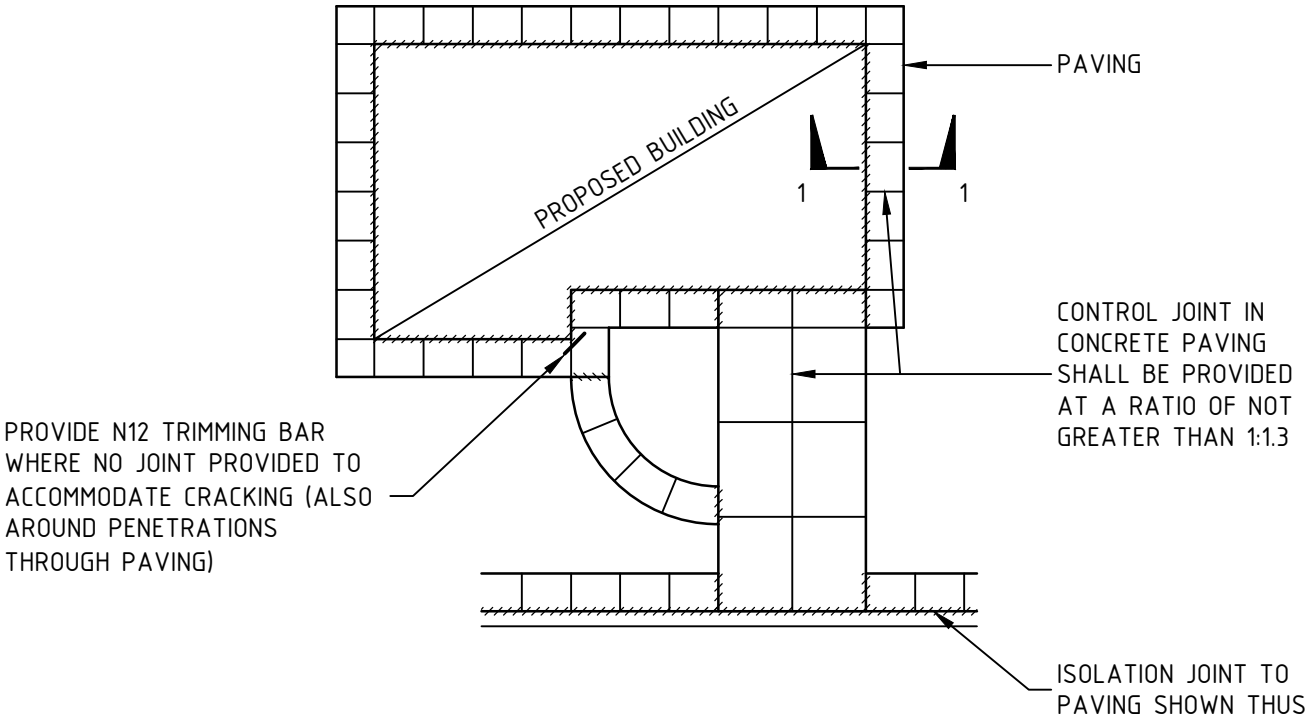
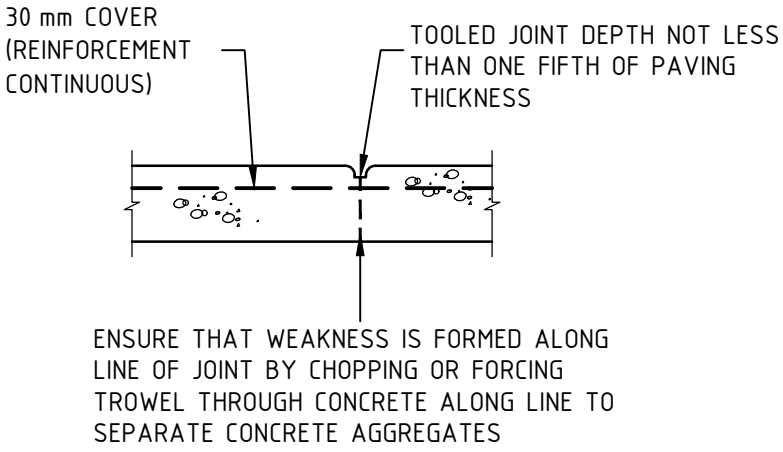
PERIMETER PAVING DETAILS (CD3)

NOT TO SCALE



PLAN OF PAVING AROUND A BUILDING



SECTION THROUGH CONTROL JOINT IN CONCRETE PAVING

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PERIMETER PAVING DETAILS (CD3)

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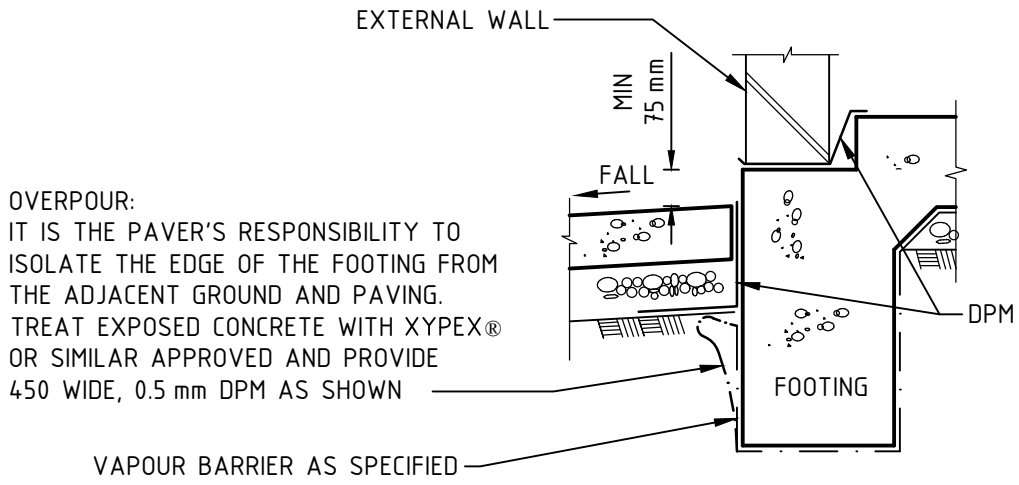
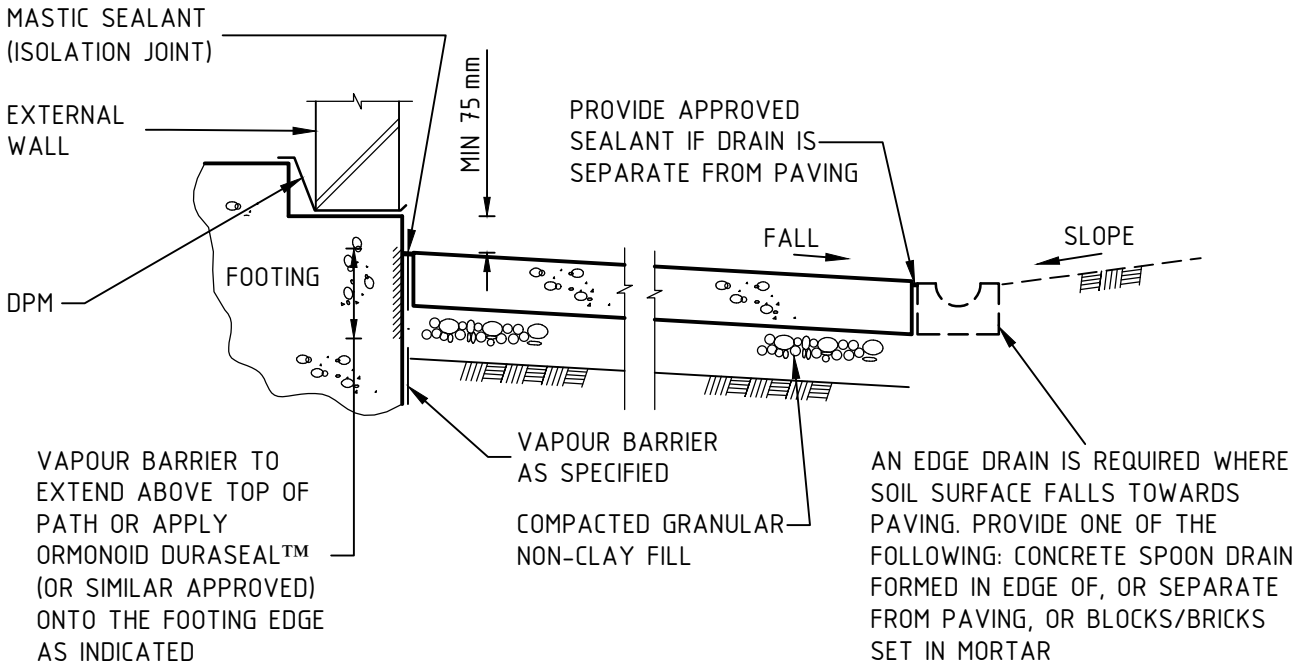


FOOTING PAVING JUNCTION DETAIL (WHERE OVERPOUR EXISTS)



SECTION 1-1

NOTES:

1. PAVING MUST NOT BRIDGE THE MASONRY DAMP PROOF MEMBRANE.
2. PAVING SHALL BE GRADED SUFFICIENTLY TO ENSURE ALL WATER CAN DRAIN CLEAR FROM THE BUILDING.
3. PROVIDE EDGE DRAINS WHERE NECESSARY TO DIVERT RUNOFF CLEAR OF THE BUILDING.
4. REFER TO CRG (SECTION 7) FOR PAVING SPECIFICATIONS INCLUDING FALLS, THICKNESSES AND REINFORCEMENT.
5. PROVIDE TERMITE PROTECTION TO AS 3660.1

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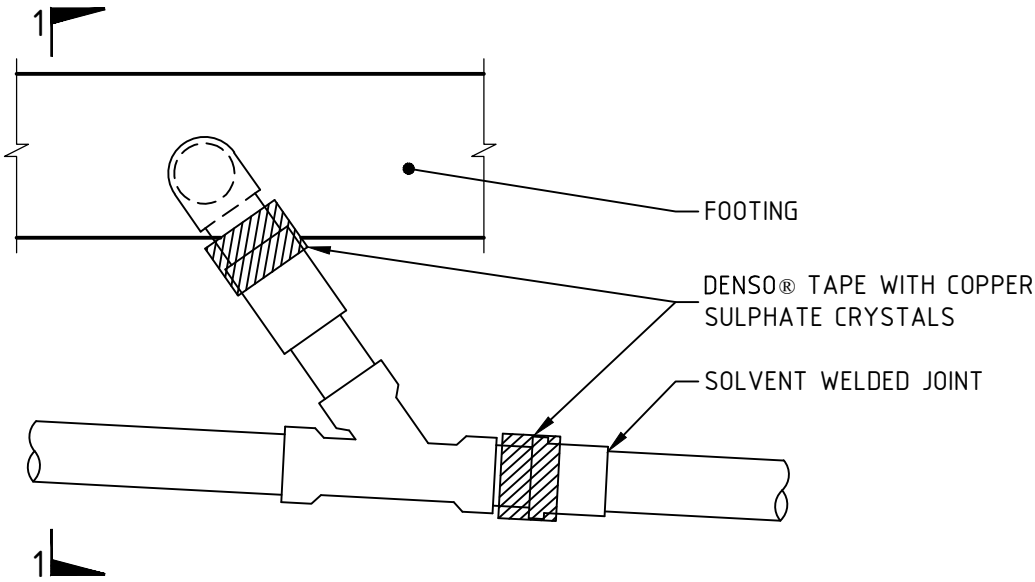
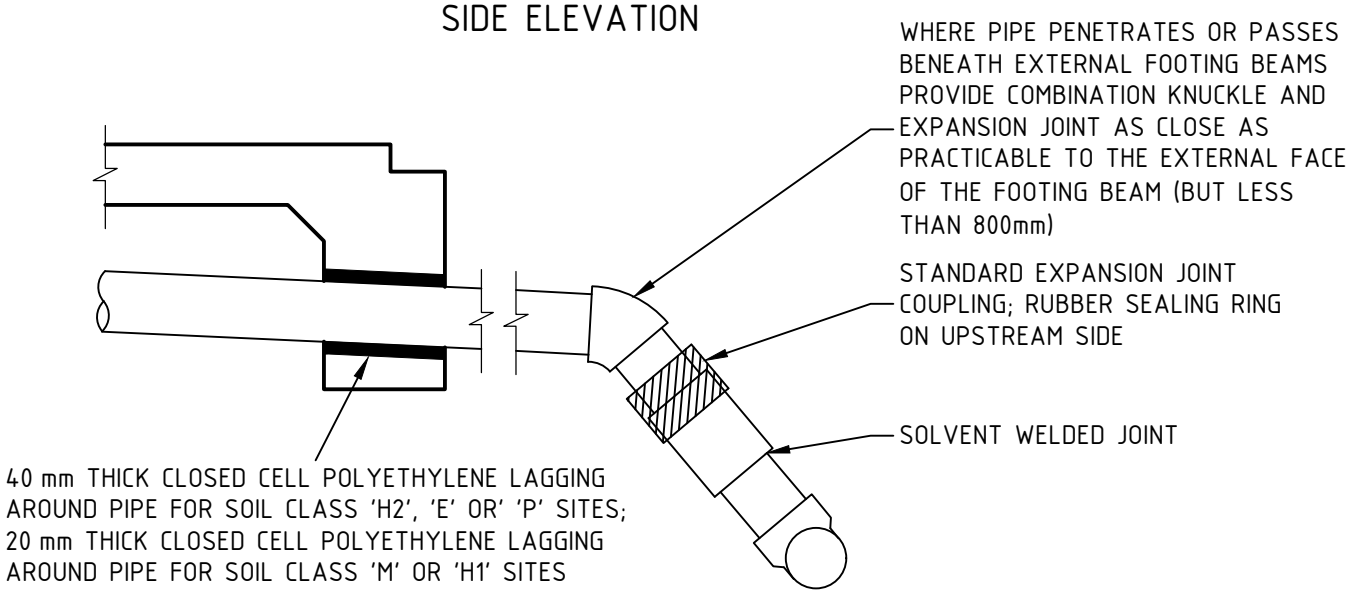
FLEXIBLE SERVICE CONNECTION DETAIL FOR CLASS H1, H2, E OR P SITES STORMWATER & SEWER (CD5)

NOT TO SCALE



SIDE ELEVATION



SECTION 1-1

NOTES:

DUE TO THE MOISTURE REACTIVE NATURE OF SOILS ON CLASS 'H1', 'H2', 'E' OR ANY SITE CLASSIFIED AS 'P', IT IS REQUIRED THAT THE SERVICE PIPES INCLUDE STANDARD EXPANSION TYPE JOINT COUPLINGS.

PROVIDE FLEXIBLE CONNECTIONS TO PIPES IN ACCORDANCE WITH THE FOLLOWING:

1. CONNECTIONS ARE REQUIRED AT EACH LOCATION WHERE ANY PIPES (65 mm OR LARGER) PENETRATE OR PASS BENEATH OR THROUGH THE EXTERNAL FOOTING BEAMS
2. TWO EXPANSION JOINT COUPLINGS ARE REQUIRED, AS DETAILED ABOVE, AT EACH CONNECTION
3. THE DENSO® TAPE MUST BE SPRINKLED WITH COPPER SULPHATE CRYSTALS PRIOR TO WRAPPING AND MUST EXTEND 50 mm BEYOND THE JOINT ON BOTH SIDES
4. DETAILS ARE APPLICABLE TO SEWER AND STORM WATER PIPES
5. FOR ADDITIONAL REQUIREMENTS REFER TO THE NATIONAL PLUMBING AND DRAINAGE CODE AS 3500

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SPECIFICATION FOR THE CONSTRUCTION OF FOOTINGS AND SLABS (CRS)

1. GENERAL

1.1 The specific type of building construction is stated on BF039 *Construction Report & Footing Recommendations (CR1)*. The standard details shown are typical only, and specific items (e.g. footing dimensions, number of bars) are to be noted as in the Construction Report.

1.2 Where specific requirements or details provided in the Construction Report or on the drawings, conflict with these general specifications, the report and / or drawings shall take precedence.

Some details will not be applicable to the site. Only appropriate details need be incorporated.

1.3 The specifications below shall apply unless noted otherwise.

2. CONCRETE

2.1 Construction methods, materials, tolerances and finishes are to comply with AS 3600 *Concrete Structures* and all other relevant Australian Standards, the Building Code of Australia and any specific requirements of the Local Council.

2.2 Concrete shall be as follows:

- Grade N20 (i.e. 20 MPa) to slab on ground, footings protected by vapour barrier and residential strip / pad footings;
- Grade N25 to suspended slabs, beams and columns and non-residential footings unprotected by vapour barrier;
- Grade N32 to members in exposed exterior environments or where concrete is to have a polished finish;
- Maximum aggregate 20 mm;
- Slump to be nominal 100 mm unless noted otherwise.

2.2.1 For sites within 1 km of the shoreline of large expanses of salt water or heavy industrial areas where surfaces (e.g. verandahs, balconies, carports) are exposed, the surface shall be protected with suitable approved topping, sealer, tiles etc or the concrete grade shall be not less than N40.

2.2.2 For sites containing high sulphate or highly saline soils (or in heavy industrial areas), the concrete surface is to be protected from the aggressive soil by a 0.2 mm branded and certified vapour barrier. Alternatively, use a concrete grade of N40 or greater.

2.3 Concrete shall be supplied in accordance with AS 1379 *Specification and supply of concrete*. Site mixed concrete shall not be used without written approval from this office.

2.4 Project control testing is not required, unless specifically noted elsewhere in the contract documents.

2.5 Sulphate-resisting cement (Type SR - AS 3972 *General purpose and blended cements*) shall be used when specified, or when it is known by the owner, builder, local council, or concrete supplier that this cement should be used at the site.

2.6 Chemical admixtures may be used, provided the concrete supplier accepts responsibility for their use.

2.7 Placement of Concrete

2.7.1 The concrete shall be placed as close as possible to its final position, and the pour shall proceed in one continuous operation, ensuring that no more than 45 minutes elapse before placing fresh concrete against previously placed, in order to eliminate 'cold joints'.

2.7.2 All concrete shall be mechanically vibrated to ensure that it is thoroughly compacted, and all excess air voids removed. Care shall be taken to ensure that the concrete does not become segregated by local over-vibration.

2.7.3 Construction joints will not be permitted in the footings without approval from the Engineer, except where noted on the detail drawings. If a raft footing system is specified it is required that the footing be poured integrally with the floor slab. If it is necessary to pour the footing beams separately to the floor slab, the beams shall be poured to a level exposing the top reinforcement by approximately 100 mm. Where construction joints are used, the concrete surface shall be formed up vertically and the hardened surface of the first pour shall be thoroughly cleaned of all laitance, loose aggregate dirt, etc. The hardened concrete shall be thoroughly wetted and neat slurry shall be applied to its surfaces in a thin layer cement immediately prior to pouring fresh concrete.

2.7.4 The construction of a slab shall achieve the following dimensional tolerances:

- The cover to the reinforcement from the surface in contact with the ground shall be within +40 mm and -10 mm of the specified cover, except that the bottom cover to beams may be increased where the beams are deeper than specified;
- The cover to the reinforcement from the internal surface shall be within +20 mm and -10 mm of the specified cover;
- The surface level to be within ±10 mm of the specified finished floor level (for levelness);
- In the absence of any specification, a steel trowel finish with a tolerance of +/-5 mm from a 3 m straightedge shall be used (for flatness);
- The thickness of the slab and the width and depth of the beam shall not be less than the specified dimension;
- More stringent tolerances may be required for some applications such as polished concrete floors where the reflection from the surface may highlight slight undulations.

2.8 Curing

2.8.1 Curing of the slab shall commence as soon as possible after the pour and certainly within 4 hours.

2.8.2 Curing may be achieved by covering with polythene sheeting for a minimum of 7 days, or by spraying with an approved curing compound, subject to compatibility with the proposed surface finishes.

2.9 Hot Weather Concreting

2.9.1 Concrete shall not be poured when the forecast temperature exceeds 36^{o} Celsius, without specific approval from the Engineer.

2.9.2 When the forecast temperature is between 32^{o} Celsius and 36^{o} Celsius pouring will only be permitted under the following conditions:

- When pouring can be completed prior to the air temperature reaching 32^{o} Celsius.
- When the site is protected from hot drying winds.
- When the slab surface can be covered with plastic sheeting, or hessian (kept wet), within 2 hours of finishing.

3. REINFORCEMENT

3.1 In accordance with AS/NZS 4671 *Steel reinforcing materials*, reinforcement designations are:

- R: Plain round structural bar
- F: Hard drawn wire fabric
- W: Hard drawn wire bar
- N: Hot rolled deformed bar
- SL: Square ribbed fabric
- RL: Rectangular ribbed fabric

3.2 Reinforcement shall be supported on concrete blocks or bar chairs, or suspended from formwork.

3.3 Reinforcement shall be placed evenly, straight and adequately wire-tied to prevent any movement and to hold it in the correct position during pouring of concrete.

3.4 Fabric shall be supported on concrete blocks or bar chairs, placed under the intersection of cross wires at 800 mm x 800 mm (maximum centres). Where the base for the slab is soft, provide spreader pans for bar chairs and / or close up the support centres as necessary.

3.5 At external corners, and intersections of external and internal footings, the reinforcement shall be lapped with a bent bar or separate corner bars, as shown on the details.

3.6 Where rod reinforcement is spliced, the minimum lap lengths shall be:

Bar Size	Lap Length (mm)	Bar Size	Lap Length (mm)
N12	500	N28	1800
N16	750	N32	2150
N20	1000	N36	2600
N24	1450		

3.7 Fabric shall be lapped one full square plus 25 mm at all joins.

3.8 Where brittle floor coverings are to be used (e.g. tiled areas), additional measures are required to control the effect of shrinkage cracking.

Such measures shall include one or more of the following:

- A flexible grout bed shall be provided, 'Resaflex' or similar.
- The placement of floor covering shall be delayed. Note: A minimum of 6 months drying of the concrete is usually required before the placement of brittle floor covering.
- Installation of control joints within the brittle floor coverings where the area exceeds 20 m2.
- 2 layers of SL72T (or 1 layer of SL92T).

3.9 Cover

3.9.1 Clear concrete cover to reinforcement, (including fitments and wire ties) shall be:

- Internal slab on fill (excludes carports): 30 mm bottom and sides, 20 mm top.
- Footings protected by vapour barrier: 40 mm bottom and sides, 20 mm top.
- Residential footings unprotected by vapour barrier: 40 mm top, 50 mm bottom and sides.
- Non-residential footings unprotected by damp-proof membrane: 50 mm top, bottom and sides.

3.9.2 Where footing beams are over-excavated, the reinforcing 'cage' is to be kept towards the top of the beam.

4. VAPOUR BARRIER

4.1 The vapour barrier shall be branded continuously '*AS 2870 Concrete Underlay, 0.2 mm High Impact Resistance*' together with the manufacturer's or distributor's name.

4.2 The vapour barrier shall be provided throughout the underside of all habitable areas and shall be continuous under all beams and slabs as depicted on the appropriate typical detail sheets.

4.3 All joints shall be lapped a minimum of 300 mm and sealed with a 50 mm wide strip of pressure-sensitive waterproof tape. All service penetrations shall be securely flashed and taped. Perforation of the vapour barrier shall be sealed before placing concrete.

4.4 Where the depth of the footing trench exceeds 800 mm, the vapour barrier shall extend down the sides only.

4.5 Where the depth of the footing trench exceeds 1000 mm, provide two layers of vapour barrier to full depth each side.

4.6 Where strip footings are continuous beyond the slab (e.g. carports, footings), the sides and base of the strip footings shall be lined with a vapour barrier for a distance of not less than 800 mm beyond the edge of the slab, unless Clause 4.4 prevails.

4.7 The vapour barrier is not mandatory under exposed slabs (carports, verandas, etc) where they are poured separately to the footing beams. Where future enclosure of carport etc, is proposed, it is required to provide the vapour barrier.

5. LEVEL PINS

5.1 Level pins puncturing the vapour barrier may be used in the footing trenches but must not be used in the area of the floor slab.

5.2 Level pins shall have 30 mm cover to all reinforcement.

5.3 Any pins used to support service pipes must be driven to a minimum of 30 mm below the finished floor level, and be fully taped to the pipe.

6. SERVICE PENETRATIONS AND FLEXIBLE CONNECTIONS

Service penetrations are permitted through footings subject to the following requirements:

6.1 A minimum of 50 mm cover shall be provided between the pipe and any reinforcement.

6.2 Pipes shall be placed through the middle third of the footing beam depth. Penetrations outside this area may require additional concrete depth or reinforcement. Where any reinforcement is cut to suit the location of pipes, additional reinforcement shall be provided, correctly placed and lapped with the main reinforcement. Such reinforcement shall be in accordance with sheet CR5-1 *Typical Footing Details – Corner Reinforcement and Service Pipe Penetration* and / or to the direction of the Engineer inspecting the work.

6.3 Where the pipe is close to the bottom bars and adequate cover is not available, additional excavation must occur below the pipe and the bottom rods placed and lapped so as to provide the correct cover.

6.4 Pipes embedded within the floor slab shall generally have 100 mm of cover over the pipe. Where this cannot be achieved the minimum cover may be reduced to 40 mm provided that the reinforcing fabric is continuous over the pipe, and the sand / rubble base is excavated to provide 100 mm of concrete all around the remainder of the pipe.

6.5 Holes provided for service penetrations through the floor slab shall not exceed 600 mm square without approval from the Engineer.

7. EDGE REBATES

7.1 Edge rebates shall be provided to all masonry cavity or veneer walls.

7.2 The minimum rebate depth shall be 25 mm, but may be increased to suit masonry coursing. The maximum rebate depth shall be 100 mm.

7.3 Rebates are not required for single leaf masonry walls, timber frame clad walls or walls on strip footings.

8. HEATING CABLES AND PIPES

8.1 Electric heating cables may be embedded in the slab without any increase in thickness.

8.2 Hydronic heating pipes may be embedded in the slab provided the slab thickness is increased by 25 mm. An additional layer of fabric (SL42 or larger) shall be provided under the pipes. The main fabric shall be placed with 20 mm cover to the top face.

9. SLABS ON FILL

9.1 Filling used under a slab, (whether existing on site or placed during site works) except where the slab has been designed as suspended, shall consist of controlled fill or rolled fill.

9.1.1 Controlled fill is material that has been placed and compacted within a defined moisture range, in layers by compaction equipment to a defined density requirement. Except as provided below, controlled fill shall be placed in accordance with engineering principles. One test for each 100 m^2 of building area (or 3 tests minimum per visit - whichever is greater) is required for every 600 mm thickness of compacted material.

Sand fill, well compacted in not more than 300 mm layers by a vibrating plate or vibrating roller, shall be deemed to comply with this requirement. This will need to be verified using acceptable testing methods.

Non-sand fill well compacted in not more than 150 mm layers by a mechanical roller, shall be deemed to comply with this requirement. In accordance with AS 1289 .5.1.1 *Methods of testing soils for engineering purposes – Soil compaction and density tests – Determination of the dry density/moisture content relation of a soil using standard compactive effort*, non-sand fill shall be compacted to 95% maximum dry density when tested.

9.1.2 Rolled fill consists of material compacted in layers of repeated rolling by an excavator. Rolled fill shall not exceed 300 mm compacted in layers of not more than 150 mm.

9.2 The fill shall be tested to ensure that it has been compacted to the specified density, OR

The slab shall be increased in thickness by 25 mm, and reinforced with an additional layer of fabric (of the same size as the top fabric), placed with 30 mm cover to the vapour barrier. The thicker slab, and additional fabric, shall be provided to the full area of any floor panel (maximum panel size of 20 m^2) (i.e. from beam-to-beam) over the deep fill, OR

Piers 500 mm (minimum) square shall be provided under the slab panel, extending to the specified minimum footing founding depth. Piers shall be located such that the distance between adjacent piers, or between a pier and a footing beam, does not exceed 1.8 m.

9.3 The above requirements may be waived when the Engineer is satisfied that the design / construction is adequate.

10. TERMITE PROTECTION

10.1 Termite protection systems shall be in accordance with AS 3660.1 *Termite management – New building work.*

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GENERAL NOTES ON SITE WORKS, BUILDING CONSTRUCTION AND SITE MANAGEMENT (CRG)

1. EARTHWORKS

1.1 Council and / or other statutory requirements giving the relationship between finished floor level, road levels, external paving and / or sewer flood gully, and paving requirement, must be adhered to. All to comply with AS 3798 *Guidelines on earthworks for commercial and residential developments*.

1.2 Unless otherwise specified in the construction report, selected approved site materials, excluding topsoil or organic-bearing soil, may be used for compacted filling. Alternatively where site materials are unsuitable because of their nature or moisture content, quarry rubble or other approved filling material may be used. The specified standard of compaction shall be provided to an area extending not less than 1 m beyond the perimeter of the building, and shall also be provided beneath any filled pavements.

1.3 Care must be taken when using vibrating and / or impact rollers if there are buildings close to the area being compacted.

1.4 Where the surface slope of an area which is to receive filling is steeper than 1 (vertical) in 8 (horizontal), a series of level benches shall be excavated along the contour over the whole of the area which will receive filling. This will stabilize the fill against downhill slip.

1.5 The footings specified in the construction report have been proportioned assuming that the contractor will achieve the specified compaction. No footing beam shall be founded in the filling unless the Engineer has checked its compaction standard and given written acceptance of its compliance with the specifications.

1.6 If shallow fill exists or is placed without the use of appropriate compaction equipment, the filling will be assumed to be incapable of supporting any building load. Accordingly any concrete slab over such filling will have increased thickness and reinforcement while trenched / bored piers founded into firm natural ground may also be specified for the footings (including waffle type). The Engineer may waive this requirement if on inspection and / or checking of the filling shows it will be able to support the design loads. Settlement of uncompacted fill can lead to damage to buildings, services, pavements, etc.

2. EXCAVATOR

2.1 It is imperative that the Owner provide sufficient supervision of the cut and fill operation in order to ensure that satisfactory completion of the site works and drainage scheme proposal are adhered to.

2.2 Vegetation and roots must be scraped off and removed from the building area at the commencement of cutting and filling. Where trees and large shrubs are removed, the surrounding soils must be watered to raise the moisture content to that of the other soils under the proposed building (refer to Section 4 for process).

2.3 Where bank heights do not exceed 2.0 m and the natural slope of the site does not exceed 1 in 5, the batter slopes recommended in Table 1 may be used.

TABLE 1: DESIRABLE BATTER SLOPES

Material	Surface Slope (Maximum)
Heavy clay	1 vertical to 1.0 horizontal
Sands and cohesionless soils	1 vertical to 1.5 horizontal
Weathered rock in good condition	1 vertical to 0.5 horizontal
Sound rock	Near vertical

2.4 The extent of the cut and fill outside the building line shall not be exceeded with respect to the following requirements:

2.4.1 Generally cut or fill within the property (i.e. not on boundary) should not exceed 900 mm unless a suitable retaining wall is specified or complies with Clause 2.3.

2.4.2 Cut or fill on the boundary shall not exceed 600 mm, unless a suitable retaining wall is specified and shall not undermine any structure that exists on an adjacent property. That is, no cut or trenching is permissible anywhere on the site if there is a risk of undermining existing structures.

2.5 Fill used under a slab (whether existing on site or placed during site works) shall consist of controlled fill or rolled fill except where the slab has been designed as suspended.

2.5.1 Controlled fill is material that has been placed and compacted, within a defined moisture range, in layers by compaction equipment to a defined density requirement. Except as provided below, controlled fill shall be placed in accordance with engineering principles. One test for each 100 m^2 of building area (or 3 tests minimum per visit - whichever is greater) is required for every 600 mm thickness of compacted material.

Sand fill, well compacted in not more than 300 mm layers by a vibrating plate or vibrating roller, shall be deemed to comply with this requirement. This will need to be verified using acceptable testing methods.

Non-sand fill well compacted in not more than 150 mm layers by a mechanical roller, shall be deemed to comply with this requirement. In accordance with AS 1289.5.1.1 *Methods of testing soils for engineering purposes – Soil compaction and density tests – Determination of the dry density/moisture content relation of a soil using standard compactive effort*, non-sand fill shall be compacted to 95% maximum dry density when tested.

2.5.2 Rolled fill consists of material compacted in layers of repeated rolling by an excavator. Rolled fill shall not exceed 300 mm compacted in layers not more than 150 mm.

2.6 Embankments shall be protected from damage arising from surface erosion or ground water flow.

Slopes and grades of the cut bench or platform shown on the drainage plan are to be strictly adhered to, to allow for the site to be drained. In particular, a temporary toe may need to be cut in the ground at the base of cut banks to provide a drain. This drain should fall sufficiently to the low side so that water does not pond. On sites where erosion may be a critical problem provision of trench drains above the cut bank may be required to prevent erosion during the construction phase.

2.7 If a retaining wall has been specified, the cut or fill must not exceed the design height / requirements of the wall.

3. SITE PREPARATION

3.1 After completion of primary earthworks the site must be prepared for footing construction. Ideally, for raft construction, or strip footings where the soil surface under the floors is sealed, soils beneath the building area should be kept in a moist condition. For strip footings where the soil surface under the floors is not sealed, the building area should be kept in a dry condition.

3.2 For concrete floors provide a working surface of a minimum compacted thickness of 100 mm (50 mm for waffle rafts) of quarry rubble or other approved material. The selected material must be free of any sharp aggregate which could damage the vapour barrier. If sharp aggregate is evident on the surface a blinding layer of sand is recommended.

4. PRE-WETTING OF SOILS

4.1 On Class H or E sites pre-wetting of soil under slabs is most advantageous, especially if construction occurs in summer or autumn. In some cases pre-wetting of the site will be mandatory, but in all cases (except as noted in Clause 3.1) it is a desirable procedure aimed at reducing the future heave of reactive clays. Similarly, pre-wetting of the site is mandatory where a new structure is proposed to be constructed over a site which had previously been:

1. Occupied by a building with suspended ground floors (e.g. timber floors, concrete slabs on brick build up, etc).
2. Sites which have had significant amounts of established vegetation or even a single large tree.
3. Part of open cropping land.

4.2 Pre-wetting can best be achieved by watering the site as follows:

1. Prior to the placement of underfloor fill mark out the area of the proposed residence (+1 m around the perimeter).
2. Apply water to the area by using garden sprinklers for a minimum of 2 hours daily for 10 to 14 days immediately prior to the commencement of construction.

   Alternatively, a garden drip irrigation system may be used with drippers evenly spaced along the hose. The flow rate required depends on the site coverage of the building (+1 m around the perimeter) and equates to 1 L/m^2 per hr for 8 to 10 days with the system running 24 hours a day. For example, if an average building and perimeter paving area of 200 m^2 is required to be covered, set the irrigation system at a flow rate of 200 L/hr. This rate should ensure minimum run-off.
3. Provide underfloor fill within 3 days of the completion of pre-wetting.

Notes:
1. Regular checking of the wetting of the site is required to ensure an even water distribution.
2. Care must be taken to ensure that the pre-wetting does not impact detrimentally on adjacent sites or structures.

4.3 As a general rule the pre-wetting exercise will be deemed to be effective if moisture has penetrated at least to a depth of 1 m below the surface. This can be checked by the provision of exploratory holes.

It is recommended that this be undertaken by this office.

5. TERMITE PROTECTION

5.1 A Termite Protection System shall be provided in accordance with AS 3660.1 *Termite management – New building work*. The system provided can only minimize the likelihood of termite infestation and it is stressed that termites can bridge or breach barrier systems. Regular inspections in accordance with the code must be carried out by the Owner.

6. SITE DRAINAGE

6.1 Due to differential moisture variations (i.e. wetting or drying) being the main cause of movement in clay soils, the provision of effective drainage is of great importance as it reduces the possibility of footings having to cope with extreme soil movements. The following outlines common causes of moisture variations.

6.2 **Wetting Up**

6.2.1 Leaking sewer, water or stormwater pipes.

6.2.2 Downpipes discharging too close to the building.

6.2.3 Sloping sites and inadequate drainage causing water to pond or collect close to the building.

6.2.4 Seepage on sloping sites caused by water travelling on the topsoil-clay, or soil-rock, interface. Cut-off drains are required in this situation.

6.2.5 Garden or lawn watering immediately adjacent to the footings. As a general rule this is not acceptable and must not be done without the explicit approval of the Engineer.

6.2.6 Over-watering of gardens and lawns.

6.2.7 Inadequate soakage trenches.

6.2.8 Flooding during, and after, building construction.

6.3 **Drying Out**

6.3.1 The non-provision of paving, particularly on the north and west sides of the building, coupled with the non-establishment of a garden.

6.3.2 A change from an established garden situation to a native garden coupled with a substantially reduced level of watering.

6.3.3 The most common cause of drying out is that caused by trees being planted too close to the footings. Trees and large shrubs require substantial amount of water, and if the soil near the tree dries out, the roots will extend in search of soil moisture. Clays will shrink as they dry, and they may cause the building to settle.

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

Many factors determine the extent of clay-drying by trees and the more important are the soil type, the size and number of trees and their species. For single trees, the drying zone area is usually the mature tree height, but the zone will be significantly larger for groups of 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. The effect of tree drying on the amount of movement is also related to the reactivity of the clay. To minimize the risk of damage, trees (especially groups of trees) shall not be planted near the building on a reactive clay site, and the following limits shall comply:

Di = 1.5 Ht for Class E and H2 sites
Di = 1.0 Ht for all other sites

Where Di is the distance of the tree from the building, and Ht is the mature height of the tree.

Planting of trees should be avoided near the foundation of a building or neighbouring building on reactive sites as they can cause damage due to drying of the clay at substantial distances. To reduce, but not eliminate, the possibility of damage, tree planting should be restricted to a distance from the house as follows:

i) 1½ x mature height for Class E sites.
ii) 1 x mature height of Class H1 and Class H2 sites.
iii) ¾ x mature height for Class M sites.

Where rows or groups of trees are involved, the distance from the building shall be increased by 50%.

These suggested limits mean that on the average suburban block, trees that grow higher than 8 m to 9 m are often impractical unless the owner accepts the risk of some damage to the building.

6.4 Due to the above factors the following work must be carried out, to minimize the detrimental effects of moisture variations.

6.4.1 Establish lawns and gardens around the building as soon as possible, and certainly within a maximum of 4 months from completion of the building.

6.4.2 Ensure all roof stormwater is discharged to the street where possible or alternatively discharged on the low side of the site not less than 6 m from the building, but not so as to concentrate a flow of water onto neighbouring property (also refer to Clause 6.6).

6.4.3 Large garden beds should not be located near the building. This will avoid the possibility of introducing too much moisture to the foundation soil by overwatering. The area near the building should be planned for paths or covered with gravel and plastic sheeting. Gardens and lawns should be watered adequately but not excessively. Uniform, consistent watering can is important to prevent damage to the foundation during dry spells such as droughts or dry summers.

6.4.4 After footings have been completed the site surface adjacent to the footings shall be graded by cutting and / or filling to provide a fall away from the building for a distance of not less than 1.0 m. Any channel formed must be graded to discharge all run-off away from the building area. Generally any cut area shall be drained via a surface drain at the base of the cut embankment discharging to the low side of the site. On steep or large sites where significant catchment area is present uphill from the building, a surface drain must also be constructed across the top of the embankment. Water must not pond adjacent to footings. If ponding occurs this water must be pumped out immediately and the above grading and drainage implemented at once.

6.5 Due to constraints of site and building levels, the cover to underground pipes may be less than the manufacturer's specification. This is necessary to prevent very significant cost increases in site works which would otherwise be required. Some damage (which shall be repaired immediately) may occur to pipes if trenching for other services is undertaken, or if vehicles travel over garden areas.

Modifications to site levels can be made if the owner does not accept these conditions.

6.6 Where site drainage designs are not included with this report, they shall be prepared by others experienced in site drainage, and shall comply with the details and requirements of this report.

6.7 **Subsurface Drainage**

Where specified in the recommendations or shown on the site drainage plan, subsurface drainage shall be installed in accordance with any details provided. Note: potential seepage or subsurface drainage problems cannot always be recognized from the results of the site investigation. All of the potential problems with respect to subsurface water flow or seepage may not be evident at the time of the investigation, or even at the time of construction, however, it may become evident after the building has been occupied for the first winter.

7. PAVING REQUIREMENTS

7.1 Pavements shall be not less than 900 mm in width (and preferably 1200 mm in width for Class E sites).

7.2 Concrete pavements shall comply with Table 2.

TABLE 2: CONCRETE PAVEMENTS

		FOR FOOT TRAFFIC ONLY		FOR LIGHT VEHICLE TRAFFICE	
Soil Classification	**Minimum* Cross Fall**	**Thickness (mm)**	**Reinforcement**	**Thickness (mm)**	**Reinforcement**
A or S	1 in 30	75	SL52 [2 m]**	100	SL62 [3 m]
M	1 in 20	75	SL52 [2 m]	100	SL62 [3 m]
H1	1 in 20	75	SL62 [2 m]	110	SL72 [4 m]
H2 or E	1 in 20	100	SL62 [3 m]	120	SL72 [4 m]

**The minimum cross fall may be dictated by the maximum allowable stated in AS 1428.1 Design for access and mobility – General requirements for access – New building work.*

*** [ ] indicates maximum distance between control joints (noting that length of adjacent sides should be in the ratio of 1 to 1.3 maximum)*

Note: for Class P (Problem) sites or pavement on uncompacted fill, refer to this office.

The paving and the ground in the immediate vicinity of the building shall be graded to slope away from the building area at a grade of 50 mm in 1 m.

7.3 Control joints shall be provided in accordance with the details attached.

7.4 Alternative pavements may be provided, e.g. brick or block pavers, hotmix, etc. Construction must be in accordance with the manufacturers or supplier's specifications, with minimum cross falls as noted above.

7.5 Where the class of soil is H or E it is recommended that paving be constructed at the end of winter, when the site soils are wet, so that cross falls constructed in the paving will not reduce. It is important, however, if the house is occupied during a winter period and no paving provided, that the soil surface around the perimeter of the house is maintained in a well drained state until such time as paving is installed. If, on these soils, it is necessary to construct paving at other times of the year, e.g. the end of summer, the cross fall provided should be not less than twice that is indicated on Table 2.

7.6 Pavements shall have a minimum set down below the rebate of 75 mm.

7.7 Paving shall be constructed on a firm clean base. Ensure that all building debris is removed from the perimeter of the building. Provide a compacted quarry rubble base if necessary to elevate paving and achieve the necessary cross fall.

7.8 The paving shall not be constructed above any damp-proof course or built-in damp- proof membrane, unless other adequate damp-proofing measures are taken.

7.9 On reactive soil sites it may be found that paving separates horizontally from the perimeter of the building. It is important that any gaps between the building and paving be immediately sealed with a flexible mastic sealant.

8. BUILDING CONSTRUCTION AND ARTICULATION

8.1 It should be realized that there are many factors which affect the performance of the building. Visible cracking can be caused by shrinkage and warping of timbers, crazing of plaster, contraction and expansion of masonry and shrinkage of concrete, as well as the most commonly attributed cause, footing distortion. Generally minor cracking is of no significance and will not detract from the performance or durability of the building. It is uneconomical, if not impossible, to eliminate all such imperfections.

8.2 It is generally recommended that masonry walls be articulated at all or some openings. Articulation involves the incorporation of movement joints (control joints). The provision of all control joints at locations specified in the report is mandatory. Where no control joints are specified for footing movement requirements, control joints must be provided in walls longer than 12 m.

8.3 Where new masonry abuts existing masonry, full height mastic filled control joints shall be used.

8.4 Because it is very difficult to prevent tilting of an extension relative to the existing building, the extension must be constructed so as to permit relative movement between the new and the existing building. This provision for relative movement applies to all work including roofs, floors, tiling, wall and ceiling finishes, etc.

9. SERVICES

9.1 Unless approved otherwise, service trenches must be positioned so that the distance between the trench and the edge of the footing is not less than the depth of the trench below the base of the footing. If this cannot be achieved the footings must be piered as indicated on the detail sheets.

9.2 All service trenches both inside and outside the perimeter of the building must be carefully backfilled with approved material, and compacted. The trenches should be sloped away from the building, and should be backfilled with clay in the

top 300 mm within 1.5 m of the building, and where pipes pass under the footings, the trench should be backfilled with clay or concrete to prevent the ingress of water beneath the footing.

9.3 On Class H or E sites special care must be taken to ensure that flexible service connections are used so as to allow for differential soil movement. An expansion coupling must be provided immediately outside the building, where the sewer connections penetrate the footing beam and at the junction of the branch to the main sewer pipe.

9.4 On Class H, E or P (filled sites) sites, a flexible junction must be provided where downpipes connect into the underground stormwater drainage pipes. A sleeved fitting is adequate, but this should be sealed with silicone on Class H or E sites.

9.5 Where pipes pass through a footing beam they must be lagged (i.e. wrapped) in accordance with the following:

- Class S, M: Provide 20 mm thick lagging (not necessarily closed cell).
- Class H1: Provide 20 mm thick closed cell polythene lagging.
- Class H2, E & P: Provide 40 mm thick closed cell polythene lagging.

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1. GENERAL

1.1 These notes shall be read in conjunction with the architectural drawings, the specifications and the Engineer's Report, etc.

1.2 All dimensions and levels shall be confirmed with the architectural drawings and / or checked on site.

1.3 Engineer's drawings must not be scaled.

1.4 The builder and / or agent shall be responsible for maintaining the stability of all structures and any elements until their completion and shall ensure that no part of structures or any elements are overstressed by excessive loading.

1.5 The specifications below shall apply unless noted otherwise.

1.6 Requests for information will generally be responded to by the engineer within 5 working days, whilst reviews of shop drawings generally within 10 working days.

2. CONCRETE

2.1 Concrete construction to comply with AS 3600 *Concrete structures.*

2.2 Concrete shall be as follows:

- Grade N20 (i.e. 20 MPa) to slab on ground, footings protected by vapour barrier and residential strip / pad footings.
- Grade N25 to suspended slabs, beams, columns and non residential footings unprotected by vapour barrier.
- Grade N32 to members exposed to exterior environments or where concrete is to have a polished finish.
- Maximum aggregate 20 mm.
- Slump to be nominal 100 mm unless noted otherwise.

2.2.1 For sites within 1 km of the shoreline of large expanses of salt water or heavy industrial areas where surfaces (e.g. verandahs, balconies, carports) are exposed, the surface shall be protected with suitable topping, sealer, tiles etc or the concrete grade shall be not less than N40.

2.2.2 For sites containing high sulphate or highly saline soils (or in heavy industrial areas), the concrete surface is to be protected from the aggressive soil by a 0.2 mm branded and certified vapour barrier. Alternatively, use a concrete grade of N40 or greater.

2.3 Construction joints to be thoroughly scabbled of all laitance and poorly compacted material. Vertical joints to be poured against shuttering (refer also BF062 *Specification for the construction of footings and slabs (CRS)* Clause 2.7.3).

2.4 All concrete to be properly cured by keeping all exposed surfaces in a moist, damp condition for at least the first 7 days after placing, or by spraying with an approved curing compound, subject to compatibility with proposed surface finishes.

2.5 Minimum stripping times*:

- Slab-soffit 14 days, props 21 days.
- Beams-sides 3 days, soffit 21 days.
- Columns and Walls - (unloaded) 3 days.

**Specific instructions on formwork stripping times / de-propping etc are required in the cases of multi-level work.*

The system of propping including any re-shoring or back-propping proposals is the responsibility of the builder / contractor and is subject to the approval of the Superintendent.

2.6 In accordance with AS/NZS 4671 *Steel reinforcing materials,* reinforcement designations are as follows:

- R: Plain round structural bar
- F: Hard drawn wire fabric
- W: Hard drawn wire bar
- N: Hot rolled deformed bar
- SL: Square ribbed fabric
- RL: Rectangular ribbed fabric

2.7 Provide 0.2 mm High Impact Resistance branded polythene membrane to AS 2870 *Residential slabs and footings* throughout underside of floor slabs on ground, all laps to be 300 mm and sealed with a 50 mm wide strip of pressure-sensitive waterproof tape.

2.8 All filling to be non-clay material compacted in 150 mm layers to 90% maximum dry density in accordance with AS 3798 *Guidelines on earthworks for commercial and residential developments*.

2.9 Where rod reinforcement is spliced, the minimum lap length shall be:

Bar Size	Lap Length (mm)	Bar Size	Lap Length (mm)
N12	500	N28	1800
N16	750	N32	2150
N20	1000	N36	2600
N24	1450		

2.10 Laps to slab mesh to be one (1) full mesh panel plus 25 mm.

2.11 Clear concrete cover to reinforcement, (including fitments and wire ties), shall be:

- Internal slab on fill: 30 mm bottom and sides, 20 mm top.
- Footings protected by vapour barrier: 40 mm bottom and sides, 20 mm top.
- Residential footings unprotected by vapour barrier: 40 mm top, 50 mm bottom and sides.
- Non-residential footings unprotected by damp-proof membrane: 50 mm top, bottom and sides.
- Suspended slabs, beams and columns: 20 mm internal, 40 mm external.
- Where concrete is exposed to aggressive soils: 65 mm general, 55 mm where protected by an approved membrane.

2.12 Concrete is to be separated from the supporting brick work by two (2) layers of 0.5 mm thick viscourse.

2.13 Walls must not be built on suspended concrete slabs or beams until form work and props supporting same have been removed.

2.14 Tension cracks may occur in slabs, apply suitable sealant for exposed surfaces to prevent possible moisture ingress.

2.15 Provide 10 mm isolation joints where concrete is adjacent steel work / masonry. Provide suitable filler and sealant.

3. MASONRY

3.1 Construction to comply with AS 3700 *Masonry structures*.

3.2 Minimum characteristic unconfined compressive strength of units to be as follows:

- Clay bricks: 40 MPa
- Concrete bricks: 10 MPa
- Concrete hollow blocks: 15 MPa

3.3 Mortar: Brick work: 1: 1 : 6 (Cement / Lime / Sand) Block work: 1: 1 : 6

3.4 Infill concrete grout to reinforced masonry to be Grade 15, slump 230 +/ - 30, 10 mm aggregate.

3.5 For hollow block retaining walls, all cores are to be grouted.

3.6 Grouting to reinforced masonry shall be compacted by rodding with a plain round bar. All air pockets and bubbles must be displaced during compaction. However, care must be taken to avoid damaging or dislodging the masonry or reinforcement while compacting the grout.

4. STEEL WORK

4.1 All Hot Rolled Steel to comply with AS 4100 *Steel structures*, AS/NZS 4600 *Cold formed steel structures* and AS 2327.1 *Composite structures – Simply supported beams*.

4.2 All welding to comply with AS/NZS 1554 *Structural steel welding,* Parts 1, 2 & 3.

4.3 All fillet welds to be 6 mm (category SP unless noted otherwise) extending the full length of the edges in contact, except where plate thicknesses are less than 6 mm, use a weld size to match.

4.4 The steel worker shall supply all HD bolts, nuts and all other bolts and washers required for the erection of the steel work, holes for HD bolts to be 3 mm oversize, holes for other bolts to be no more than 2 mm oversize. Minimum connection: 10 mm plate with 2 M16 8.8/S bolts unless otherwise noted.

4.5 Where HSFG bolts are required bolting shall comply with AS 4100.

4.7 All base plates, HD bolts and columns in concrete which is in contact with ground to have concrete cover of 75 mm minimum.

4.8 Minimum edge distance taken from centre of fastener *(Where 'D' is the nominal diameter of the fastener)* shall be:

- Sheared or hand flame cut edge: 1.75D
- Rolled plate, machine flame cut sawn or planed edge: 1.50D
- Rolled edge of a rolled section: 1.25D

4.8 Steel work to be concrete encased must first be wrapped with RF41 mesh. The reinforcement is to be placed 25 mm from the steel work.

4.9 Provide a 10 mm clearance between vertical faces of steel work and adjacent masonry walls. Provide W6 ties between steel work and masonry at 600 centres (max).

4.10 All steel work to be adequately propped and braced during construction until all permanent bracing, masonry and cladding has been erected.

4.11 All cold formed sections are to be constructed in accordance with the manufacturer's specifications. Trimming members the same size as the adjoining member shall be provided at no additional cost, to support all edges of sheeting at an angle other than 90 degrees to purlin / girt (refer to purlin manufacturer for details).

4.12 Steel work Protective coatings to be:

• Exposed external steel work within 1 km from breaking surf or within 100 m of salt water not subject to breaking surf, or heaving industrial areas, or corrosive water:	Hot-Dip Galvanized, and painted.
• Exposed external steel work (not exposed to corrosive environment):	Hot-Dip Galvanized, 'Dimet' treated or one coat sprayed Inorganic zinc silicate paint over class 2.5 abrasive blast surface.
• Steel work acting as downpipe or gutter:	Hot-Dip Galvanized.
• Internal steel work (not exposed to moisture or corrosive environment):	Red oxide zinc chromate primer (Rozc) over wire brush surface.

Note: All steelwork in contact with the ground, paving or soil etc, shall, in addition to the protection required above, be either wrapped with "Denso" tape or encased with concrete a minimum 75 mm thick.

4.13 Two (2) copies of shop detail drawings are to be submitted to the engineer and review of the same obtained before commencing fabrication. Review will not cover dimensions. Shop drawings will generally be reviewed by the engineers within 10 working days.

5. TIMBER

5.1 All to comply with AS 1720.1 *Timber structures – Design methods* and AS 1684 *Residential timber framed construction*.

5.2 All MGP10 grade timber must exclude "heart in" material to give the timber a minimum joint group strength of JD4, in accordance with AS 1720.

6. EARTHWORKS

All to comply with AS 3798 *Guidelines on earthworks for commercial and residential developments.*

7. SITE INSPECTIONS

Must be carried out at the following stages (Refer to *Construction Report and Footing Recommendations (CR1)* for engineer recommendations):

- After site preparation and trenching for the footing beams.
- After the preparation of reinforcement, prior to the placement of any concrete.

Additional inspections may be carried out at the discretion of the Engineer and / or as requested by the Owner / Agent[1]:

- At the concrete pour.
- After completion of the masonry prior to construction of the roof to ensure correct placement of control joints.
- Upon completion of the installation of paving, stormwater drains, pipes and structures.

8. SURFACE PROTECTIVE COATINGS

All structural members and surfaces, i.e. beams, columns, walls, floors, ceilings, roofs and the like both internally and externally shall be coated with an approved protective coating to suit their intended use / exposure environment, which is to be applied in strict accordance with the manufacturer's recommendations and specifications (see also Clause 4.12).

9. RETAINING WALLS

Refer to sheet BF063 *General notes for retaining wall construction (RWN).*

10. TERMITE PROTECTION

Termite protection system shall be in accordance with AS 3660.1 *Termite management – New building work*.

[1] *Agent refers to architect, builder, project manager, contractor, supervisor or any other such person that has authority to act on the Owner's behalf.*

REACTIVE SOIL MOVEMENT CALCULATIONS

Sub-number :

Boreholes : 1 to 4

These calculations comply with the requirements of AS 2870—2011 and "Special Provisions for the Design of Residential Slabs and Footings for South Australian Conditions", February 2013.

The values of the Differential Mound Movement y_m for the Centre Heave (C/H) and Edge Heave (E/H) conditions are intended for use in the Walsh Method of Analysis and comply with Clause F2 of AS 2870—2011.

Depth of Design Suction Change :	4.0	metres	Table 2.4
Depth of the Cracked Zone :	3.0	metres	Clause 2.3.2
Include the effects of trees :	Y	(Y=Yes, N=No)	

Summary of soil profile parameters used in calculations

	HOLE 1		HOLE 2		HOLE 3		HOLE 4	
Fill < 5 yrs **		metres		metres		metres		metres
Cut < 2 yrs **		metres		metres		metres		metres
Bedrock **		metres		metres		metres		metres
Water Table **		metres		metres		metres		metres
Horizons	Depth	Ips	Depth	Ips	Depth	Ips	Depth	Ips
1	0.30	0.002	0.20	0.002	0.30	0.002	0.30	0.002
2	0.40	0.005	0.30	0.005	0.70	0.030	0.40	0.005
3	0.75	0.030	0.70	0.030	1.30	0.020	0.80	0.030
4	1.40	0.020	1.20	0.020	1.80	0.015	1.60	0.020
5	2.00	0.015	2.00	0.015	2.00	0.025	2.20	0.015
6	2.40	0.025	2.40	0.025	2.50	0.035	2.50	0.025
7	4.00	0.035	4.00	0.035	4.00	0.050	4.00	0.035

** Leave blank if this parameter does not influence the design

Summary of tree effect parameters (to AS 2870—2011 Appendix H)

This design is for a TREE GROUP

HT =	7.0	Design height of tree group (m)	
D_t =	5.0	Distance to tree group (m)	
D_i / HT =	1.5	Tree Factor	Appendix H
S_v =	1.2	Surface Value of ΔpF	Table 2.4
Δu_{base} =	0.55	due to the effect of the group of trees	
and H_t =	4.5	metres	Appendix H

Summary of calculated surface movement values

	HOLE 1	HOLE 2	HOLE 3	HOLE 4
Characteristic Surface Movement, y_s (mm)	**50.2**	**52.0**	**61.3**	**49.9**
Surface Movement due to the Effects of Trees, y_t (mm)	**33.4**	**33.4**	**46.0**	**32.9**

The maximum value of y_s is 61 mm **Site Classification : P (Trees)**

=>For design, use:	**C/H: y_m =**	**43 mm**	Appendix F2
	E/H: y_m =	**31 mm**	Appendix F2
=>For design, use:	**y_t =**	**46 mm**	Appendix H

Notes / Comments :

In the case where trees have been found on the site or tree planting is planned in the vicinity of the proposed works, this design attempts to account for their effects by allowing for a vertical soil movement greater than would be expected to occur as a result of normal seasonal moisture movements beneath and adjacent to the footing. However, due to the complexity of tree root geometry, variable moisture extraction by the tree and the difficulty in predicting future tree growth, a precise design for the effects of trees is outside current knowledge.

The Owner must understand that, although appropriate precautions have been taken in this design for the effects of trees, some tree-induced movement in the structure must be accepted.

Ref.:	**1806063**
Date:	**03-Jun-20**
Design:	**PC**
Page:	**FC112**

RESIDENTIAL FOOTING CALCULATIONS - SUMMARY SHEET

Sub-number :

The calculations are in accordance with AS 2870—2011 Residential slabs and footings

Site Address/Location : 82 - 90 JOHNS ROAD (LOTS 1-8, STAGE A))
PROSPECT SA

STRUCTURE AND LOAD TYPES

Structure Type : Veneer
Articulation : True
Construction : Two Storeys
Roof : Steel Sheeting

WALSH DESIGN PARAMETERS

Depth of Design Suction Change :	4.0 metres	Soil Profile Type :	Class D
Characteristic Movement - y_s :	61 mm	Default Centre Heave Stiffness :	1000 kPa/m
Centre Heave - y_m* :	43 mm	Default Edge Heave Stiffness :	1500 kPa/m
Edge Heave - y_m* :	31 mm	Hard:Soft Mound Stiffness Ratio :	5
Design Surface Movement - y_t** :	46 mm	Design Deflection Ratio :	400
Design is for Tree Removal :	N	Differential Deflection Limit :	30 mm

* The calculated heave values are in accordance with AS 2870—2011, Appendix F2 (Walsh method).
** The calculated design movement due to trees is in accordance with AS 2870—2011, Appendix H.

BEAM & SLAB DESIGN DETAILS

Slab Thickness :	110 mm	Top Face Bar Diameter :	16 mm
Top Face Fabric :	SL92	Bottom Face Bar Diameter :	16 mm
Area of Fabric Reinforcement :	287 mm^2/m	Cover to Top Reinforcement :	20 mm
Reinforcement f_{sy} :	500 MPa	Cover to Bottom Reinforcement :	30 mm
Reinforcement Modulus :	200E+3 MPa	Effective Beam Depth (C/H) :	1060 mm
		Effective Beam Depth (E/H) :	1050 mm
Internal Beam Width :	350 mm	**Internal Beams**	
External Beam Width :	350 mm	No. of Top Face Bars :	4
Overall Beam Depth :	1100 mm	No. of Bottom Face Bars :	4
Concrete f'c :	20 MPa	**External Beams**	
Concrete Modulus :	15E+3 MPa	No. of Top Face Bars :	4
		No. of Bottom Face Bars :	4

DESIGN SUMMARY

***** DESIGN IS SATISFACTORY - Refer to Calculation Sheets for Details.**

CONSTRUCTION TYPE

Articulated Masonry Veneer

SLAB

Thickness 110 mm
Fabric Reinforcement SL92

BEAMS

Beam Type	Depth x Width (mm)	(mm)	Bar reinforcement Top	Bottom
External	1100	350	4.N16	4.N16
Internal	1100	350	4.N16	4.N16

General Notes

Concrete f'c 20 MPa at 28 days
Cover - Top 20 mm
- Bottom 30 mm

DESIGN ASSUMPTIONS

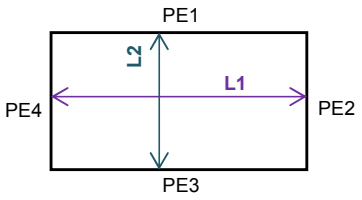
No. of rectangles in this design: 1

1. Building Construction : Double Storey | Walls: Art. Masonry Veneer | Roof: Steel Sheeting

2. Max. Differential $\Delta_{allowable}$: L/400 ≤ 30mm

DESIGN RECTANGLE 1

Design Rectangle Length (L1) : 38.000 m
Design Rectangle Width (L2) : 13.500 m
No. of Beams Parallel to L1 : 6
No. of Beams Parallel to L2 : 17
Section Area of Beams : 0.39 m^2
Trial Internal Beam Size : 350 x 1100



:. Soft Swell Stiffness of 100q ≈ 2530 kPa/m

LOADS

Uniform Slab Loading

Footing Slab	2.64 kPa
Live Load	1.50 kPa
Finishes, Partitions	1.00 kPa
Internal Footings	5.75 kPa
Other Uniform Slab Loadings	8.00 kPa
Total	18.89 kPa

Footing Edge Loading

PE1	Lower External Wall:	Art. Masonry Veneer	1.87 x 2.4 kPa	4.48 kN/m
	Upper External Wall:	Power Panel	6.70 x 1.6 kPa	10.72 kN/m
	Roof:	Steel Sheeting	5.50 x 0.40 kPa	2.20 kN/m
	Floor:	Timber	4.80 x 1.55 kPa	7.44 kN/m
	Footing Self Weight			9.24 kN/m
			Total	34.08 kN/m
PE2	Lower External Wall:	Art. Masonry Veneer	1.87 x 2.4 kPa	4.48 kN/m
	Upper External Wall:	Power Panel	6.70 x 1.6 kPa	10.72 kN/m
	Roof	Steel Sheeting	1.00 x 0.40 kPa	0.40 kN/m
	Floor	Timber	1.00 x 1.55 kPa	1.55 kN/m
	Footing Self Weight			9.24 kN/m
			Total	26.39 kN/m
PE3	Lower External Wall:	Art. Masonry Veneer	1.87 x 2.4 kPa	4.48 kN/m
	Upper External Wall:	Power Panel	6.70 x 1.6 kPa	10.72 kN/m
	Roof	Steel Sheeting	5.50 x 0.40 kPa	2.20 kN/m
	Floor	Timber	4.80 x 1.55 kPa	7.44 kN/m
	Footing Self Weight			9.24 kN/m
			Total	34.08 kN/m
PE4	Lower External Wall:	Art. Masonry Veneer	1.87 x 2.4 kPa	4.48 kN/m
	Upper External Wall:	Power Panel	6.70 x 1.6 kPa	10.72 kN/m
	Roof	Steel Sheeting	1.00 x 0.40 kPa	0.40 kN/m
	Floor	Timber	1.00 x 1.55 kPa	1.55 kN/m
	Footing Self Weight			9.24 kN/m
			Total	26.39 kN/m

RESIDENTIAL FOOTING CALCULATIONS

The calculations are in accordance with AS 2870—2011 Residential slabs and footings

RECTANGLE 1 - BEAMS PARALLEL TO L1

STRUCTURE AND LOAD DETAILS — **Structure Type : Veneer** — **Articulation : True** — **Number of Beam Elements:** 100

Rectangle Length :	38.000	metres	Equivalent Uniform Load :	23.94	kPa	Soil Profile Type :	Class D	
Rectangle Width :	13.500	metres	Centre Line Load :	0.00	kN/m	Ys :	61	mm
Slab Thickness :	110	mm	Edge Line Load :	26.39	kN/m	Yt :	46	mm
Total No. of Beams :	6		Concrete f'c :	20	MPa	Concrete Modulus :	15E+3	kPa

BEAM DETAILS			**Internal Beams**			**External Beams**		
Overall Beam Depth :	1100	mm	Beam Width :	350	mm	Beam Width :	350	mm
Fabric Reinforcement			Top Face Bar Diameter :	16	mm	Top Face Bar Diameter :	16	mm
Top Face Fabric :	SL92		No. of Top Face Bars :	4		No. of Top Face Bars :	4	
Area of Fabric Reinforcement :	287	mm^2/m	Cover to Top Reinforcement :	20	mm	Cover to Top Reinforcement :	20	mm
Fsy :	500	MPa	Bottom Face Bar Diameter :	16	mm	Bottom Face Bar Diameter :	16	mm
Steel Modulus :	200E+3	MPa	No. of Bottom Face Bars :	4		No. of Bottom Face Bars :	4	
			Cover to Bottom Reinforcement :	30	mm	Cover to Bottom Reinforcement :	30	mm

WALSH DESIGN METHOD	**Centre Heave**		**Internal Beams**			**External Beams**		
Ym :	89	mm	Effective Beam Depth :	1060	mm	Effective Beam Depth :	1060	mm
Soft Swell Stiffness :	2530	kPa/m	Effective Flange Width :	2350	mm	Effective Flange Width :	1350	mm
Mound Edge distance, e :	2.972	m	Top Face Ast :	1474	mm^2	Top Face Ast :	1187	mm^2
Walsh Factor C1 :	0.97		Required Beam Capacity :	413.84	kNm/beam	Required Beam Capacity :	206.92	kNm/beam
Walsh Factor C2 :	0.99		Required Beam Stiffness :	29.97	E+9 mm^4	Required Beam Stiffness :	14.99	E+9 mm^4
Max BM :	153.28	kNm/m	Steel Ratio :	0.0040		Steel Ratio :	0.0032	
Max Shear Force :	64.35	kN/m	Bending Capacity :	587.9	kNm	Bending Capacity :	479.3	kNm
Calc. I-required :	11.10	E+9 mm^4/m	I-Gross :	73.35	E+9 mm^4	I-Gross :	59.90	E+9 mm^4
Calc. Span/Deflection Ratio :	1257		I-Cracked :	14.50	E+9 mm^4	I-Cracked :	12.18	E+9 mm^4
Calc. Delta/Ym Ratio :	0.34		Cracking Moment :	356.8	kNm	Cracking Moment :	245.0	kNm
			I-Effective :	52.22	E+9 mm^4	I-Effective :	59.90	E+9 mm^4

Internal - Bending : Provided Capacity of 587.9 kNm > Required Capacity of 413.8 kNm :. OK
Stiffness : Provided Stiffness of 52.22E+9 mm^4 > Required Stiffness of 29.97E+9 mm^4 :. OK

External - Bending : Provided Capacity of 479.3 kNm > Required Capacity of 206.9 kNm :. OK
Stiffness : Provided Stiffness of 59.9E+9 mm^4 > Required Stiffness of 14.99E+9 mm^4 :. OK

WALSH DESIGN METHOD	**Edge Heave**		**Internal Beams**			**External Beams**		
Ym :	31	mm	Effective Beam Depth :	1050	mm	Effective Beam Depth :	1050	mm
Soft Swell Stiffness :	2530	kPa/m	Effective Flange Width :	2700	mm	Effective Flange Width :	1350	mm
Mound Edge distance, e :	1.840	m	Bottom Face Ast :	800	mm^2	Bottom Face Ast :	800	mm^2
Mound Shape Factor, Wf :	0.00		Required Beam Capacity :	14.82	kNm/beam	Required Beam Capacity :	7.41	kNm/beam
Walsh Factor C1 :	1.00		Required Beam Stiffness :	0.24	E+9 mm^4	Required Beam Stiffness :	0.12	E+9 mm^4
Walsh Factor C2 :	1.00		Steel Ratio :	0.0003		Steel Ratio :	0.0006	
Max BM :	5.49	kNm/m	Bending Capacity :	334.6	kNm	Bending Capacity :	333.2	kNm
Max Shear Force :	24.38	kN/m	I-Gross :	76.98	E+9 mm^4	I-Gross :	59.90	E+9 mm^4
Calc. I-required :	0.09	E+9 mm^4/m	I-Cracked :	10.48	E+9 mm^4	I-Cracked :	10.00	E+9 mm^4
Calc. Span/Deflection Ratio :	5608		Cracking Moment :	277.5	kNm	Cracking Moment :	245.0	kNm
Calc. Delta/Ym Ratio :	0.22		I-Effective :	76.98	E+9 mm^4	I-Effective :	59.90	E+9 mm^4

Internal - Bending : Provided Capacity of 334.6 kNm > Required Capacity of 14.8 kNm :. OK
Stiffness : Provided Stiffness of 76.98E+9 mm^4 > Required Stiffness of 0.24E+9 mm^4 :. OK

External - Bending : Provided Capacity of 333.2 kNm > Required Capacity of 7.4 kNm :. OK
Stiffness : Provided Stiffness of 59.9E+9 mm^4 > Required Stiffness of 0.12E+9 mm^4 :. OK

RESIDENTIAL FOOTING CALCULATIONS

The calculations are in accordance with AS 2870—2011 Residential slabs and footings

RECTANGLE 1 - BEAMS PARALLEL TO L2

STRUCTURE AND LOAD DETAILS — **Structure Type : Veneer** — **Articulation : True** — **Number of Beam Elements:** 100

Rectangle Length :	13.500	metres	Equivalent Uniform Load :	20.28	kPa	Soil Profile Type :	Class D	
Rectangle Width :	38.000	metres	Centre Line Load :	0.00	kN/m	Ys :	61	mm
Slab Thickness :	110	mm	Edge Line Load :	34.08	kN/m	Yt :	46	mm
No. of Beams :	17		Concrete f'c :	20	MPa	Concrete Modulus :	15E+3	kPa

BEAM DETAILS

			Internal Beams			External Beams		
Overall Beam Depth :	1100	mm	Beam Width :	350	mm	Beam Width :	350	mm
Fabric Reinforcement			Top Face Bar Diameter :	16	mm	Top Face Bar Diameter :	16	mm
Top Face Fabric :	SL92		No. of Top Face Bars :	4		No. of Top Face Bars :	4	
Area of Fabric Reinforcement :	287	mm^2/m	Cover to Top Reinforcement :	20	mm	Cover to Top Reinforcement :	20	mm
Fsy :	500	MPa	Bottom Face Bar Diameter :	16	mm	Bottom Face Bar Diameter :	16	mm
Steel Modulus :	200E+3	MPa	No. of Bottom Face Bars :	4		No. of Bottom Face Bars :	4	
			Cover to Bottom Reinforcement :	30	mm	Cover to Bottom Reinforcement :	30	mm

WALSH DESIGN METHOD — **Centre Heave**

			Internal Beams			External Beams		
Ym :	89	mm	Effective Beam Depth :	1060	mm	Effective Beam Depth :	1060	mm
Soft Swell Stiffness :	2530	kPa/m	Effective Flange Width :	2350	mm	Effective Flange Width :	1188	mm
Mound Edge distance, e :	2.972	m	Top Face Ast :	1474	mm^2	Top Face Ast :	1141	mm^2
Walsh Factor C1 :	0.73		Required Beam Capacity :	438.05	kNm/beam	Required Beam Capacity :	219.03	kNm/beam
Walsh Factor C2 :	0.57		Required Beam Stiffness :	19.81	E+9 mm^4	Required Beam Stiffness :	9.91	E+9 mm^4
Max BM :	184.44	kNm/m	Steel Ratio :	0.0040		Steel Ratio :	0.0031	
Max Shear Force :	65.79	kN/m	Bending Capacity :	587.9	kNm	Bending Capacity :	461.4	kNm
Calc. I-required :	8.34	E+9 mm^4/m	I-Gross :	73.35	E+9 mm^4	I-Gross :	57.13	E+9 mm^4
Calc. Span/Deflection Ratio :	445		I-Cracked :	14.50	E+9 mm^4	I-Cracked :	11.78	E+9 mm^4
Calc. Delta/Ym Ratio :	0.34		Cracking Moment :	356.8	kNm	Cracking Moment :	226.3	kNm
			I-Effective :	46.30	E+9 mm^4	I-Effective :	57.13	E+9 mm^4

Internal - Bending : Provided Capacity of 587.9 kNm > Required Capacity of 438.1 kNm :. OK
Stiffness : Provided Stiffness of 46.3E+9 mm^4 > Required Stiffness of 19.81E+9 mm^4 :. OK

External - Bending : Provided Capacity of 461.4 kNm > Required Capacity of 219 kNm :. OK
Stiffness : Provided Stiffness of 57.13E+9 mm^4 > Required Stiffness of 9.91E+9 mm^4 :. OK

WALSH DESIGN METHOD — **Edge Heave**

			Internal Beams			External Beams		
Ym :	31	mm	Effective Beam Depth :	1050	mm	Effective Beam Depth :	1050	mm
Soft Swell Stiffness :	2530	kPa/m	Effective Flange Width :	2375	mm	Effective Flange Width :	1188	mm
Mound Edge distance, e :	1.840	m	Bottom Face Ast :	800	mm^2	Bottom Face Ast :	800	mm^2
Mound Shape Factor, Wf :	0.00		Required Beam Capacity :	10.54	kNm/beam	Required Beam Capacity :	5.27	kNm/beam
Walsh Factor C1 :	0.99		Required Beam Stiffness :	0.15	E+9 mm^4	Required Beam Stiffness :	0.07	E+9 mm^4
Walsh Factor C2 :	1.00		Steel Ratio :	0.0003		Steel Ratio :	0.0006	
Max BM :	4.44	kNm/m	Bending Capacity :	334.4	kNm	Bending Capacity :	332.8	kNm
Max Shear Force :	28.93	kN/m	I-Gross :	73.62	E+9 mm^4	I-Gross :	57.13	E+9 mm^4
Calc. I-required :	0.06	E+9 mm^4/m	I-Cracked :	10.41	E+9 mm^4	I-Cracked :	9.90	E+9 mm^4
Calc. Span/Deflection Ratio :	2574		Cracking Moment :	271.8	kNm	Cracking Moment :	238.9	kNm
Calc. Delta/Ym Ratio :	0.17		I-Effective :	73.62	E+9 mm^4	I-Effective :	57.13	E+9 mm^4

Internal - Bending : Provided Capacity of 334.4 kNm > Required Capacity of 10.5 kNm :. OK
Stiffness : Provided Stiffness of 73.62E+9 mm^4 > Required Stiffness of 0.15E+9 mm^4 :. OK

External - Bending : Provided Capacity of 332.8 kNm > Required Capacity of 5.3 kNm :. OK
Stiffness : Provided Stiffness of 57.13E+9 mm^4 > Required Stiffness of 0.07E+9 mm^4 :. OK

Block fence (RBW) (Lateral)

$H = 1.4m$, $L = 1m$, $Q_{ult} = 0.68kPa$ (N1)

$W^* = (1.5 \times 0.68kPa)\,1m = 1.02 kN/m$.

$M^* = \frac{W^* L^2}{2} = \frac{1.02(1.4^2)}{2} = 1 kNm$.

A_{sd} is the lesser of:

$A_{st} = \frac{\pi d^2}{4} \times \frac{1000}{400} = \frac{\pi (12)^2}{4} \times \frac{1000}{400} = 282 mm^2/m$

$A_{st} = \frac{0.2 \alpha_1 1.3 \times f'_m \times b \times d}{f'_{sy}} = \frac{0.2 \times 1.3 \times 8.1 \times 700 \times 75}{500} = 320 mm^2$

$\therefore$ Adopted $A_{st} = 282 mm^2$.

$$M_d = \phi f_{sy} A_{sd} d \left[1 - \frac{0.6 f_{sy} A_{st}}{1.3 f'_m b d}\right]$$

$$= 0.75 \times 500 \times 282 \times 75 \left[1 - \frac{0.6 \times 500 \times 282}{1.3 \times 8.1 \times 700 \times 75}\right]$$

$$= 7.93 kNm \times 0.84$$

$M_d = 6.71 kNm > M^*$ $\therefore$ ok

Footing overturning

$M^* = \frac{K_p \delta d^3}{10}$ $K_p = 3$, $\delta = 18 kN/m^3$

$d^3 = \frac{10 M^*}{K_p \delta} = \frac{10 \times 1}{3 \times 18} = 0.2$

$d = \sqrt[3]{0.2} = 584 mm$

Adopted 750 deep footing.

Checked : .....
Date : ...../...../.....

Foundation Maintenance and Footing Performance:
A Homeowner's Guide

PUBLISHING

BTF 18-2011 replaces Information Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870-2011, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume, particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.

In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes

Notes

1. Where controlled fill has been used, the site may be classified A to E according to the type of fill used.
2. Filled sites. Class P is used for sites which include soft fills, such as clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soil subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.
3. Where deep-seated moisture changes exist on sites at depths of 3 m or greater, further classification is needed for Classes M to E (M-D, H1-D, H2-D and E-D).

Tree root growth
Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation
Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

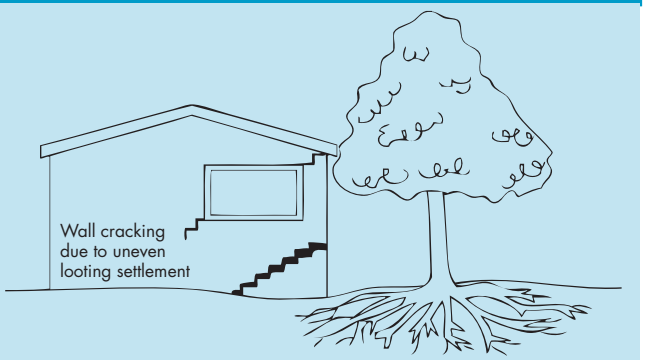
The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Trees can cause shrinkage and damage



Movement caused by tree roots
In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself
Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures
Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation causes a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem. Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870-2011.

AS 2870-2011 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

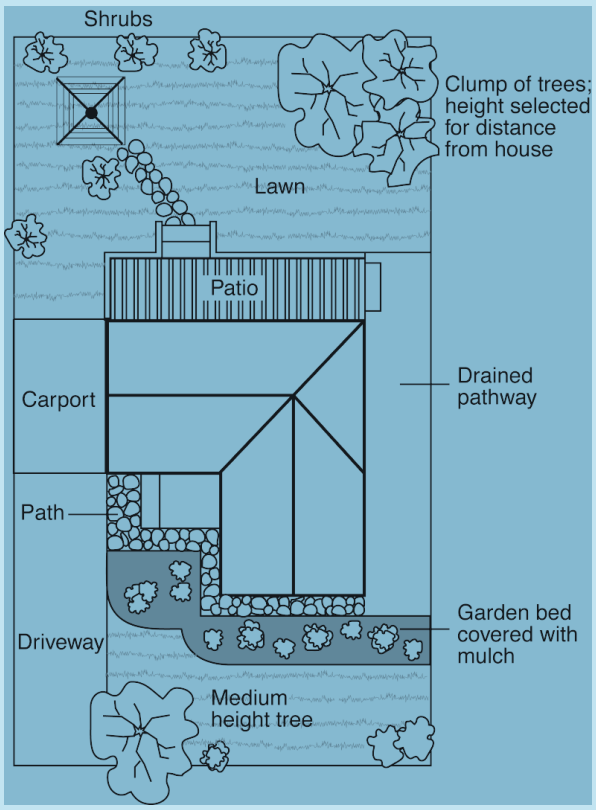
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving should

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

Gardens for a reactive site



extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

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Distributed by

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