Dean Iuliano & Company
CONSULTING STRUCTURAL AND CIVIL ENGINEERS

STRUCTURAL

DOCUMENTATION

S TATARELLI
5 ATHOS PLACE
PARADISE SA 5075

100 RUNDLE STREET KENT TOWN SA 5067
EMAIL: diuleng@bigpond.net.au
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close liaison + thorough research + quality drawings = sound efficient construction

Dean Iuliano & Company

CONSULTING STRUCTURAL
AND CIVIL ENGINEERS

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PROJECT: THREE NEW DWELLINGS

ADDRESS: 5 ATHOS PLACE
PARADISE SA 5075

OWNER: S TATARELLI

DI&CO JOB NO: ATH3836-1

DATE: **25 JULY 2019**

Issue Record

Date	*Issued to*	*Purpose*	*By*	*Transmitted by*	*Documents*
23/08/2019	S Tatarelli	Owner's Copy	D I	Hand delivered	1 x Construction Report 1 x Dwgs C01, S01, S02, S03
20/08/2019	Spectra Building Designers	Development Approval	D I	Email	Construction Report Dwgs C01, S01, S02, S03

CONSTRUCTION REPORT

FOOTINGS AND FOUNDATIONS

GENERAL

This is a Construction Report containing our recommendations for Footings and Foundations for proposed building works to be carried out at a particular site. **It is the Owner's responsibility to ensure that all** recommendations contained herein and in Appendix A of Australian Standard AS 2870-2011 - Residential Slabs and Footings, "Guide to Home Owners on Foundation Maintenance and Footing Performance", which is reprinted in the CSIRO Information Sheet, **are adhered to.** If the Owner does not wish to accept the advice contained within this report or wishes to have a stronger and stiffer footing system for the purpose of reducing the risk of cracking in the building, the Owner shall advise the Engineer in writing.

This document shall be kept by the Building Owner for future reference, as it contains important information regarding the design and construction of the footings as well as recommendations on site drainage, tree planting and other pertinent matters, all of which have an effect on the performance of the footings.

SOIL CHARACTERISTICS

Six boreholes were drilled, at the locations shown approximately on the Driller's plan, for the purpose of providing basic soils information from which this footing recommendation has been determined. Please note that, in common with any random sampling technique, it is possible that subsequent excavation may uncover soil strata variations or conditions different from those indicated by the initial drilling. The soil profiles are shown on the borehole logs.

The site is of instability classification: **H2 — D / P** **H**ighly reactive clay sites, which can experience very high ground movement from **D**eep seated moisture changes

These are high plasticity clays having ready access to surface moisture.
The behaviour of this soil type is typified by potentially large differential shrinkage and swelling movements due to moisture changes, often resulting in Category 1 or Category 2 damage with occasional examples of Category 3, or more severe, damage. Refer to Appendix C of Australian Standard AS 2870-2011, re-printed in the CSIRO information sheet attached hereto for a description of the damage categories.

SOILS ASSOCIATION MAP AND INVESTIGATION OF NEARBY SITES

With reference to the Soils Association Map of the Adelaide Region compiled under the direction of the Director of Mines, the Soils in this area are predominantly Red Brown Earths, Type RB3. Information regarding soil profiles for nearby sites has not been investigated.

 continued…………/-

FOUNDATION PREPARATION

First, clear all vegetation and any topsoil containing organic matter from the area to be occupied by the proposed building and surrounding paving. Ensure that surface water is drained away from this area.

Excavate and fill, as indicated on the Site Drainage drawing, to the nominated bench level. Fill shall be placed in accordance with the Specification. Note that any integral piers required, as shown on the footing plan have been determined based on the bench level noted. Any variation to this level shall be referred to the Engineer for review of the footing design.

Excavate trenches for the footing beams. Note that external footings shall be founded a minimum of 300 mm below existing or finished ground level, whichever is the lower and on natural, firm, undisturbed soil. Any external footings adjacent a site boundary shall be founded 600 mm below the original natural ground level. Internal footings shall be founded on firm undisturbed soil. It may be necessary in some circumstances to increase the specified footing depth to achieve this.

If the soils exposed during the excavation process appear to vary from that described in the borehole logs, stop work and seek further instructions from the Engineer.

Blind the quarry rubble with a thin sand layer to protect the underfloor membrane.

The Engineer shall carry out a site inspection at completion of excavation for footings (before covering the ground with the specified damp proof membrane).

Provide any specified white ant treatment to the foundation soils.

Place the specified underfloor damp proof membrane.

FOOTING SPECIFICATION

Footings shall be constructed strictly in accordance with the attached footing plan, general details and specification.

Footing sizes shall be of the minimum dimensions indicated on the drawings.

The Engineer shall carry out a site inspection at completion of reinforcement fixing and prior to commencement of pouring of concrete.

 continued…………/-

NOTES

1. The basis of the design of these footings as required by regulation, aims to provide performance characteristics under a combination of Dead Load, Live Load and Foundation Movement, to achieve acceptable probabilities of serviceability and safety during a 50 year design life for the building.

   Some walls may crack even though the footing system has performed its design task and are generally expected to experience Category 0 - 1 damage. Refer to Appendix C of Australian Standard AS 2870-2011, re-printed in the CSIRO information sheet attached hereto for a description of the damage categories. Category 2 damage could be expected to occur under some conditions for the occasional building.

   For these categories of damage, it is the intention of the regulations that consequent repairs are part of normal maintenance and are therefore the responsibility of the owner.

2. No new **tree** shall be allowed to grow closer to the building than a distance equal to its mature height.

   THESE FOOTINGS HAVE NOT BEEN DESIGNED FOR TREE EFFECTS

   We have considered existing trees in the vicinity of the proposed dwelling and have determined that those trees are beyond the zone of influence on the design soil swell.

3. Care shall be taken to reduce the risk of **leaks in plumbing** and drainage pipes near the footings by implementing the following measures:

   - Where any pipe penetrates footing beams, provide 40 mm closed cell polyethylene lagging.
   - Where sewer or stormwater drainage pipes penetrate perimeter footing beams, approved flexible connections shall be provided in the pipework, on the outside of the building, within 300 mm of the face of the beam.

4. **Backfilling where service trenches pass under footings** shall be with 4% cement treated quarry rubble, placed in layers and compacted to 95 % Modified Compaction, determined in accordance with AS1289.5.2.1 and the attached Specification. This shall extend for one metre inside and one metre outside the building line. This work is required to prevent moisture entering the underfloor zone via a service trench and possibly inducing extreme soil heave beneath the building.

5. **Ground slab areas**, which are to be covered with **ceramic tiles** within six to ten weeks of pouring the concrete, require heavier fabric reinforcement. Use either one layer of RF92, or two layers of RF72 in the top face of these slab areas. Other options are available to limit transfer of concrete shrinkage cracks into floor tile finishes. Please refer to this office for further details.

 continued…………/-

6. **Crack control joints** shall be incorporated in walls at the locations shown on the footing plan.

   Construction for joints in masonry shall be in accordance with Articulation Detail Sheet attached and be in accordance with the requirements of the Building Code of Australia and the recommendations of Technical Note 61 published by the Cement and Concrete Association of Australia.

   Construction for joints in lightweight sheet claddings shall be in accordance with the manufacturers' technical details.

7. It is recommended that **impervious paving** should be constructed round the perimeter of the building as described in the Specification, prior to practical completion of the building.

8. **Stormwater** from roofs and paving must be conveyed in properly jointed pipes to the street drainage system.

signed

Dean Iuliano ***BE MIEAust CPEng***

ATTACHMENTS TO THIS REPORT

SOILS

SPK Geodrill Drilling Record and Site Plan

Borehole Logs & Site Soil Classification

SITEWORK AND DRAINAGE

Site and Drainage Plan	**- drawing No. C01 (A3 size)**
Standard Detail Sheets	
Plumbing through footings	**- SD-PLBG1, SD-PLBG 2, SD-PLBG 3 (1/07/99)**
Perimeter Paving	**- SD-PAVING 1 (1/07/99)**

FOOTINGS

Footing Layout Plan & Details	**- drawing No. S01 (A3 size)**
Footing Details	**- drawing No. S02 (A4 size)**
Standard Detail Sheets	
Conventional Beam Section	**- SD-RAFT1, SD-RAFT2 (1/07/99)**
Strip Beam Section	**- SD-STRIP 1 (13/12/99)**

SUPERSTRUCTURE ELEMENTS

Steel Lintel Plan	**- drawing No. S03 (A3 size)**
Earthquake Assessment	
Standard Detail Sheets	
Articulation	**- SD-WALJNTS 1 (1/07/99)**

SPECIFICATION

COUNCIL SUBMISSION COPY

Calculations

OWNER'S COPY

CSIRO Information Sheet BTF18

"Guide to Home Owners on Foundations Maintenance and Footing Performance".

Calculations

SOILS

GEODRILL

ENGINEER:	Juliano
JOB NO.:	ATH 3836-1

SITE INFORMATION							
NEW STRUCT.	✓	ADDITION		S/ POOL		OTHER	
HYDRAULIC	✓	PUSH TUBE	✓	HYD HAMMER	✓	AUGER	
HAND GEAR		ENVIRON					

AUGER USED FROM										
START ROCK DEPTH										
END ROCK DEPTH										
CORES	1	2	3	4	5	6	7	8	9	10
DEPTH	2100	3	2100	2100	3	3				
RESISTANCE										
LOW	✓	✓	✓	✓	✓	✓				
MEDIUM	✓	✓	✓	✓						
HIGH	✓	✓	✓	✓						
WATER TABLE	—	—	—	—	—	—				
CORE RECOVERY										
100%	✓	✓	✓	✓	✓	✓				
LOSS	—	—	—	—	—	—				
STRETCHED	—	—	—	—	—	—				

SURFACE	DRY	MOIST ✓	WET ✓	
SOIL STRENGTH	HARD	FIRM ✓	SOFT ✓	LOOSE
VEGETATION	GRASS ✓	TREES	GRAVEL	PAVED
CRACKING	YES	NO ✓		

UNUSUAL FEATURES – SHOW ON LOCATION MAP

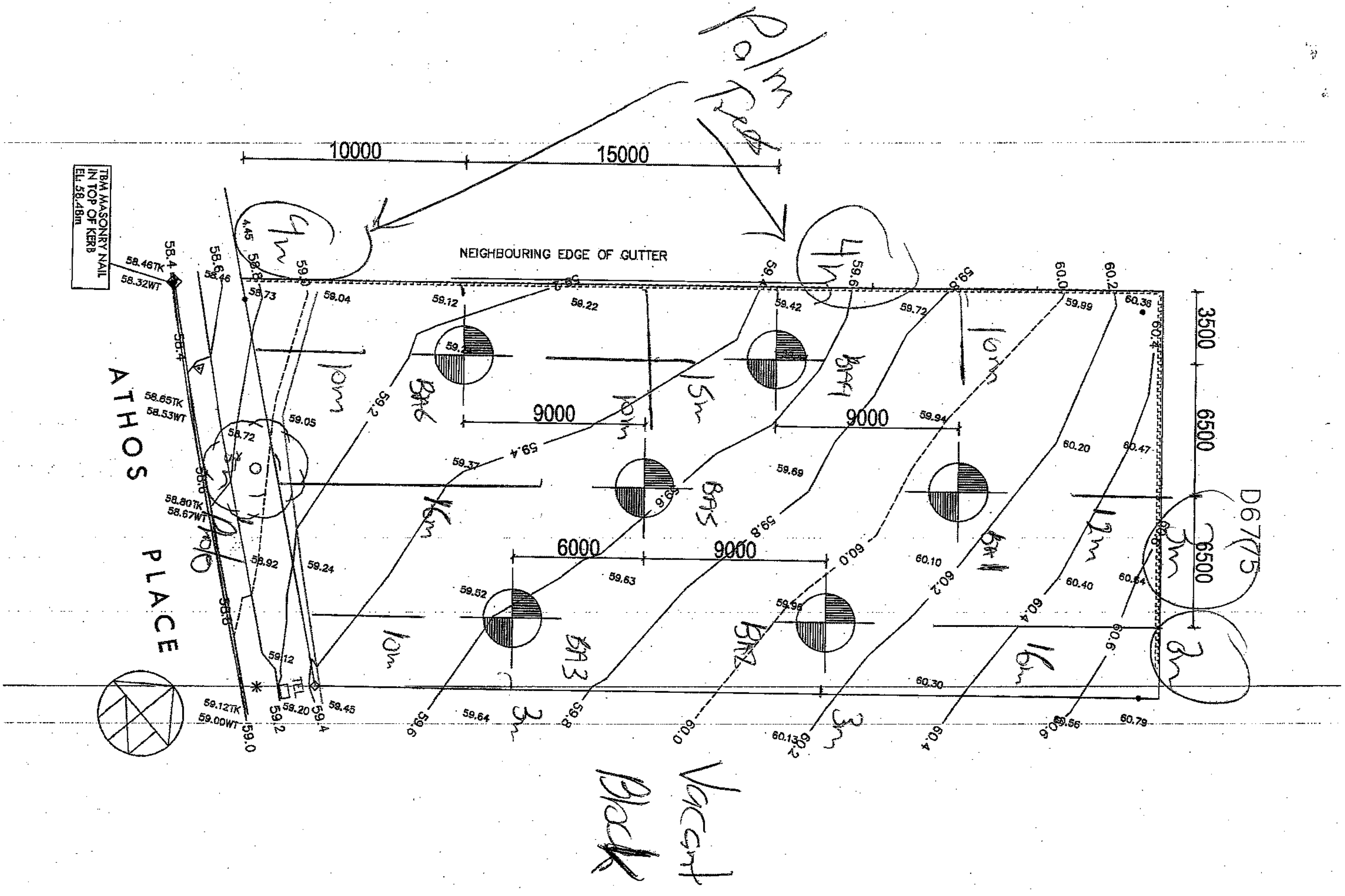
HEAPS OF FILLING	YES ?	NO ✓
ROCK OUTCROPS	YES	NO ✓
PITS	YES	NO ✓
EXCAVATIONS	YES	NO ✓
DRAINAGE CHANNELS	YES	NO ✓
OTHER (specify if yes)		
SLOPE	LEVEL ✓	FALL

CRACKING IN EXISTING BUILDING	YES	NO ✓
BUILDING LOCATED WITHIN 600mm OF BUILDING	YES	NO ✓
LARGE TREES ON BLOCKS BORDERING SITE IN QUESTION. SHOW ON LOCATION MAP IF YES	YES ✓	NO

REMARKS:

DRILLERS INITIALS	**UNIT NO**	**DATE DRILLED**
DL	2	14/8/1[illegible]

SPK Geodrill Ph: 8186 3690 Fax: 8326 4471 Email: sales@geodrill.com.au


TBM MASONRY NAIL
IN TOP OF KERB
EL. 58.48m
ATHOS PLACE
NEIGHBOURING EDGE OF GUTTER
10000
15000
9000
9000
6000
9000
3500
6500
6500
TEL
D67/75
Palm Tree
Vacant Block

NEW DWELLING

5 ATHOS PLACE PARADISE SA
S TATARELLI

sheet no: BORE 1
file ref: ATH3836-1
date drilled: 14/08/2018
logged by: Fred Enever & Assoc.

BORE 1	Soil Description	Texture	Colour	Field Moisture Content	Reactivity	Ipt (%)	Bearing	Unified Soil Classifictn	Thickness of Soil Layer (mm)	Δ pF	Ys (mm)	Δ pF WITH TREE (Single)	Ys WITH TREE (Single)
0										1.20		1.20	
	CLAY Silty	Firm	Dark Brown	-	-	2.2	Medium	CL CH	150	1.18	3.9	0.01	0.0
150													
	CLAY Silty	Stiff	Red Brown	at **PL**	Low Moderate	3.5	Medium	CH	350	1.10	13.5	0.03	0.4
500													
	CLAY Silty Calcareous	Very Firm	Light Brown Mottled	Damp	High	2.5	Medium	CL CH	500	0.98	12.2	0.08	1.0
1000													
	CLAY Silty Calcareous	Hard	Brown / Cream Mottled	<< **PL**	High	3.0	Medium	CH	850	0.77	19.7	0.15	3.9
1850													
	CLAY Silty Calcareous abundant Quartz Gravels	Hard	Light Brown Mottled	≤ **PL**	High	3.0	Medium	CH GP	250	0.61	4.6	0.21	1.6
2100	***REFUSAL (GRAVELS)***												
						3.0			1900	0.29	16.2	0.33	18.7
4000										0.00		0.43	

Note: **PL** = Plastic Limit

Tree Height HT = 10.0
Distance of tree to building D_t = 5.0
Tree Influence Distance D_i = 10.0

Soil Classification: **Class H2-D**

Design for trees? **No** y_s = 70.1 y_t = 0.0

Design differential mound movement, y_m = 0.7 x y_s = **49.1** + y_t = **49.1**

NEW DWELLING

5 ATHOS PLACE PARADISE SA
S TATARELLI

sheet no: BORE 2
file ref: ATH3836-1
date drilled: 14/08/2018
logged by: Fred Enever & Assoc.

BORE 2	Soil Description	Texture	Colour	Field Moisture Content	Reactivity	Ipt (%)	Bearing	Unified Soil Classifictn	Thickness of Soil Layer (mm)	Δ pF	Ys (mm)	Δ pF WITH TREE (Single)	Ys WITH TREE (Single)
0										1.20		1.20	
	CLAY Silty	Firm	Dark Brown	-	-	2.2	Medium	CL CH	150	1.18	3.9	0.01	0.0
150													
	CLAY Silty	Stiff	Red Brown	at PL	Low Moderate	3.5	Medium	CH	450	1.09	17.1	0.04	0.6
600													
	CLAY Silty Calcareous	Very Firm	Light Brown Mottled	Damp	High	2.5	Medium	CL CH	300	0.98	7.3	0.08	0.6
900													
	CLAY Silty Calcareous	Hard	Brown / Cream Mottled	<< PL	High	3.0	Medium	CH	1300	0.74	28.7	0.17	6.5
2200													
	CLAY Silty Sandy Calcareous appreciable Limestone Gravels	Very Firm	Brown / Light Brown Mottled	Damp	High	3.0	Medium	CH	800	0.42	10.1	0.28	6.7
3000													
						3.0			1000	0.15	4.5	0.38	11.3
4000										0.00		0.43	

Note: **PL** = Plastic Limit

Tree Height	HT =	10.0
Distance of tree to building	D_t =	5.0
Tree Influence Distance	D_i =	10.0

Soil Classification: **Class H2-D**

Design for trees? **No** y_s = 71.6 y_t = 0.0

Design differential mound movement, y_m = 0.7 x y_s = **50.1** + y_t = **50.1**

NEW DWELLING

5 ATHOS PLACE PARADISE SA
S TATARELLI

sheet no: BORE 3
file ref: ATH3836-1
date drilled: 14/08/2018
logged by: Fred Enever & Assoc.

BORE 3	Soil Description	Texture	Colour	Field Moisture Content	Reactivity	Ipt (%)	Bearing	Unified Soil Classifictn	Thickness of Soil Layer (mm)	Δ pF	Ys (mm)	Δ pF WITH TREE (Single)	Ys WITH TREE (Single)
0										1.20		1.20	
	CLAY Silty	Firm	Dark Brown	-	-	2.2	Medium	CL CH	100	1.19	2.6	0.01	0.0
100													
	CLAY Silty	Stiff	Red Brown	at PL	Low Moderate	3.5	Medium	CH	700	1.07	26.1	0.05	1.2
800													
	CLAY Silty Calcareous	Very Firm	Light Brown Mottled	Damp	High	2.5	Medium	CL CH	450	0.89	10.0	0.11	1.2
1250													
	CLAY Silty Sandy appreciable Gravels	Hard	Red Brown Mottled	Damp	High	3.0	Medium	CH	850	0.70	17.8	0.18	4.6
2100	***REFUSAL (GRAVELS***												
						3.0			1900	0.29	16.2	0.33	18.7
4000										0.00		0.43	

Note: PL = Plastic Limit

Tree Height HT = 10.0
Distance of tree to building D_t = 5.0
Tree Influence Distance D_i = 10.0

Soil Classification: **Class H2-D**

Design for trees? **No** y_s = 72.8 y_t = 0.0

Design differential mound movement, y_m = 0.7 x y_s = **50.9** + y_t = **50.9**

NEW DWELLING

5 ATHOS PLACE PARADISE SA
S TATARELLI

sheet no: BORE 4
file ref: ATH3836-1
date drilled: 14/08/2018
logged by: Fred Enever & Assoc.

BORE 4	Soil Description	Texture	Colour	Field Moisture Content	Reactivity	Ipt (%)	Bearing	Unified Soil Classifictn	Thickness of Soil Layer (mm)	Δ pF	Ys (mm)	Δ pF WITH TREE (Single)	Ys WITH TREE (Single)
0										1.20		1.20	
	CLAY Silty	Firm	Dark Brown	-	-	2.2	Medium	CL CH	50	1.19	1.3	0.00	0.0
50													
	CLAY Silty	Stiff	Red Brown	at PL	Low Moderate	3.5	Medium	CH	350	1.13	13.9	0.02	0.3
400													
	CLAY Silty Calcareous	Very Firm	Light Brown Mottled	Damp	High	2.5	Medium	CL CH	1100	0.92	25.2	0.10	2.8
1500													
	CLAY Silty Sandy Calcareous appreciable Limestone Gravels	Very Firm	Brown / Light Brown Mottled	Damp	High	3.0	Medium	CH	300	0.71	6.3	0.18	1.6
1800													
	CLAY Silty Sandy appreciable Gravels	Hard	Red Brown Mottled	Damp	High	3.0	Medium	CH	300	0.62	5.5	0.21	1.9
2100	***REFUSAL (GRAVELS***												
						3.0			1900	0.29	16.2	0.33	18.7
4000										0.00		0.43	

Note: PL = Plastic Limit

Tree Height HT = 10.0
Distance of tree to building D_t = 5.0
Tree Influence Distance D_i = 10.0

Soil Classification: **Class H2-D**

Design for trees? **No** y_s = 68.5 y_t = 0.0

Design differential mound movement, $y_m = 0.7 \times y_s$ = **47.9** $+ y_t$ = **47.9**

NEW DWELLING

5 ATHOS PLACE PARADISE SA
S TATARELLI

sheet no: BORE 5
file ref: ATH3836-1
date drilled: 14/08/2018
logged by: Fred Enever & Assoc.

BORE 5	Soil Description	Texture	Colour	Field Moisture Content	Reactivity	Ipt (%)	Bearing	Unified Soil Classifictn	Thickness of Soil Layer (mm)	Δ pF	Ys (mm)	Δ pF	Ys
												WITH TREE (Single)	
0										1.20		1.20	
	CLAY Silty	Very Stiff	Red Brown	< PL	High	3.5	Medium	CH	600	1.11	23.3	0.03	0.7
600													
	CLAY Silty Calcareous abundant Limestone Gravels	Very Firm	Cream	Damp	Moderate	2.0	Medium	CL GP	1000	0.87	17.4	0.12	2.4
1600													
	CLAY Silty Sandy abundant Gravels	Firm	Brown Mottled	Damp	Low Moderate	1.5	Medium	CL GP	1000	0.57	8.6	0.23	3.4
2600													
	CLAY Silty Calcareous appreciable Gravels	Hard	Brown / Light Brown Mottled	Damp	Moderate High	2.5	Medium	CL CH	400	0.36	3.6	0.30	3.0
3000													
						2.5			1000	0.15	3.8	0.38	9.4
4000										0.00		0.43	

Note: PL = Plastic Limit

Tree Height HT = 10.0
Distance of tree to building D_t = 5.0
Tree Influence Distance D_i = 10.0

Soil Classification: **BORES 1, 2, 3, 4 & 6 CRITICAL**

Design for trees? **No** y_s = 56.6 y_t = 0.0

Design differential mound movement, y_m = 0.7 x y_s = **39.6** + y_t = **39.6**

Dean Iuliano & Company CONSULTING STRUCTURAL & CIVIL ENGINEERS

NEW DWELLING

5 ATHOS PLACE PARADISE SA
S TATARELLI

sheet no: BORE 6
file ref: ATH3836-1
date drilled: 14/08/2018
logged by: Fred Enever & Assoc.

BORE 6	Soil Description	Texture	Colour	Field Moisture Content	Reactivity	Ipt (%)	Bearing	Unified Soil Classifictn	Thickness of Soil Layer (mm)	Δ pF	Ys (mm)	Δ pF WITH TREE (Single)	Ys WITH TREE (Single)
0										1.20		1.20	
	CLAY Silty	Firm	Dark Brown	at PL	Moderate High	2.2	Medium	CL CH	150	1.18	3.9	0.01	0.0
150													
	CLAY Silty	Very Stiff	Red Brown	< PL	High	3.5	Medium	CH	800	1.04	29.0	0.06	1.7
950													
	CLAY Silty Calcareous	Hard	Red Brown Cream Patches	Damp	High	3.0	Medium	CH	1450	0.70	30.3	0.18	7.8
2400													
	CLAY Silty Calcareous appreciable Gravels	Hard	Brown / Light Brown Mottled	Damp	Moderate High	2.5	Medium	CL CH	600	0.39	5.9	0.29	4.4
3000													
						2.5			1000	0.15	3.8	0.38	9.4
4000										0.00		0.43	

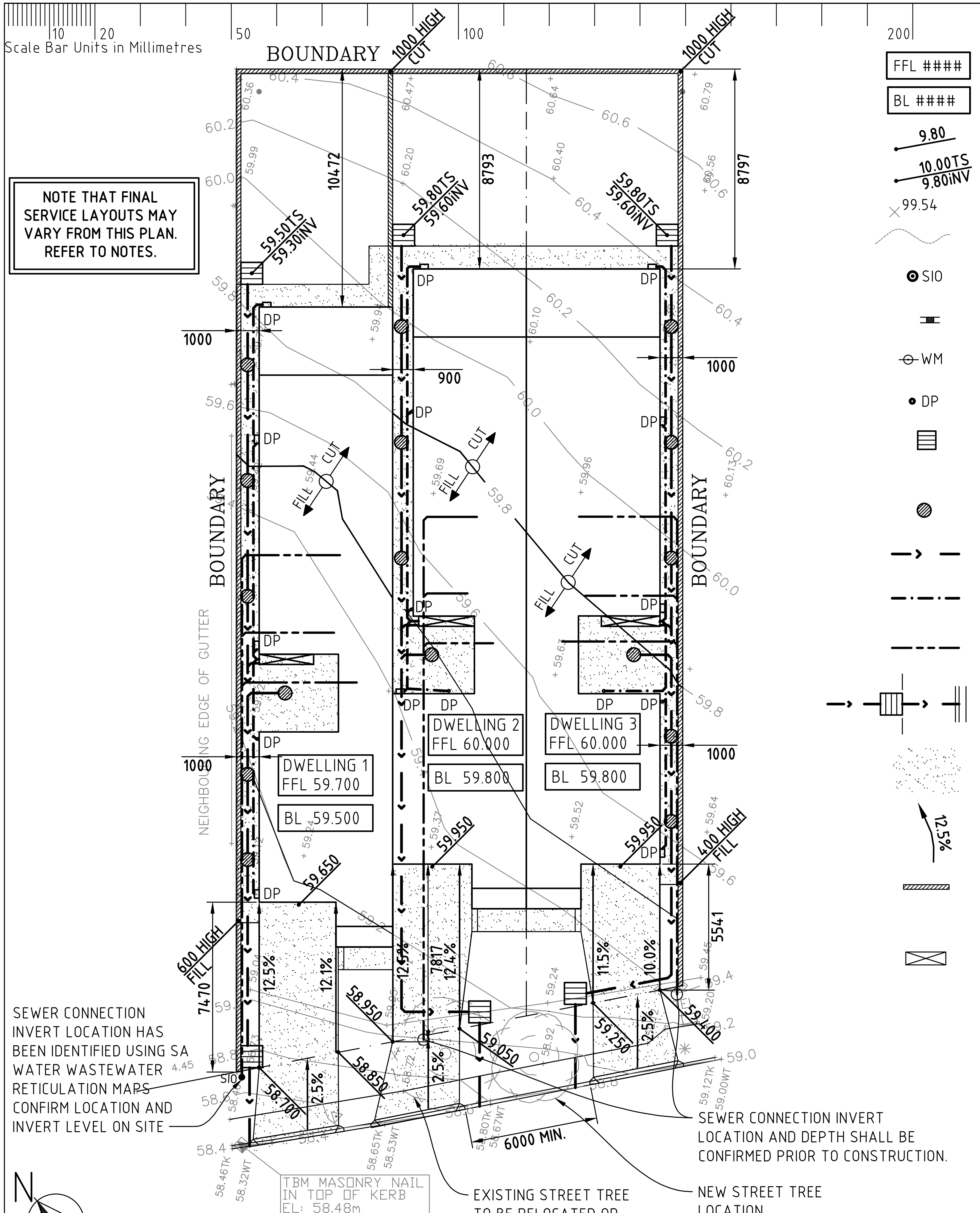
Note: **PL** = Plastic Limit

Tree Height	HT =	10.0
Distance of tree to building	D_t =	5.0
Tree Influence Distance	D_i =	10.0

Soil Classification: **Class H2-D**   Design for trees? **No** y_s = 72.8 y_t = 0.0

Design differential mound movement, y_m = 0.7 x y_s = **51.0**   + y_t = **51.0**

SITEWORKS AND DRAINAGE



PLAN - SITE & DRAINAGE
1:200

LEGEND

- FFL #### — FLOOR LEVEL
- BL #### — BENCH LEVEL
- 9.80 — NEW PAVING LEVELS (TM - TO MATCH)
- 10.00TS / 9.80INV — TOP OF SUMP & PIPE INVERT LEVELS
- ×99.54 — EXISTING SITE LEVELS
- EXISTING CONTOUR
- SIO — SEWER INSPECTION OPENING
- STOBIE POLE
- WM — WATER METER
- DP — DOWNPIPE
- GRATED SUMP 350×350 PROPRIETARY PLASTIC SUMP LIGHT DUTY GRATED COVER
- 90ø GRATED INLET PIT
- STORMWATER PIPE 90Ø P.V.C. (MIN FALL 1:100)
- STORMWATER PIPE 100Ø P.V.C. (SEALED WET SYSTEM)
- SEWER PIPE (MIN FALL 1:60)
- BOUNDARY SUMP AND STORMWATER PIPE FOOTPATH CROSSOVER TO COUNCIL REQUIREMENTS
- PAVING EXTENT
- 12.5% — PAVING RISE DIRECTION & GRADE
- SELECTED RETAINING WALL TO RETAIN MAXIMUM 1000mm OF CUT/FILL MAXIMUM WALL HEIGHTS SHOWN ON PLAN
- MIN. 3000L CAPACITY RAINWATER TANK (1000L RETENTION + 2000L DETENTION) INSTALLED IN ACCORDANCE WITH COUNCIL GUIDELINES & GOVERNMENT SPECIFICATIONS. TANK SHALL COLLECT 100% OF THE ROOF AREA AND SHALL DISCHARGE TO THE STREET WATER TABLE WITH A DISCHARGE RATE NOT GREATER THAN 0.7 L/s. ROOF WATER TO BE DISCHARGED VIA TANK WITHIN A SEALED WET SYSTEM.

SITE IDENTIFICATION

- THIS IS AN ENGINEERING SURVEY PLAN AND SHALL NOT BE TAKEN AS A CADASTRAL OR IDENTIFICATION SURVEY. BOUNDARY DATA SHOWN IS TO BE TAKEN AS A GUIDE ONLY. OWNER/BUILDER TO CONFIRM ALL INFORMATION REGARDING BOUNDARIES PRIOR TO CONSTRUCTION.

STORMWATER NOTES

- STORMWATER PIPE, DOWNPIPE, RAINWATER TANK AND PUMP STATION LOCATIONS RELATIVE TO THE BUILDING MAY BE ADJUSTED TO SUIT OTHER SERVICES, LANDSCAPING DESIGN AND CLIENT REQUIREMENTS PROVIDED THAT COMPLIANCE WITH AS/NZS3500.3 AND ANY COUNCIL DETENTION AND RETENTION REQUIREMENTS ARE MAINTAINED.
- FLEXIBLE CONNECTIONS FOR STORMWATER PIPES ARE REQUIRED FOR THIS SITE. PROVIDE 40mm CLOSED CELL POLYETHYLENE LAGGING..
- PROVIDE 100mm COVER TO STORM WATER PIPES UNLESS THEY ARE LIKELY TO BE SUBJECTED TO VEHICULAR LOADING, IN WHICH CASE 450mm COVER IS REQUIRED, OR ENCASE PIPE IN 100mm THICK CONCRETE.
- PROVIDE SEALED (PRESSURISED) STORM WATER SYSTEM FOR PIPES TO RAINWATER TANK.

SEWER NOTES

- FLEXIBLE CONNECTIONS FOR SEWER PIPES ARE REQUIRED FOR THIS SITE. PROVIDE 40mm CLOSED CELL POLYETHYLENE LAGGING.
- PATH LEVEL AT FLOOD GULLY TO BE A MINIMUM OF 150mm BELOW THE TOP SURFACE LEVEL OF THE SHOWER GRATE.
- THE SEWER LINE SHOWN IS INDICATIVE ONLY. THE INVERTS SHOWN HAVE BEEN PROVIDED ONLY TO DETERMINE WHETHER OR NOT ADDITIONAL PIERS TO FOOTINGS ARE REQUIRED.
- MANDATORY ALL SEWER PIPES TO BE LAID ON FIRM NATURAL GROUND.

LANDSCAPING NOTES

- THE FOOTING DESIGN HAS NOT TAKEN INTO ACCOUNT THE EFFECTS OF TREES. THEREFORE PLANTING OF LARGE TREES OR SHRUBS ADJACENT OR CLOSE TO THE PROPOSED CONSTRUCTIONS SHOULD BE AVOIDED AND LANDSCAPING SHOULD CONSIST OF LAWNS OR GARDENS WHERE SUMMER WATERING IS MAINTAINED.

Dean Iuliano & Company
Consulting Engineers structural - civil
100 Rundle Street KENT TOWN SA 5067
Tel (08) 8363 3900 Fax (08) 8127 9545
Email diuleng@bigpond.net.au

THREE NEW DWELLINGS
-
5 ATHOS PLACE PARADISE SA
SOFIA TATARELLI

AMENDMENTS

	DATE	DESCRIPTION
B	25/07/19	REDUCTION TO DWELLING FOOTPRINTS
A	12/11/18	ALTERATIONS TO COUNCIL REQUIREMENTS

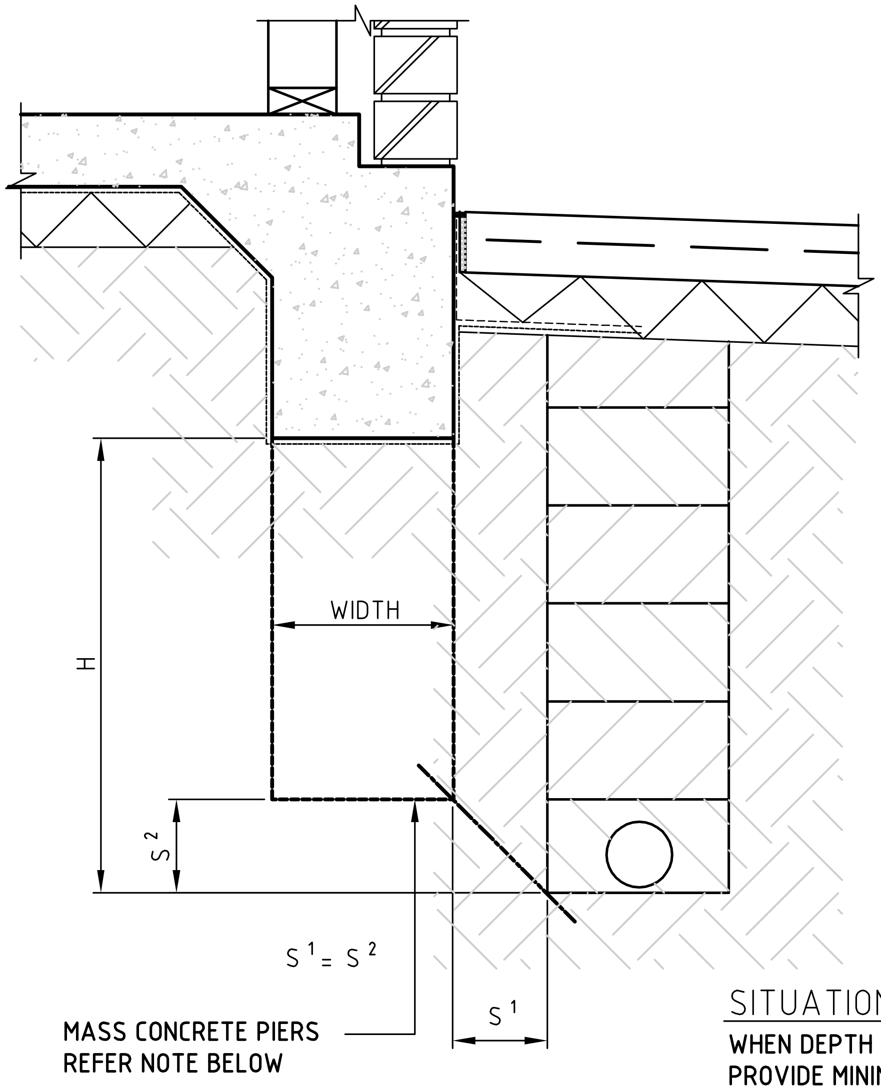
date: 16/08/18 file ref: ATH3836−1
drawn by: SR / MI sheet no: C01 rev: B A3
amended: 25/07/19

Dean Iuliano & Company

Consulting Engineers structural - civil

STANDARD FOOTING DETAILS
PLUMBING SHEET 1

SHEET NO.: SD-PLBG 1
DATE: 1/07/99
DRAWN BY: D. I.



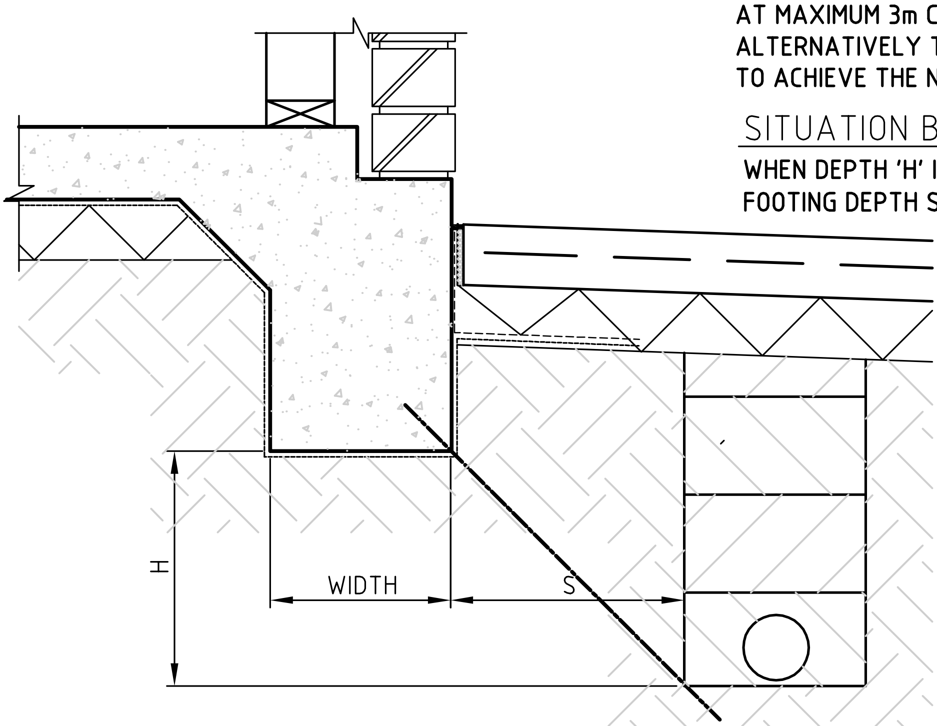
BACKFILL TRENCH WITH SANDY MATERIAL IN LAYERS NOT EXCEEDING 200mm THICK. EACH LAYER SHALL BE COMPACTED BY APPROVED METHODS TO THE SPECIFIED STANDARD BEFORE THE NEXT LAYER IS PLACED. THE BACKFILL SHALL BE FREE OF CLAY LUMPS AND BUILDING DEBRIS.

SITUATION A

WHEN DEPTH 'H' IS GREATER THAN DISTANCE 'S' PROVIDE MINIMUM 1m LONG MASS CONCRETE PIERS AT THE SAME WIDTH AS THE FOOTING BEAM AT MAXIMUM 3m CENTRES TO THE DEPTH SHOWN. ALTERNATIVELY THE BEAM DEPTH MAY BE INCREASED TO ACHIEVE THE NECESSARY FOUNDING DEPTH.

SITUATION B

WHEN DEPTH 'H' IS LESS THAN THE DISTANCE 'S' FOOTING DEPTH SPECIFIED REMAINS UNALTERED



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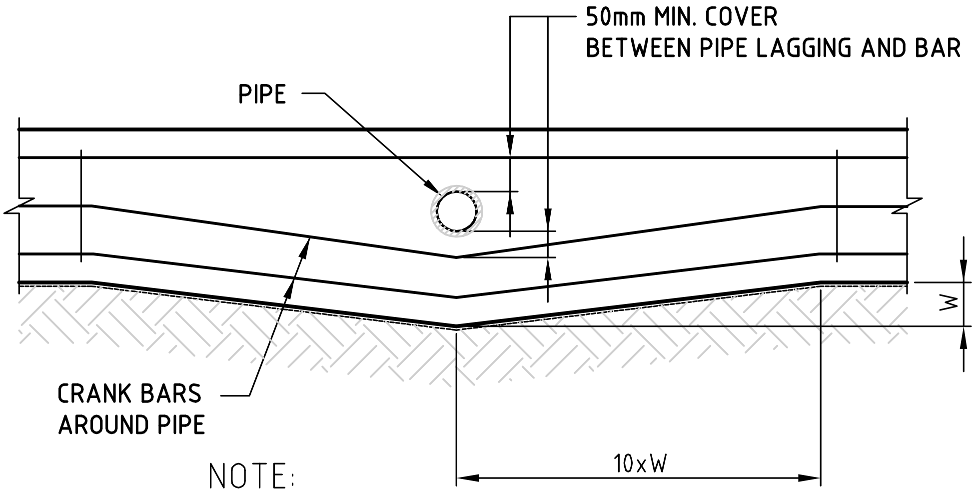
STANDARD FOOTING DETAILS
PLUMBING SHEET 2

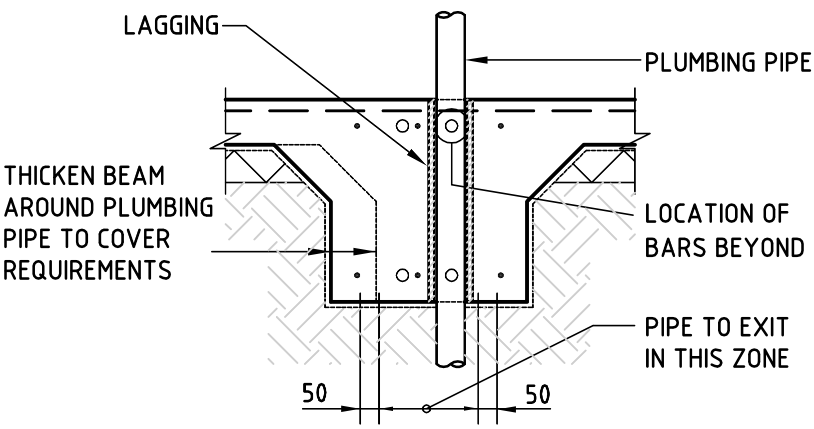
SHEET NO.: SD-PLBG 2
DATE: 1/07/99
DRAWN BY: D. I.



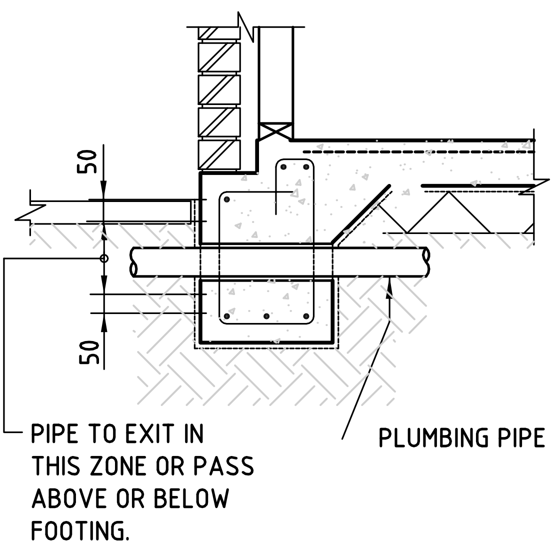
NOTE:

TYPICAL ARRANGEMENT ONLY, MAY BE MODIFIED TO SUIT PIPE LOCATION, FOOTING WIDTH AND REINFORCEMENT ARRANGEMENT SUBJECT TO ENGINEERS FINAL APPROVAL

PLAN OF FOOTING BEAM WIDENING FOR VERTICAL SERVICE PENETRATION



VERTICAL PIPE PENETRATION THROUGH FOOTING



HORIZONTAL PIPE PENETRATION THROUGH FOOTING

NOTES

1. CLOSED CELL POLYETHYLENE LAGGING SHALL BE USED AROUND ALL STORMWATER AND SEWER PIPE PENETRATIONS THROUGH FOOTINGS. THE LAGGING SHALL BE 20mm THICK ON CLASS "M" SITE AND 40mm THICK ON CLASS "H" AND "E" SITES.

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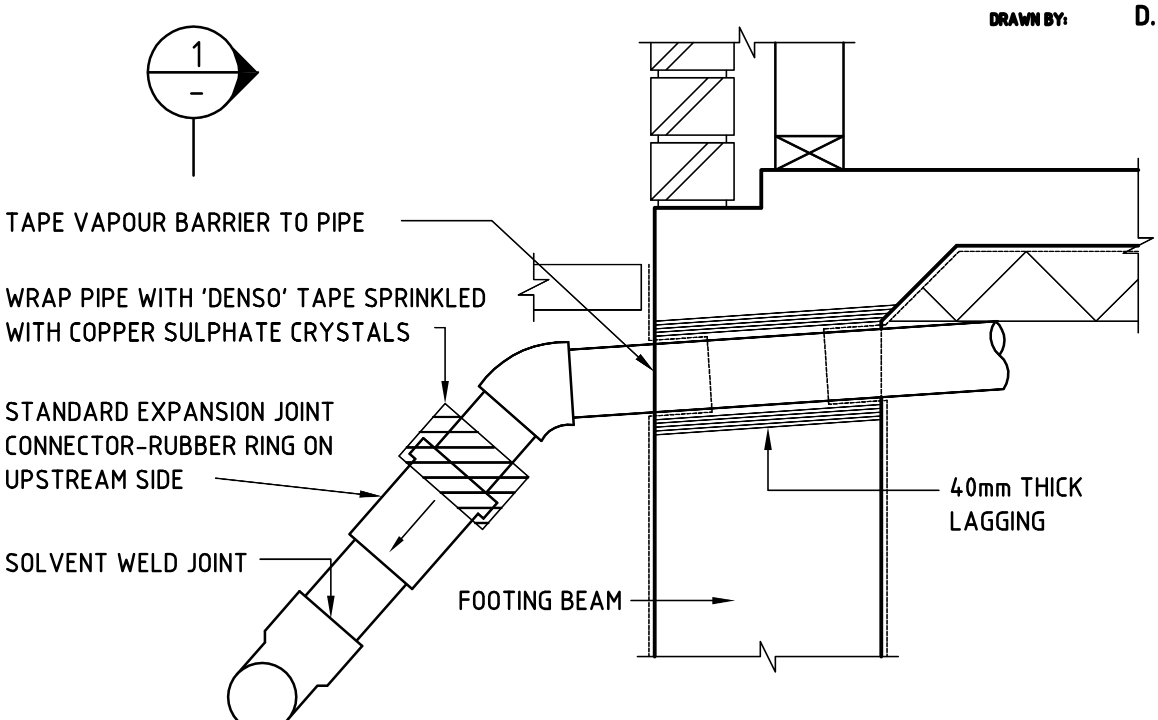
STANDARD FOOTING DETAILS
PLUMBING SHEET 3

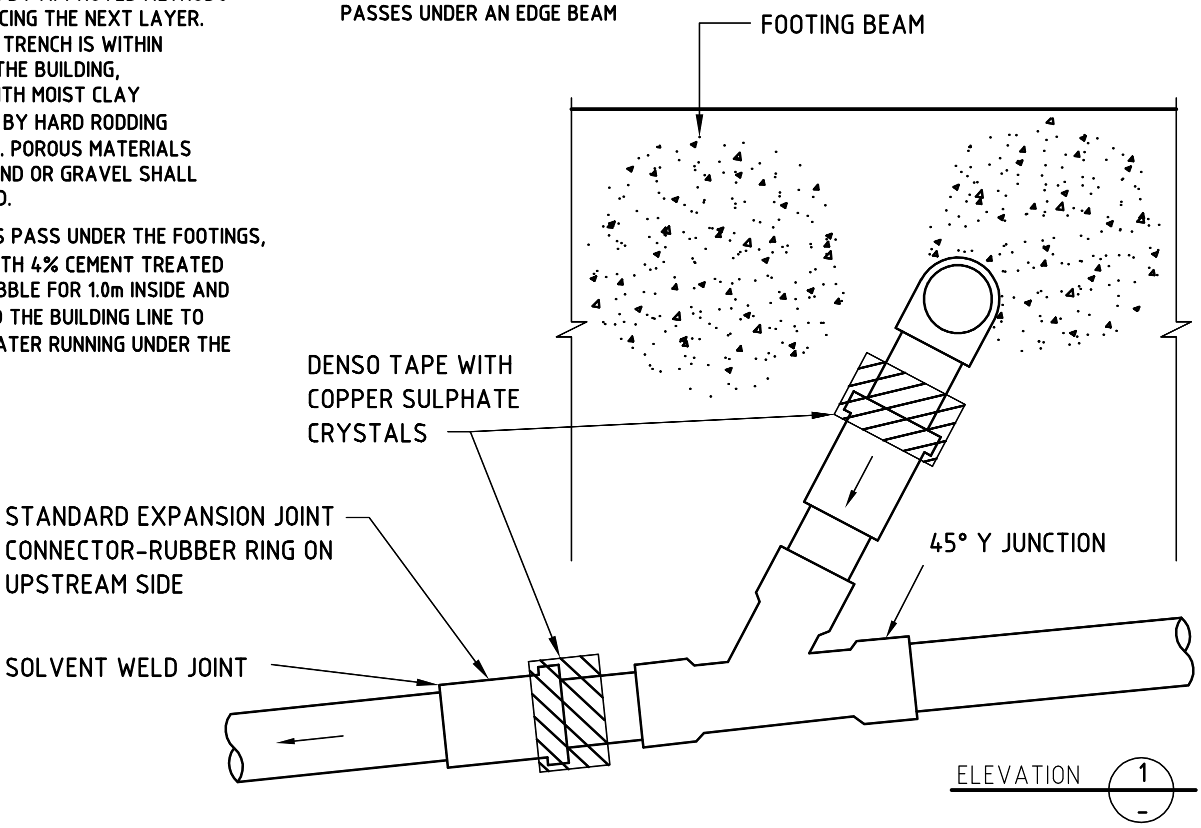
SHEET NO.: SD-PLBG 3
DATE: 1/07/99
DRAWN BY: D. I.



SECTION

NOTE:

1. ALL PLUMBING TRENCHES, FOR BOTH STORMWATER AND SEWER SHALL BE CONSTRUCTED SO THAT THE BASE SLOPES AWAY FROM THE BUILDING.
2. BACKFILL TRENCHES WITH A SUITABLE GRANULAR METRIAL IN LAYERS NOT TO EXCEED 200mm THICK. COMPACT EACH LAYER BY APPROVED METHODS BEFORE PLACING THE NEXT LAYER. WHERE ANY TRENCH IS WITHIN 2000mm OF THE BUILDING, BACKFILL WITH MOIST CLAY COMPACTED BY HARD RODDING OR TAMPING. POROUS MATERIALS SUCH AS SAND OR GRAVEL SHALL NOT BE USED.
3. WHERE PIPES PASS UNDER THE FOOTINGS, BACKFILL WITH 4% CEMENT TREATED QUARRY RUBBLE FOR 1.0m INSIDE AND 1.0m BEYOND THE BUILDING LINE TO PREVENT WATER RUNNING UNDER THE BUILDING.
4. PROVIDE THIS TYPE OF CONNECTION TO ANY SERVICE PIPE GREATER THAN 50mm DIAMETER
5. THIS DETAIL ALSO APPLIES AT THE PERIMETER OF THE BUILDING TO ANY PIPE WHICH PASSES UNDER AN EDGE BEAM



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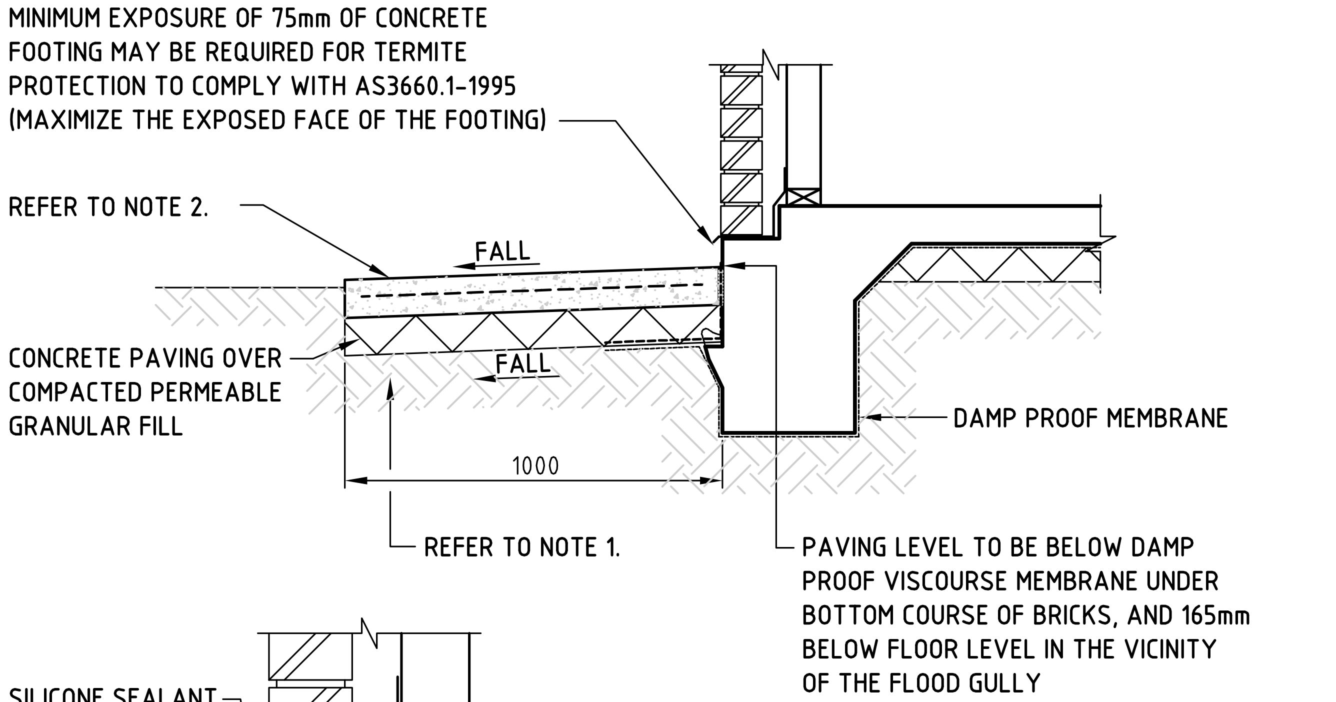
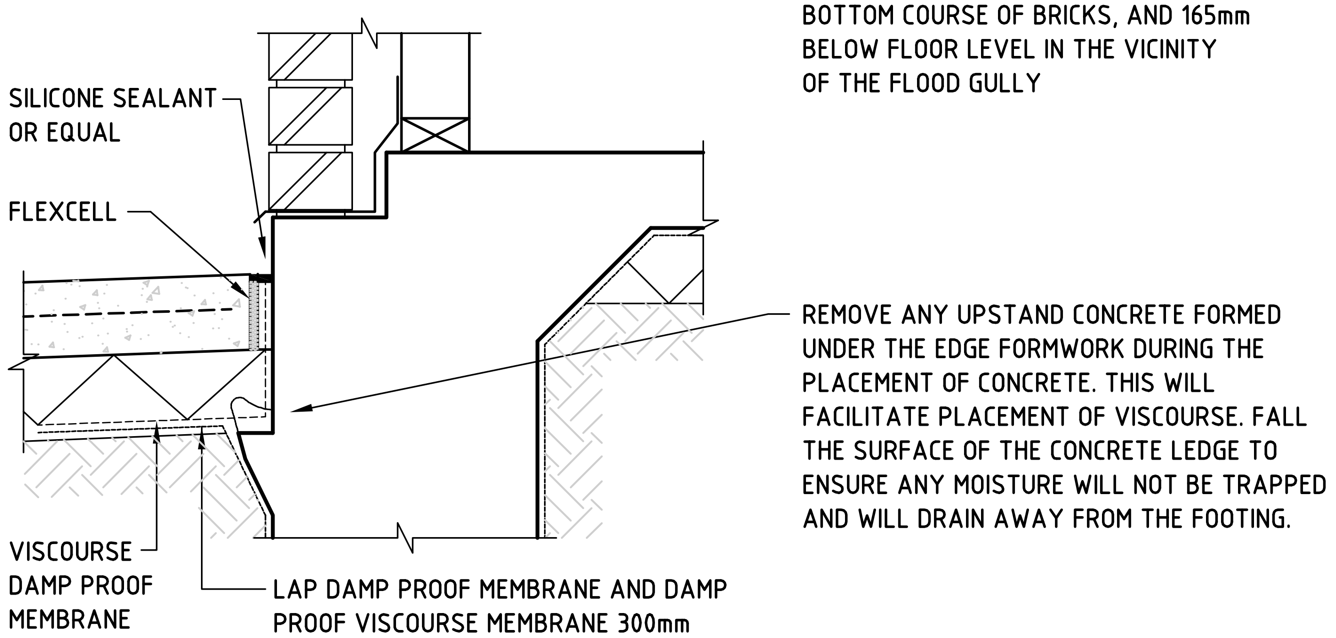
STANDARD FOOTING DETAILS
PAVINGS SHEET 1

SHEET NO.: SD-PAVING 1
DATE: 1/07/99
DRAWN BY: D. I.



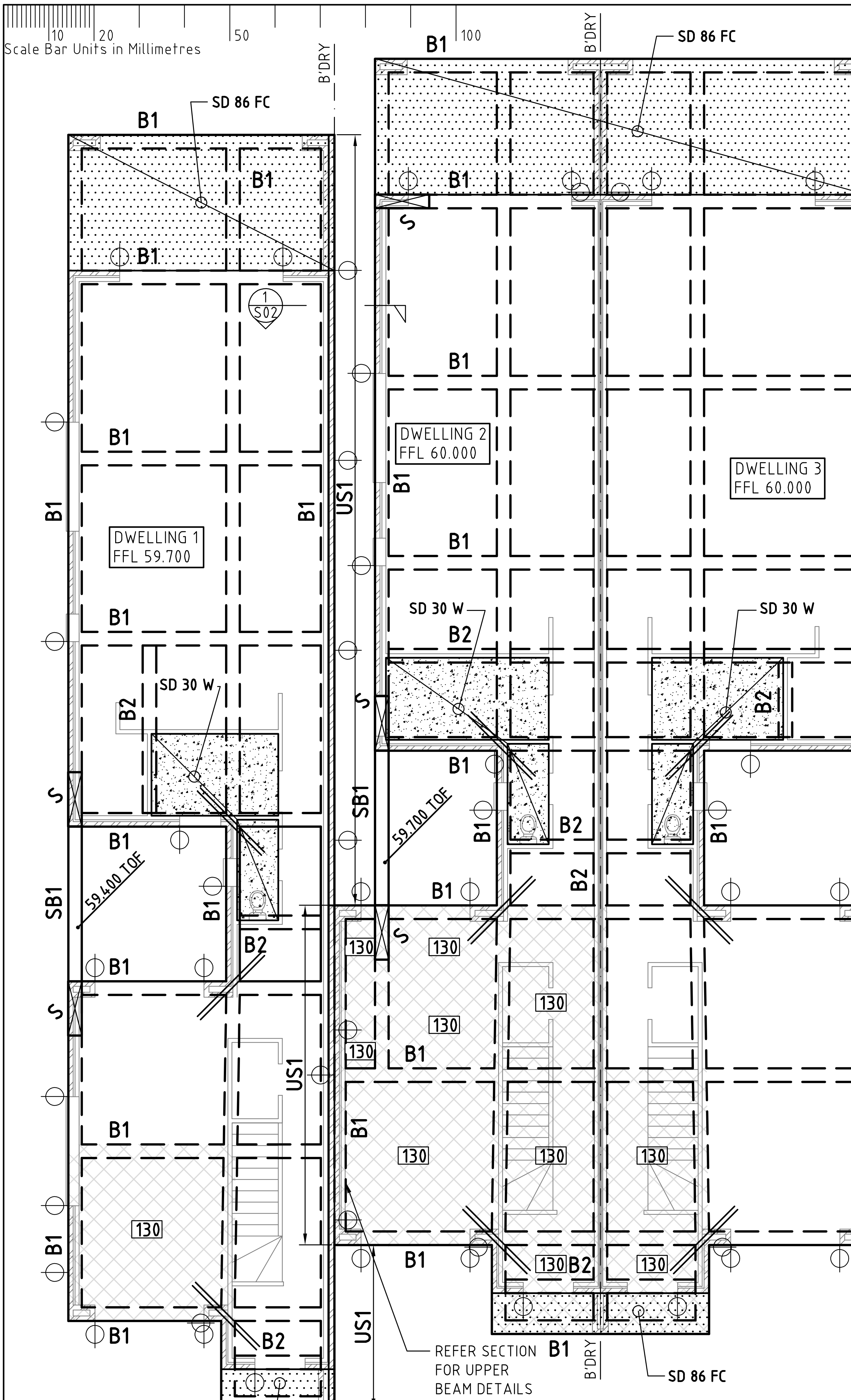


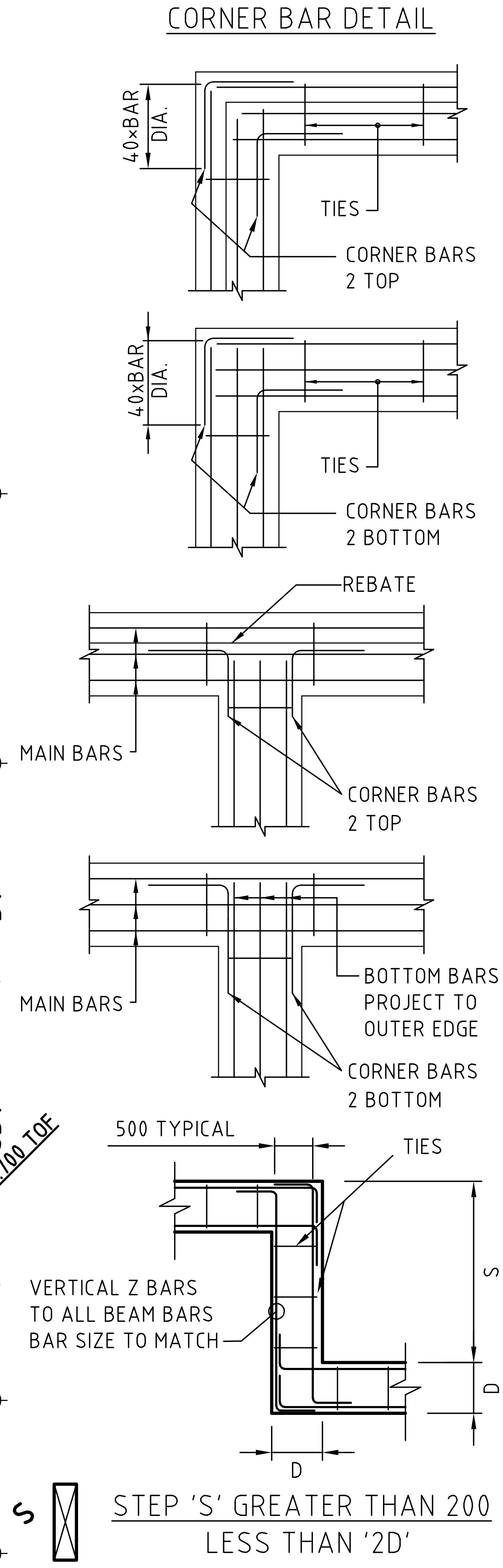
ENLARGED DETAIL

NOTE

1. BUILDER SHALL ENSURE SUBGRADE SURFACE SLOPES AWAY FROM THE FOOTING. UNDER NO CIRCUMSTANCES SHALL THE SURFACE FALL TOWARDS THE FOOTING.
2. PAVING IS TO HAVE A MINIMUM FALL OF 35mm PER 1m WIDTH AWAY FROM FOOTINGS, EXCEPT ON CLASS H AND E SITES, WHERE A MINIMUM OF 50mm PER 1m WIDTH CROSSFALL AWAY FROM FOOTINGS MUST BE PROVIDED.

FOOTINGS





S — STEP 'S' GREATER THAN 200 LESS THAN '2D'

UL — 1200 LONG UNDER-LAP OF THE LOWER FOOTING BEAM TO THE HIGHER FOOTING BEAM TYPICAL

NOTES:

1. READ THIS DRAWING TOGETHER WITH THE ARCHITECTURAL DWGS FOR ALL SET OUT DIMENSIONS
2. CONCRETE STRENGTH SHALL BE GRADE N20
3. LAPS TO REINFORCEMENT SHALL BE:
   - FABRIC — ONE FULL MESH PLUS 25mm
   - BARS — N12 - 500mm, N16 - 700mm

PLAN - FOOTINGS
1:100

100 THICK SLAB SL72 TOP 20 COVER INTEGRAL WITH BEAMS
130 — 130 THICK SLAB SL72 TOP 20 COVER SL72 BOTTOM 30 COVER INTEGRAL WITH BEAMS
SD 30 W — SETDOWN 30mm WET AREAS
SD 86 FC — SETDOWN 86mm FINISH CONCRETE
MASONRY CONTROL JOINT REFER DETAIL
2N16 BARS×2000 LONG PLACED UNDER FABRIC
RBP — 350x350 MIN. REINFORCED BRICK PIER 1N16 BAR EMBEDDED 450 INTO FOOTING BAR TO EXTEND TO TOP OF PIER FILL CORE WITH 3:1 SAND:CEMENT MORTAR

FOOTING BEAM SCHEDULE

MARK	DEPTH	WIDTH	REINFORCEMENT			COVER
			TOP	BOTTOM	TIES	
B1	750	300	3N16	3N16	W6-800	50
B2	450	300	2N16	2N16	W6-800	50
SB1	1000	300	3N16	3N16	W8-400	50

NOTE THAT THE SOIL ON THIS SITE IS CLASSIFICATION H2 - D

FLEXIBLE CONNECTIONS SHALL BE USED WHERE DRAINAGE PIPES PENETRATE PERIMETER FOOTING BEAMS

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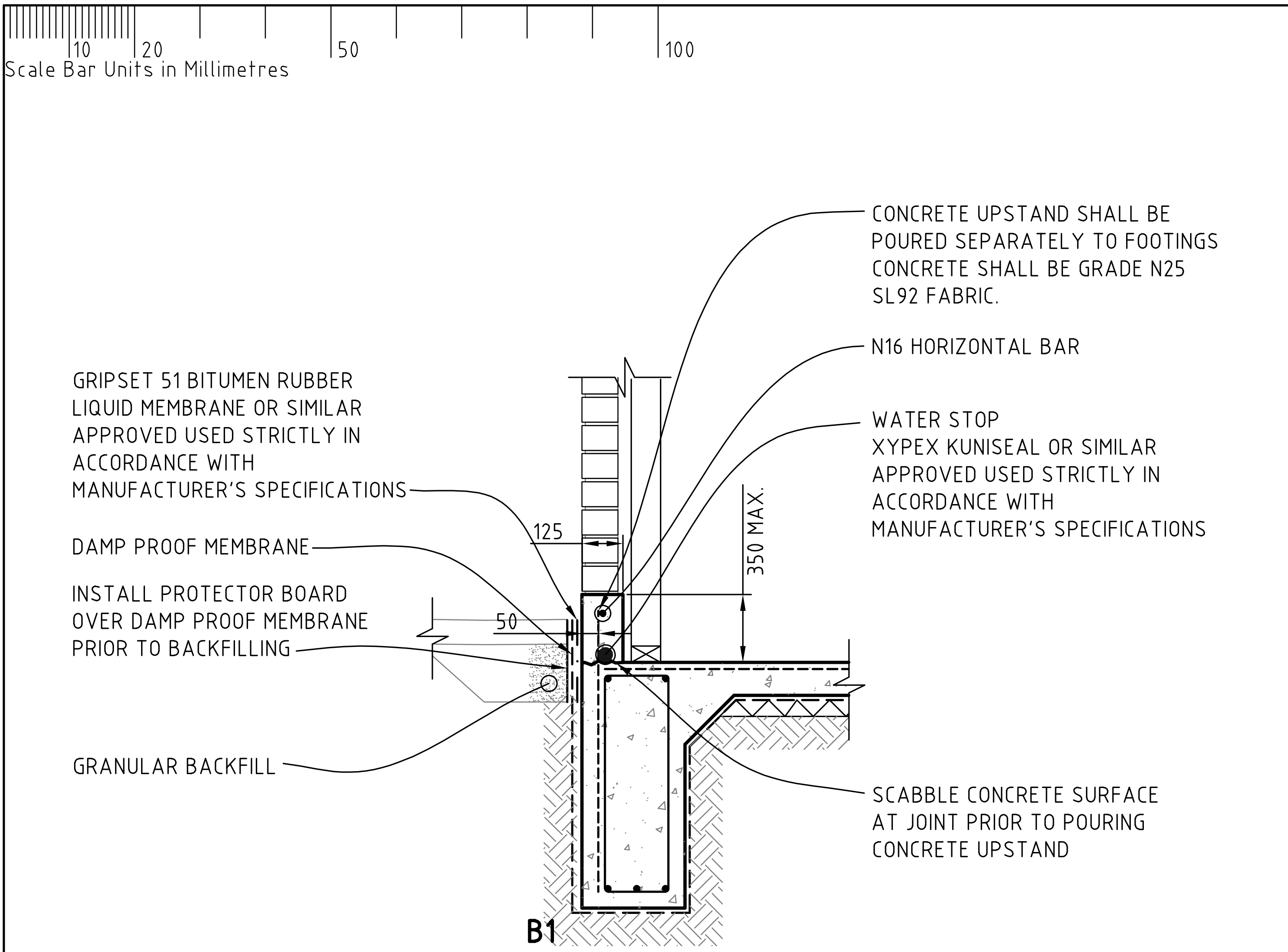
THREE NEW DWELLINGS
-
5 ATHOS PLACE PARADISE SA
SOFIA TATARELLI

drawn by: SR / MI	file ref: ATH3836-1		
design by: MI	sheet no: S01	rev: A	A3
checked by: DI			
date: 25/07/19		amended: 31/08/19	

Scale Bar Units in Millimetres



SECTION 1 UPSTAND SLAB (US1)
1:20 S01

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THREE NEW DWELLINGS
-
5 ATHOS PLACE PARADISE SA
SOFIA TATARELLI

date: 25/07/19 file ref: ATH3836-1
drawn by: MI/SR sheet no: S02 rev: A A4
amended: 31/08/19

Dean Iuliano & Company

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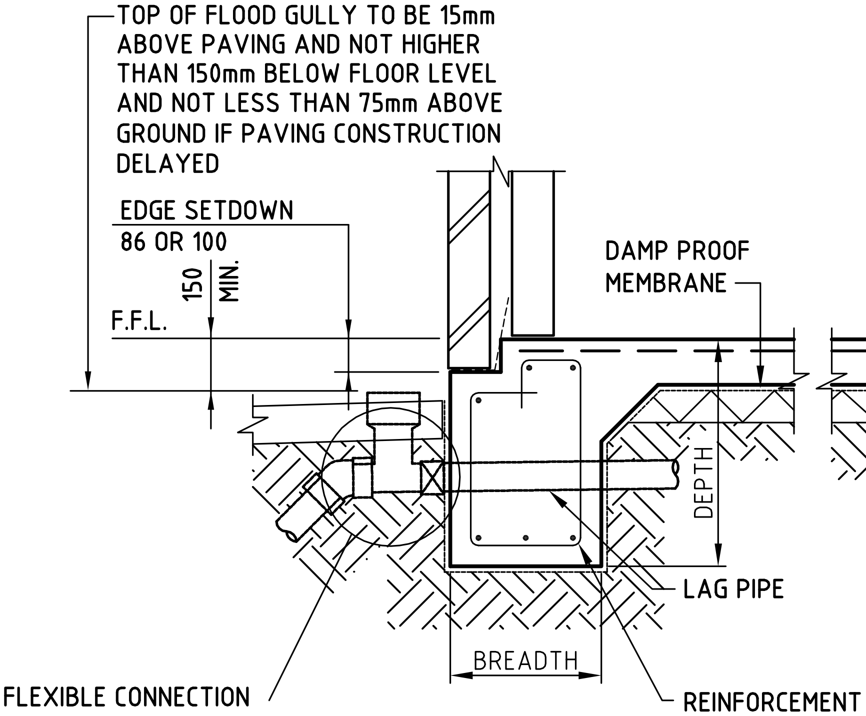
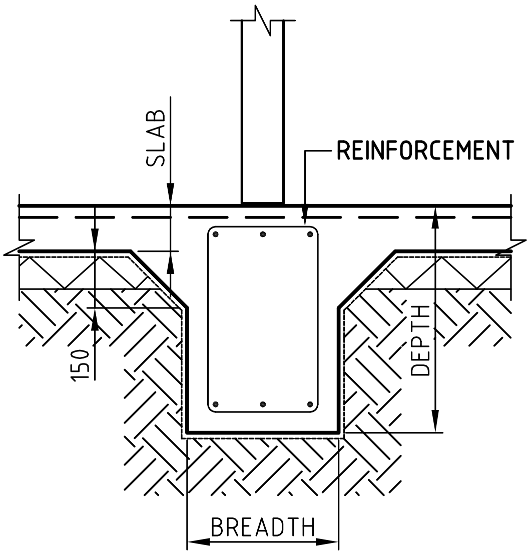
STANDARD FOOTING DETAILS
RAFT FOOTING SHEET 1

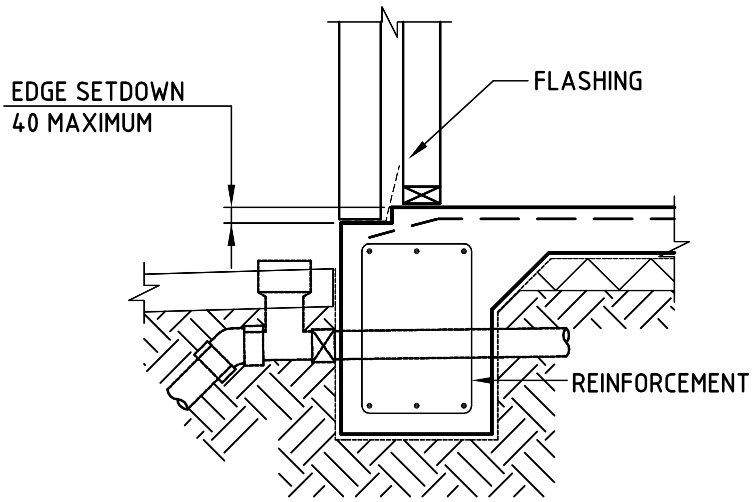
SHEET NO.: SD-RAFT 1
DATE: 1/07/99
DRAWN BY: D. I.



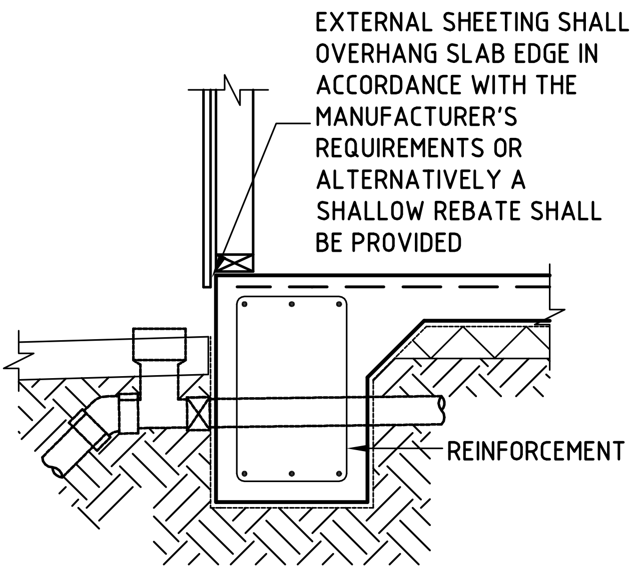
EXTERNAL
EDGE REBATE 86-100mm MAX.



INTERNAL



EXTERNAL
EDGE REBATE 40mm MAX.



EXTERNAL
EDGE REBATE NONE

CLEAR CONCRETE COVER TO REINFORCEMENT:
BEAMS 50mm
SLABS 20mm

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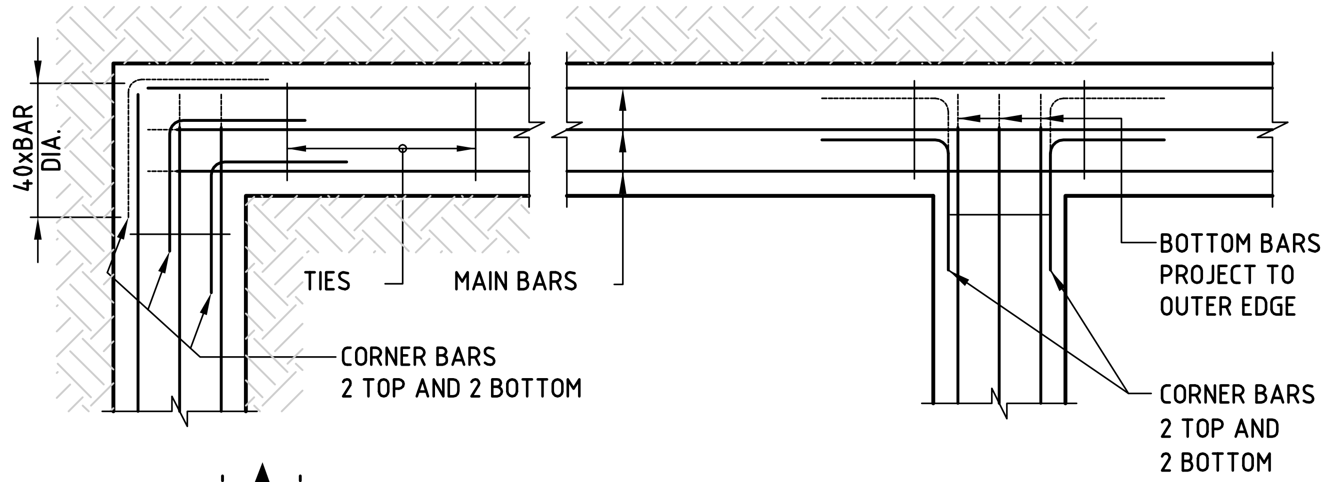
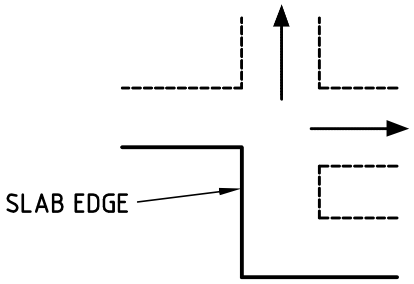
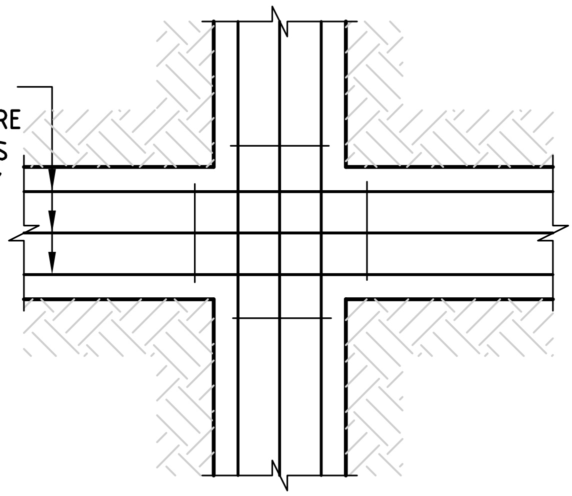
STANDARD FOOTING DETAILS
RAFT FOOTING SHEET 2

SHEET NO.: SD-RAFT 2
DATE: 1/07/99
DRAWN BY: D. I.





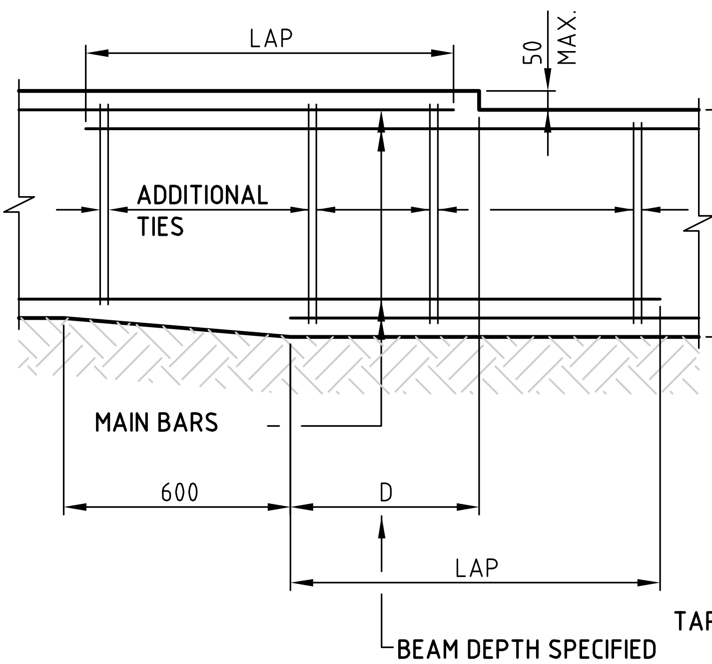
NOTE:
MAIN BARS TO BE CONTINUOUS WHERE POSSIBLE. SPLICES WHEN NECESSARY AS SPECIFIED.

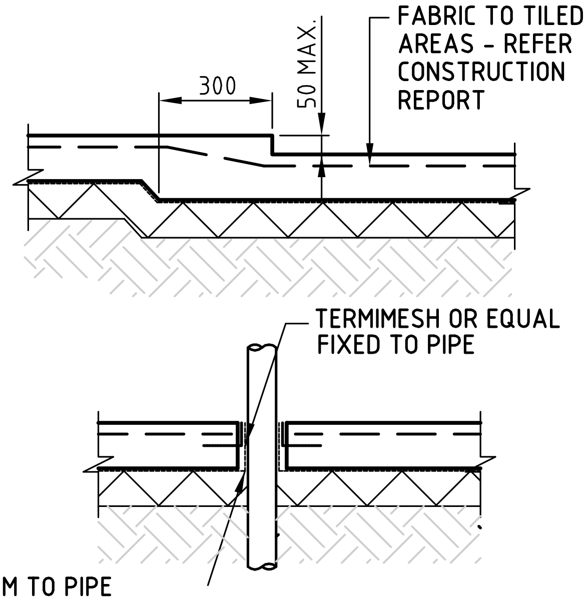


IF NUMBER OF TOP BARS IN EXTERNAL BEAM IS GREATER THAN THAT FOR INTERNAL BEAM CONTINUE TOP BARS OF EXTERNAL BEAM 1m INTO INTERNAL BEAM

REINFORCEMENT EXTENSIONS AT RE-ENTRANT CORNERS

PLAN DETAILS OF BEAM JUNCTIONS





BEAM SET DOWN

SLAB SECTIONS

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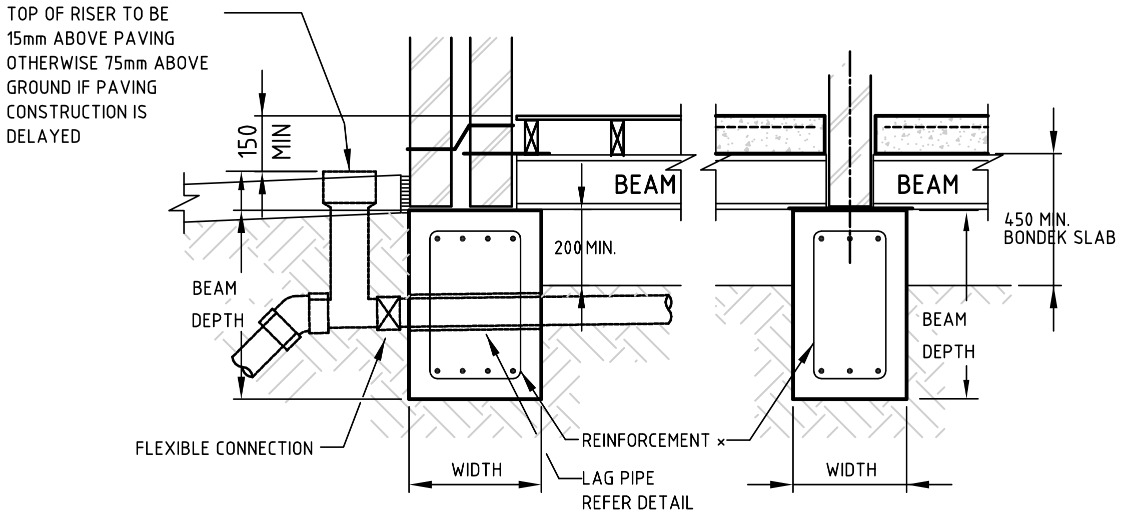
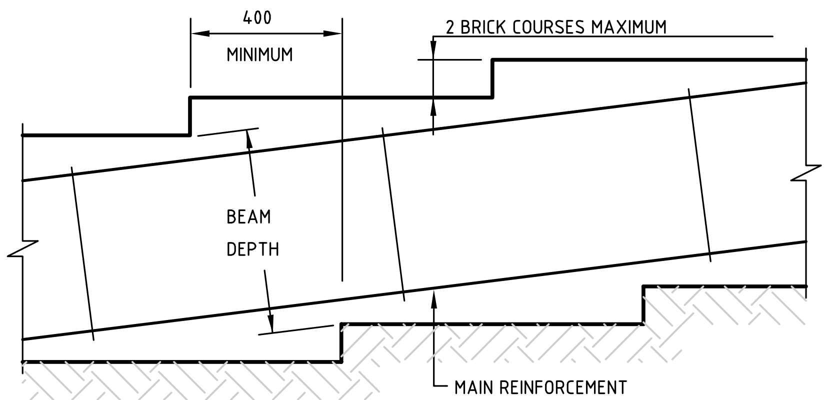
STANDARD FOOTING DETAILS
STRIP FOOTINGS

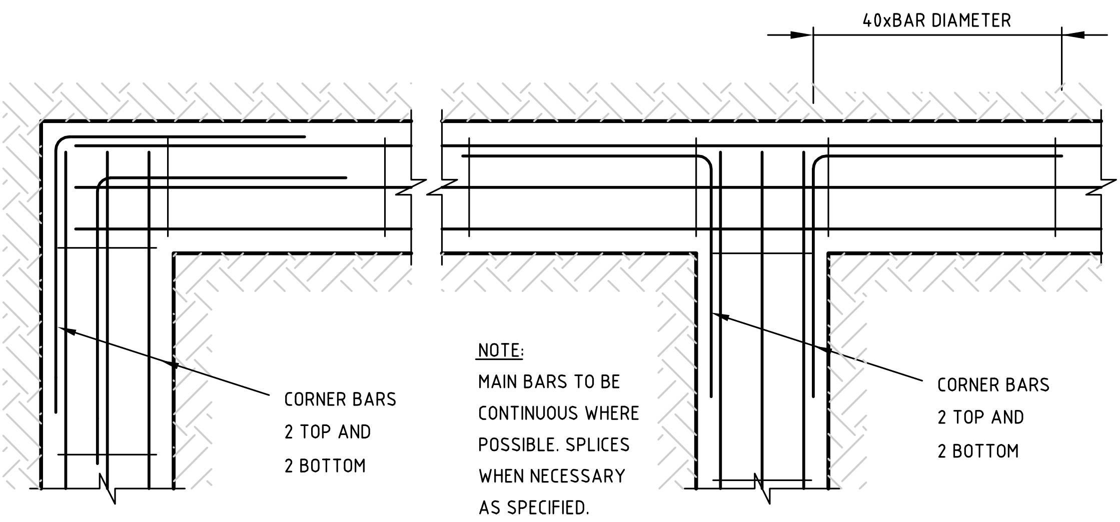
SHEET NO.:	SD-STRIP 1
DATE:	1/07/99
DRAWN BY:	D. I.



EXTERNAL   INTERNAL

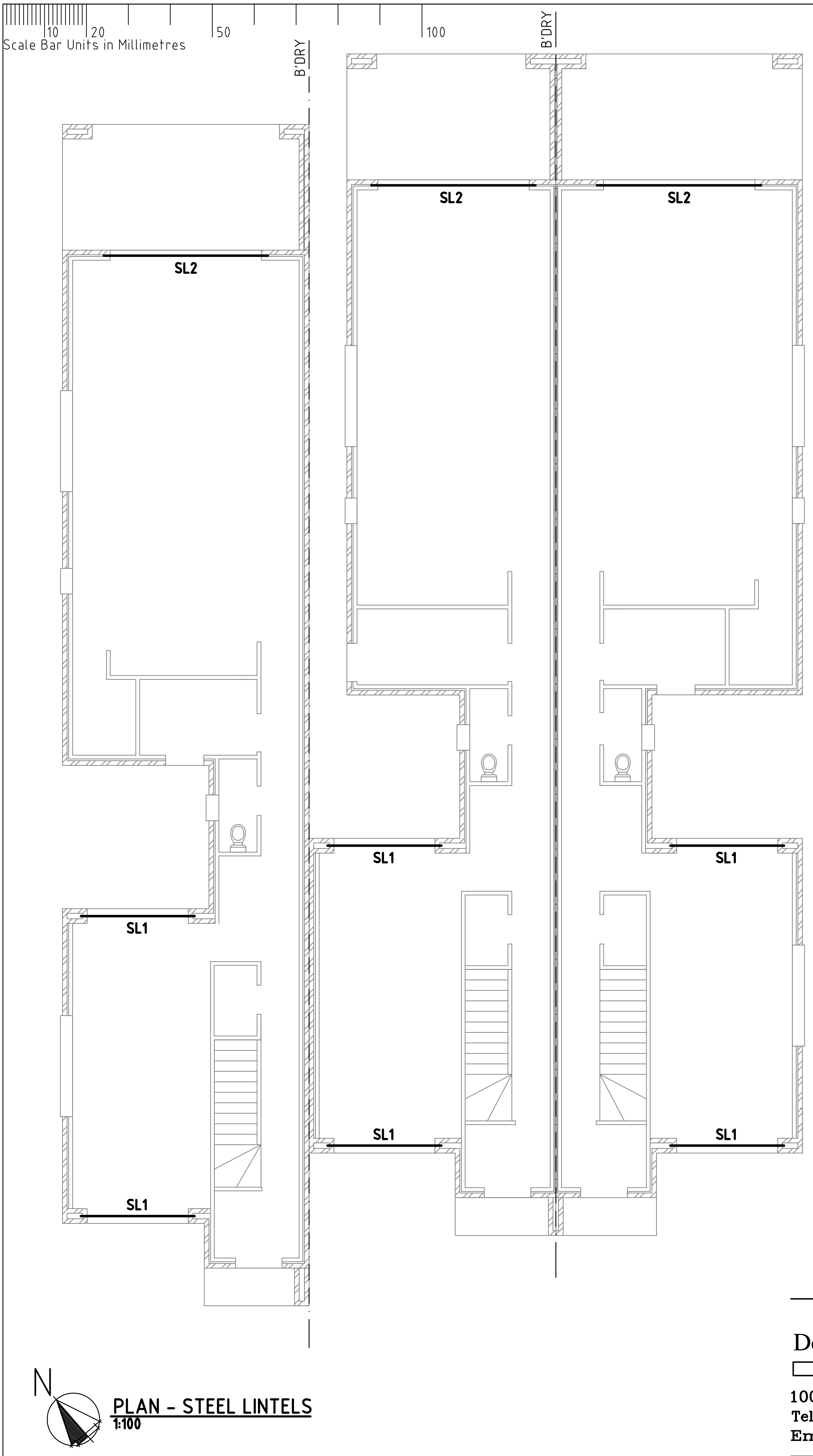


FOOTING ELEVATION



PLAN DETAILS AT STRIP FOOTING JUNCTIONS

SUPERSTRUCTURE ELEMENTS



NOTES:

1. READ THIS DRAWING TOGETHER WITH THE ARCHITECTURAL DRAWINGS FOR ALL SET OUT DIMENSIONS
2. ALL STEELWORK SHALL BE IN ACCORDANCE WITH AS4100
3. CONNECTIONS SHALL BE TO THE FOLLOWING MINIMUM REQUIREMENTS UNLESS SHOWN OTHERWISE:
   a) ALL WELDS SHALL BE 6mm CATEGORY SP CONTINUOUS FILLET WELDS ALL ROUND. WELDING CONSUMABLES TO BE E41XX
   b) ALL BOLTS SHALL BE M16 4.6/S, WITH A MINIMUM OF TWO BOLTS PER CONNECTION
   c) CLEATS SHALL BE 10mm THICK
4. ALL STEELWORK SHALL BE DEGREASED AND POWER WIRE BRUSHED AND THEN PAINTED WITH A ZINC PHOSPHATE ANTI-CORROSIVE PRIMER MINIMUM DRY FILM THICKNESS OF 75 MICRONS
5. T-BAR WELDING SHALL BE 300mm CONTINUOUS 6mm FILLET WELD EACH END, THEN MISS 150mm, WELD 100mm, etc. SEAL WELD BETWEEN
6. ALL STEELWORK EXPOSED TO THE WEATHER SHALL BE GRIT BLASTED TO CLASS 2.5 OF AS1627 PT.4 AND PRIMED WITH AN APPROVED INORGANIC ZINC SILICATE TO ACHIEVE A MINIMUM DRY FILM THICKNESS OF 80 MICRONS

PLAN - STEEL LINTELS
1:100

FRAMING SCHEDULE			
STEEL			
MARK	MEMBER	NOTES	TIE-DOWNS/CONNECTIONS
SL1	150×12 STEM + 300×10 LEDGE	T-BAR LINTEL	200mm BEARING EACH END
SL2	150×100×10 UA	ANGLE LINTEL	200mm BEARING EACH END

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THREE NEW DWELLINGS
-
5 ATHOS PLACE PARADISE SA
SOFIA TATARELLI

drawn by:	SR / MI	file ref:	ATH3836-1
design by:	MI	sheet no:	S03
checked by:	DI	rev:	— A3
date:	25/07/19	amended:	-

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CONSULTING STRUCTURAL
AND CIVIL ENGINEERS

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EARTHQUAKE LOADS

Project :	THREE NEW DWELLINGS 5 ATHOS PLACE PARADISE SA S TATARELLI	File Ref : ATH3836-1

Annual Probability of Exceedance (P)	1/500	after BCA Volume 2 Table 3.11.3a
Probability Factor (k_p)	1.0	after AS1170.4 – 2007 Table 3.1
Hazard Factor for Adelaide (Z)	0.10	after AS1170.4 – 2007 Table 3.2
k_pZ	0.10	(≤ 0.11)

NO SPECIFIC EARTHQUAKE DESIGN OR DETAILING IS REQUIRED

after Table A1 of AS1170.4 – 2007, for a domestic structure (housing) designed and detailed for lateral wind forces in accordance with AS1684, AS3600, AS3700, AS/NZS1664, AS1720.1, or NASH Standard Part 1.

Signed 25 July 2019

Dean Iuliano *BE MIEAust CPEng*

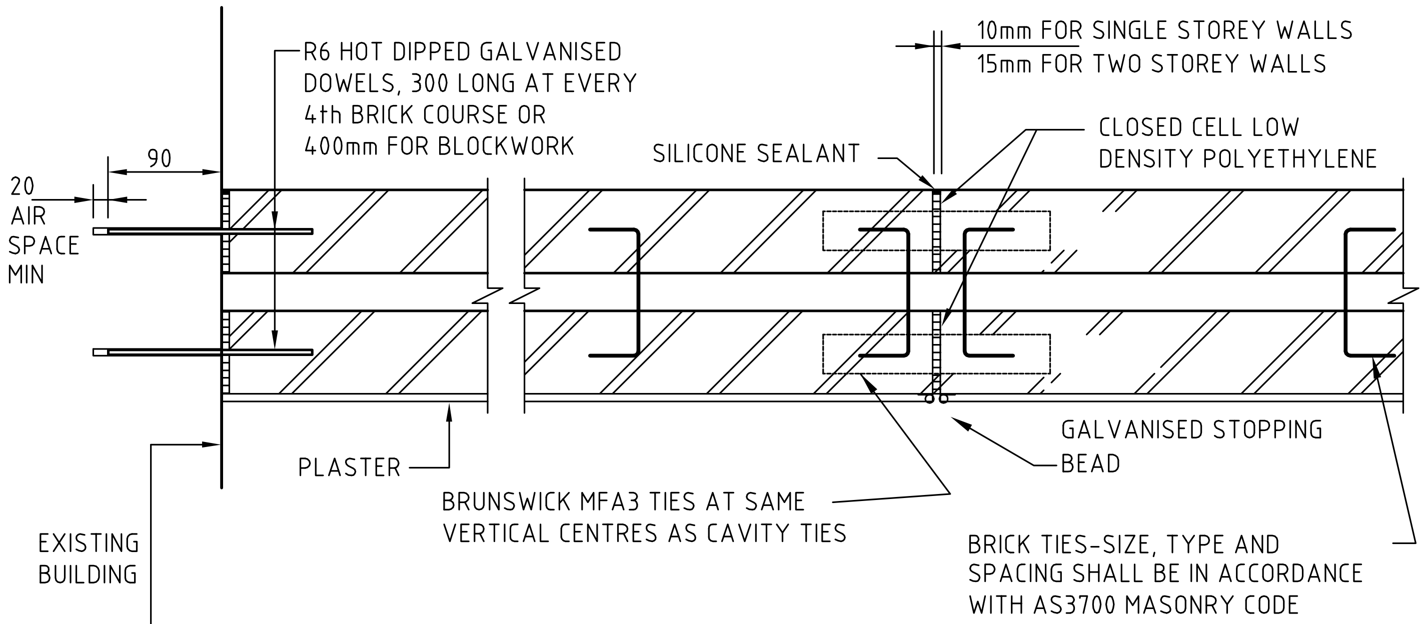
close liaison + thorough research + quality drawings = sound efficient construction

Dean Iuliano & Company

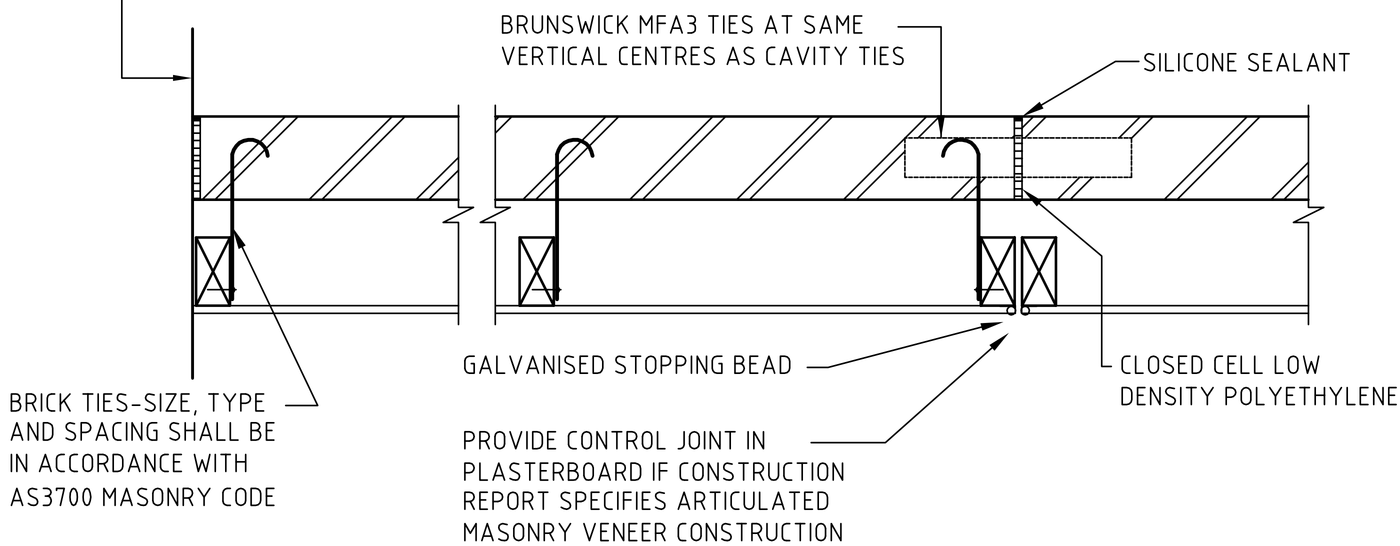
Consulting Engineers structural - civil

STANDARD FOOTING DETAILS
WALL CONTROL JOINT SHEET 1

SHEET NO.: SD-WALJNTS 1
DATE: 1/07/99
DRAWN BY: D. I.



SOLID MASONRY CONSTRUCTION



VENEER CONSTRUCTION

SPECIFICATIONS

SPECIFICATION

This Specification sets out the general requirements for Footing and Foundation work for new homes and additions and other buildings constructed in a similar manner. It is an attachment to Construction Reports and shall be read together with all other engineering and architectural documents prepared for the project.

Refer to the Engineer if any requirement is at variance with the Architectural Specification or with notes on the drawings.

EARTHWORKS

Site Clearing And Preparation

Remove everything on or above the site surface, including rubbish, vegetable matter and organic debris, scrub, timber, stumps, boulders, rubble, and the like and top soil containing organic matter, from the area to be covered by the building.

Grub out stumps and roots over 75 mm diameter to a minimum depth of 500 mm under buildings or paving, or 300 mm below finished surface in unpaved areas. Fill any over- excavation with compacted material as specified below.

Where necessary, break up and remove old slabs, foundations, paving, drains, manholes and the like found.

Pre-wetting

Water the site in and around the area to be covered by the building before under-slab filling is placed when pre-wetting is called for in the Construction Report. Watering shall be carried out with garden sprinklers for a minimum of 2 hours daily for a period of preferably 10-14 days immediately prior to commencement of construction. After watering, the under-slab filling must be placed and compacted within 3 days.

Where there are reactive clays on the site and a raft is to be constructed, pre-wetting of the site is most advantageous, particularly if construction is to take place after any prolonged period of low rainfall. It is aimed at reducing the future heave of reactive clays which has been seen to occur when dry clay soils are covered by a raft slab.

Boundary Conditions

Under no circumstances shall any excavation be carried out against a neighbouring building constructed along a boundary without the Engineer's prior knowledge and approval. Underpinning may be required before building work can proceed.

Cut at a boundary should not exceed 600 mm unless adequate retaining walls are provided.
Filling to the boundary should only be against an adequate retaining wall.

Steps between Benches

Generally cut or fill within the property (i.e. not on boundary) should not exceed 900 mm unless a suitable retaining wall or stable bank is provided.

Placement Of "Controlled Fill"

The filler material shall be clean site excavated soils which do not contain organic or other deleterious matter, or imported quarry rubble as specified below, spread in layers not exceeding 150 mm in depth before compaction at optimum moisture content. Each layer shall be compacted in turn and no layer shall be placed over any uncompacted layer. Compaction shall be achieved by means of a vibrating roller of suitable type (smoothdrum rollers for granular materials or sheepsfoot rollers for clays). Sufficient passes shall be made with the roller to compact the filler into a solid foundation. The Relative Compaction achieved shall be not less than that specified in the Construction Report

Take care with vibrating rollers, particularly if there are houses or other structures constructed on adjacent allotments. Contact the Engineer if in doubt regarding this.

Slope Stability

The Contractor shall at all times have due regard to the long term stability of filled and cut sloped surfaces.

All slopes shall be protected from excessive stormwater run-off by grading the top surface to drain water away from the sloping faces.

For untrafficked banks not exceeding 1.5 m high, the following batters may be constructed where the natural surface slope does not exceed one vertical to five horizontal.

DESIRABLE BATTER/SLOPES IN CUTS

MATERIAL	SURFACE SLOPE
Heavy Clay	1 vertical to 1 horizontal
Sands and cohesionless materials generally	1 vertical to 2 horizontal
Friable to sandy cohesionless soils	1 vertical to 1-1/2 horizontal
Weathered rock in good condition	1 vertical to 0-1/2 horizontal
Sound rock	Nearly vertical

For conditions not specifically covered above, this office should be requested to provide further instructions or recommendations.

For filled sites, where the natural surface slope does not exceed 1 vertical to 5 horizontal, the maximum embankment height shall not exceed 1.5 m and shall project not less than 1 m beyond the area of the site to be covered by the building. The batters of the filled surface shall not exceed the slope indicated below:

REQUIRED BATTER TO FILLED SLOPES

MATERIAL	SURFACE SLOPE
Clay and Silts	1 vertical to 2 horizontal
Sands	1 vertical to 3 horizontal
Quarry Rubble	1 vertical to 3 horizontal

NOTE: Embankments should be protected from damage arising from surface erosion or ground water flow.

If a retaining wall has been specified the cut or fill should not exceed the design height of the specified retaining wall.

Slopes and gradings of the cut bench or platform shown on the cut and fill plans are to be adhered to strictly to allow for the site to be drained. In particular, a temporary drainage channel may need to be cut in the floor 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 sand sites and sites where erosion may be a critical problem, provision of trench drains above the cut bank to prevent erosion during the construction phase, may be required.

Imported Filling

Filler material shall be 20 mm Quarry Rubble consisting of durable quartzite, limestone or other suitable stone. It shall be substantially free from any weathered or disintegrated stone, and shall not contain clay lumps, vegetable matter or other deleterious materials. The material shall comply in all respects with the Department of Road Transport. Specification No. PM21.

"Uncontrolled" Fill

Uncontrolled fill shall be compacted sufficiently to be used as a working platform to temporarily support footing beams and slabs designed to self supporting between piers drilled or excavated through the filling and founded on underlying firm natural undisturbed soils.

Uncontrolled fill shall not contain large rocks, builders debris, organic matter or any other deleterious substance which will hinder or prevent excavation for the piers and trenches.

Paving laid on "Uncontrolled" fill should preferably be segmental brick or block, which can be re-levelled if settlements occur with time.

Preparation

After completion of primary earthworks the site must be prepared for footing construction. Ideally, for raft construction, soils beneath the building area shall be kept in as moist a condition as possible. For strip footings with timber floors the building area shall be kept as dry as possible.

For rafts, provide a working surface of a minimum compacted thickness of 100 mm of quarry rubble or other approved material. The selected material must be free of any sharp aggregate at the surface, which could damage the vapour barrier. If necessary, blind surface with sand.

NOTE: The thickness of the working surface may be dictated by Local Council requirements or statutory requirements giving the relationship between finished floor level, external paving and or the sewer floor gully. This shall be taken into account when establishing building platform levels.

DAMP PROOF MEMBRANE

The damp proof membrane shall be high impact polythene not less than 0.200 mm thick laid continuously over the area to be covered by building except where shown otherwise on the Detail Sheets.

At joins, lap the sheets 300 mm and seal with a waterproof pressure sensitive tape. Where service pipes penetrate the membrane, seal the pipes to the membrane with waterproof tape.

Prior to commencement of concrete placement, tape over all holes, puncture etc. Level pins shall not be driven through the membrane.

Where strip footings extend beyond a stiffened raft footing, extend the Damp Proof Membrane one 600 mm beyond the external edge of the concrete raft, and wrap this membrane around the strip footing.

CONCRETE

General

Concrete work shall conform to AS 3600 SAA Concrete Structures.

Materials

The cement used in the works shall comply with AS 3972, Portland and Blended Cements. The properties and gradings of coarse and fine aggregate shall comply with AS 2758 Part 1.

Water shall be clean and shall not contain any matter or constituent which will be harmful to concrete.

Admixtures shall not be used without the approval of the Engineer.

Premixed concrete for the whole of the works shall be supplied by one manufacturer and shall comply with this Specification, AS 3600 and AS 1379.

Steel reinforcement to be used in the works shall be as listed in the Construction Report.

Types of reinforcement are designated as defined hereunder:

Prefix 'N' denotes rolled high tensile deformed bar complying with AS 1302

Prefix 'S' denotes structural grade deformed bar complying with AS 1302

Prefix 'R' denotes plain round structural grade bar complying with AS 1302

Prefix 'SL' denotes hard-drawn reinforcing fabric to AS 1304

It is the Builder's responsibility to supply all necessary support and spacer bars not necessarily shown on the drawings.

Grade Of Concrete And Testing

The grade of concrete to be used in the works shall be as designated below:

Grade Designation	N20	N25	N32
Specified Characteristic Strength at 28 days	20 MPa	25 MPa	32 Mpa
Nominal Size of Coarse Aggregate	20 mm	20 mm	20 mm

Workability shall be measured by the use of a slump test. The concrete "design slump" shall be between 60 mm and 90 mm.

Project control testing is not required unless specifically mentioned in the Construction Report. The testing authority shall be NATA approved. If any test fails to meet the strength requirement the Engineer shall be informed.

Placing Concrete

All work shall be in accordance with the requirements of AS 3600.

The placing of concrete shall be carried out continuously until the work is completed. If the Builder wishes to provide a construction joint in the works he shall obtain the Engineer's approval and instructions for making the joint.

All concrete shall be fully compacted by means of power driven vibrators operating at a frequency exceeding 8000 cycles per minute. Concrete shall be worked thoroughly against the formwork and around any reinforcement without displacing them.

Surface Finish

Formwork shall comply with AS 3610. Unformed surfaces shall be steel trowelled to a smooth plane surface except where set down areas etc., will be covered by subsequent hard finishes eg., mosaic tiling. These areas may be screeded to the desired levels.

Curing Of Concrete

Curing of concrete shall be carried out strictly in accordance with the requirements of AS 3600. When hot and/or windy conditions prevail the Builder shall ensure that every precaution is made to prevent premature drying of the concrete surfaces.

SERVICES

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. If this cannot be achieved the Engineer must be notified BEFORE footing construction commences so that appropriate alternatives can be made to the footing design.

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

- Sleeves shall desirably be placed at the mid depth of the footing and a minimum of 50 mm cover shall be provided between the sleeve or pipe and the reinforcing steel. Where this is not achieved the following must be done.

- Provide additional reinforcement correctly placed and lapping 50 bar diameters either side of the sleeve.

- Where the sleeve is close to the bottom reinforcement additional excavation must occur below the pipe and the bottom rods placed and lapped so as to provide the correct cover.

- IT IS GENERALLY UNACCEPTABLE TO HAVE PIPES PLACED BETWEEN PARALLEL REINFORCEMENT. WHERE THIS CANNOT BE AVOIDED ADDITIONAL STEEL AS DIRECTED BY THE ENGINEER MUST BE PROVIDED.

- Where pipes pass through a footing beam they must be wrapped in closed cell polyethylene of thickness as noted in the Report, or similar material approved by the Engineer, so as to allow relative movement between the footings and the pipes.

- On Class H or E sites, further measures to protect services are required, as follows:

    1. Connections of stormwater and waste drains should include flexible connections where they exit from the building.

2. All sewer trenches both within and outside the perimeter of the building must be carefully backfilled with approved material and compacted.

3. Backfilling where service trenches pass under footings shall be with 4% cement treated quarry rubble, placed in layers and compacted to 95 % Modified Compaction. This shall extend for one metre inside and one metre outside the building line. This work is required to prevent moisture entering the underfloor zone via a service trench and possibly inducing extreme soil heave beneath the building.

PAVING REQUIREMENTS

- Concrete pavements shall have a thickness of not less than 75 mm. Where the soil class given in the Footing Recommendation is class M, H or E it is recommended that concrete paving be reinforced with F62 fabric in a single top layer.

- Control joints shall be provided at a maximum of 2.0m centres and at all re-entrant corners, or at the locations shown on the drawings.

- Pavements shall be not less than 1 m, and preferably 1.2 m in width and shall have a crossfall of not less than 35 mm per 1 width, except for class E sites which shall be 50mm per 1 m width, unless noted otherwise.

- On Class H or E sites it is recommended that paving be constructed at the end of winter, when the site soils are wet, so that crossfalls constructed in the paving will not reduce. It is important, however, if the building is occupied during a winter period and no paving provided, that the soil surface around the perimeter has been maintained in a well drained state until such time as paving is installed.

- 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 crossfall.

- The paving shall not be constructed above any damp-proof course or built in damp-proof membrane.

- Any gaps between the paving and the building shall be sealed with a flexible sealant to prevent surface water entering the soils adjacent to the footings.

- Ensure that the dimension from the top of paving to the external damp proof course is not less than:

Class 'S' site	50 mm	
Class 'M' site	50 mm	But not higher than 150mm below finished floor level,
Class 'H' site	100 mm	unless detailed otherwise on the drawings.
Class 'E' site	120 mm	

These dimensions may be increased to give appropriate control to prevent infestation from Subterranean Termites. Refer to the Architects/Building Designers Specification

Foundation Maintenance and Footing Performance: A Homeowner's Guide

CSIRO

BTF 18 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, 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 with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

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.

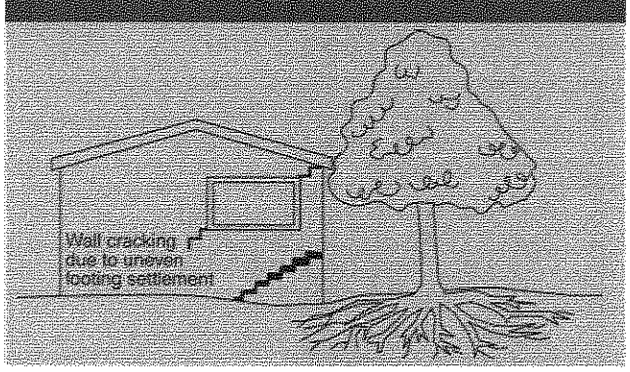
Seasonal swelling/shrinkage in clay

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.

Trees can cause shrinkage and damage



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.

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 cause 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.

AS 2870 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.

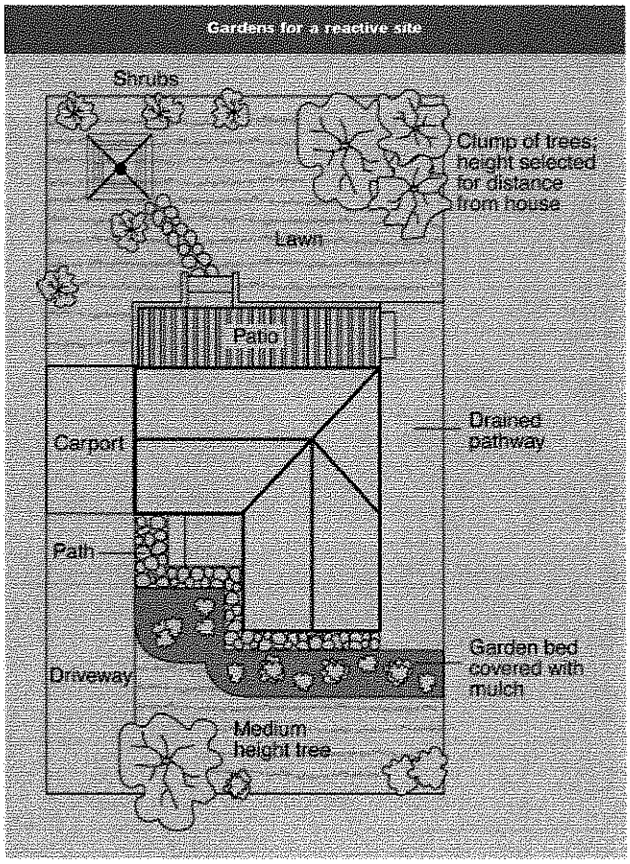
It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

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

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 depend on number of cracks	4



should 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.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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CALCULATIONS

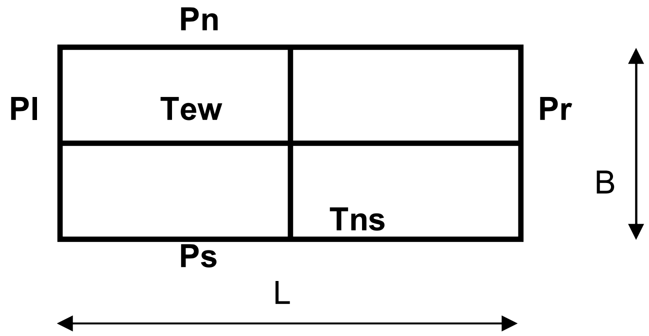
THREE NEW DWELLINGS

5 ATHOS PLACE PARADISE SA
S TATARELLI

sheet no: **A01**
file ref: ATH**3836-1**
date: 31/08/2019
by: **M M I**

RAFT ANALYSIS – SLOG

TWO STOREY
ARTICULATED MASONRY VENEER
NO TREE EFFECTS CONSIDERED
DWELLING 1



Length (m)	**28.26**	No of Beams parallel to Long Span	**3**	Deflection Ratio	≤ L / **400**
Breadth (m)	**5.88**	No of Beams parallel to Short Span	**8**	Deflection Limit (mm)	**30**
Ym (mm) - CH	**25.0**	Length of Upper Internal Walls (m)	**30.0**		
- EH	**25.0**	Length of Lower Internal Walls (m)	**30.0**		

BUILDING LOADS		kPa		
ROOF	METAL SHEET + CEILING	0.40		
EXTERNAL WALL	AAC CLAD TIMBER FRAME	1.00		
or	MASONRY VENEER	2.40		
PARTYWALL	AAC SHAFT LINER	1.00		
UPPER INTERNAL WALL	TIMBER + PLASTERBOARD	0.30	HGHT =	2.55 m
LOWER INTERNAL WALL	TIMBER + PLASTERBOARD	0.30	HGHT =	2.70 m
UPPER FLOOR	TIMBER FLOOR + CEILING	0.50		
GROUND FLOOR	CONCRETE SLAB	2.40	SLAB =	100 mm
FLOOR LIVE	RESIDENTIAL	1.50		

DESIGN LOADS	Pl		Pr		Pn		Ps		Tns		Tew	
	LW	kN/m	LW	kN/m	LW	kN/m	LW	kN/m	LW	kN/m	LW	kN/m
ROOF	-	-	-	-	2.94	1.18	2.94	1.18	-	-	-	-
UPPER INTERNAL WALLS	-	-	-	-	2.94	0.41	2.94	0.41	-	-	-	-
UPPER FLOOR DEAD	-	-	-	-	2.94	1.47	2.94	1.47	-	-	-	-
UPPER FLOOR LIVE	-	-	-	-	2.94	2.21	2.94	2.21	-	-	-	-
PARTYWALL	-	-	-	-	-	-	-	-	-	-	-	-
UPPER EXTERNAL WALLS	3.90	3.90	3.90	9.36	3.90	3.90	3.90	3.90	-	-	-	-
LOWER EXTERNAL WALLS	4.00	9.60	4.00	9.60	4.00	9.60	4.00	9.60	-	-	-	-
Total (kN/m)		**13.50**		**18.96**		**18.76**		**18.76**		**0.00**		**0.00**

LW = LOAD WIDTH or WALL HEIGHT (m)

		kPa
w	LOWER INTERNAL WALLS	0.15
	GROUND FLOOR LIVE	0.75
	Total (kPa)	**0.90**

INPUT DATA   Footing Analysis by: SLOG

Site: 5 Athos Place PARADISE
Reference: ATH3836-1
Date: 26/07/19

Structure geometry

Length of Structure L:	28.26 m
Breadth of Structure:	5.88 m
No. beams parallel to Long Span:	3
No. beams parallel to Short Span:	8
Deflection Ratio △/L:	400
Maximum Allowable Deflection △:	30 mm
Depth Footing not Embedded:	0.2 m

Soil Properties

Soil Heave Ym:	55 mm
Depth of suction change Hs:	4 m
Mound stiffness k:	1454 kPa/m

Structure loads

Edge Load on West End:	13.5 kN/m
Edge Load on East End:	18.96 kN/m
Edge Load on North Side:	18.76 kN/m
Edge Load on South Side:	18.76 kN/m
North-South Centre Load:	0 kN/m
East-West Centre Load:	0 kN/m
Uniform distributed load:	0.9 kPa

Raft Footing Properties (for Input Steel)

Sub-Beam Width:	300 mm
Sub-Beam Top Bars:	600 mm^2
Sub-Beam Bottom Bars:	600 mm^2
Sub-Beam Steel Grade:	500 MPa
Top Concrete Cover:	50 mm
Bottom Concrete Cover:	65 mm
Slab Thickness:	100 mm
Area Slab Steel:	143 mm^2/m
Slab Steel Grade:	500 MPa
Concrete Compressive Strength f'c:	20 MPa
Concrete Tensile Strength Hogging:	1.8 MPa
Concrete Tensile Strength Sagging:	2.7 MPa
Young's Modulus of Concrete:	15000 MPa
Requested Mu/Mcr Ratio Hogging:	1.5
Requested Mu/Mcr Ratio Sagging:	1.5
Slab Panel Width:	888 mm

Additional Properties

Soil Edge Heave:	55 mm
Beam Side Friction:	25 kPa

OUTPUT - Raft Footing

Footing Analysis by: SLOG

Site: 5 Athos Place PARADISE
Reference: ATH3836-1
Date: 26/07/19

Required Capacities per Beam

	Long Span		Short Span	
Centre Heave				
Ultimate Negative Moment:	-130.9	kNm	-230.9	kNm
Ultimate Positive Moment:	8.0	kNm	0.0	kNm
Max Shear:	-49.5	kN	-96.9	kN
Required Stiffness:	60.508	MNm^2	44.200	MNm^2
Edge Heave				
Ultimate Negative Moment:	-0.2	kNm	-21.4	kNm
Ultimate Positive Moment:	14.6	kNm	11.5	kNm
Max Shear:	-18.5	kN	56.9	kN
Required Stiffness:	1.960	MNm^2	3.533	MNm^2

RAFT REQUIREMENTS

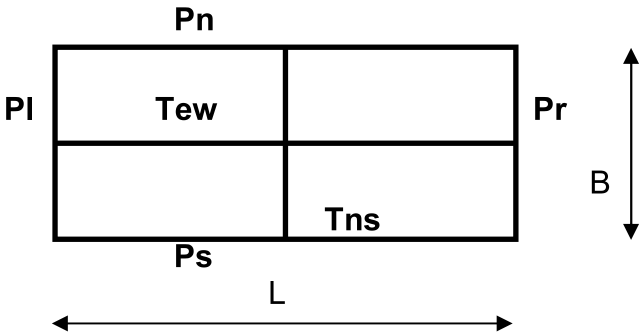
Sub-beams:	300	**mm wide x**	750	**mm deep**		
Slab:	100	**mm**	143	**mm^2/m Steel**	500	**MPa**
Subbeam top bars:	600	**mm^2 Steel**	500	**MPa**		
Subbeam bottom bars:	600	**mm^2 Steel**	500	**MPa**		
Concrete:	20	**MPa**				

Actual Capacities per Beam

	Centre Heave		Edge Heave	
Sub-beam depth:	750	mm	750	mm
Input top bars	600	mm^2		
Input bottom bars			600	mm^2
Ultimate Moment Mu:	241.2	kNm	202.5	kNm
Cracking Moment Mcr:	90.8	kNm	94.7	kNm
Mu/M* =	1.31		17.29	
Mu/Mcr =	2.66		2.14	
Stiffness:	70.011	MNm^2	232.797	MNm^2

RAFT ANALYSIS – SLOG

TWO STOREY
ARTICULATED MASONRY VENEER
NO TREE EFFECTS CONSIDERED
DWELLINGS 2 & 3



Length (m)	**28.17**	No of Beams parallel to Long Span	**4**	Deflection Ratio	≤ L / **400**
Breadth (m)	**11.76**	No of Beams parallel to Short Span	**8**	Deflection Limit (mm)	**30**
Ym (mm) - CH	**25.0**	Length of Upper Internal Walls (m)	**60.0**		
- EH	**25.0**	Length of Lower Internal Walls (m)	**60.0**		

BUILDING LOADS		kPa		
ROOF	METAL SHEET + CEILING	0.40		
EXTERNAL WALL	AAC CLAD TIMBER FRAME	1.00		
or	MASONRY VENEER	2.40		
PARTYWALL	AAC SHAFT LINER	1.00		
UPPER INTERNAL WALL	TIMBER + PLASTERBOARD	0.30	HGHT =	2.55 m
LOWER INTERNAL WALL	TIMBER + PLASTERBOARD	0.30	HGHT =	2.70 m
UPPER FLOOR	TIMBER FLOOR + CEILING	0.50		
GROUND FLOOR	CONCRETE SLAB	2.40	SLAB =	100 mm
FLOOR LIVE	RESIDENTIAL	1.50		

DESIGN LOADS	Pl		Pr		Pn		Ps		Tns		Tew	
	LW	kN/m	LW	kN/m	LW	kN/m	LW	kN/m	LW	kN/m	LW	kN/m
ROOF	-	-	-	-	2.94	1.18	2.94	1.18	-	-	5.88	2.35
UPPER INTERNAL WALLS	-	-	-	-	2.94	0.41	2.94	0.41	-	-	5.88	0.81
UPPER FLOOR DEAD	-	-	-	-	2.94	1.47	2.94	1.47	-	-	5.88	2.94
UPPER FLOOR LIVE	-	-	-	-	2.94	2.21	2.94	2.21	-	-	5.88	4.41
PARTYWALL	-	-	-	-	-	-	-	-	-	-	7.90	7.90
UPPER EXTERNAL WALLS	3.90	3.90	3.90	9.36	3.90	3.90	3.90	3.90	-	-	-	-
LOWER EXTERNAL WALLS	4.00	9.60	4.00	9.60	4.00	9.60	4.00	9.60	-	-	-	-
Total (kN/m)		**13.50**		**18.96**		**18.76**		**18.76**		**0.00**		**18.42**

LW = LOAD WIDTH or WALL HEIGHT (m)

		kPa
w	LOWER INTERNAL WALLS	0.15
	GROUND FLOOR LIVE	0.75
	Total (kPa)	**0.90**

INPUT DATA

Footing Analysis by: SLOG

Site:	5 Athos Place PARADISE
Reference:	ATH3836-1
Date:	26/07/19

Structure geometry

Length of Structure L:	28.17 m
Breadth of Structure:	11.76 m
No. beams parallel to Long Span:	4
No. beams parallel to Short Span:	8
Deflection Ratio △/L:	400
Maximum Allowable Deflection △:	30 mm
Depth Footing not Embedded:	0.2 m

Soil Properties

Soil Heave Ym:	55 mm
Depth of suction change Hs:	4 m
Mound stiffness k:	1213 kPa/m

Structure loads

Edge Load on West End:	13.5 kN/m
Edge Load on East End:	18.96 kN/m
Edge Load on North Side:	18.76 kN/m
Edge Load on South Side:	18.76 kN/m
North-South Centre Load:	0 kN/m
East-West Centre Load:	18.42 kN/m
Uniform distributed load:	0.9 kPa

Raft Footing Properties (for Input Steel)

Sub-Beam Width:	300 mm
Sub-Beam Top Bars:	600 mm^2
Sub-Beam Bottom Bars:	600 mm^2
Sub-Beam Steel Grade:	500 MPa
Top Concrete Cover:	50 mm
Bottom Concrete Cover:	65 mm
Slab Thickness:	100 mm
Area Slab Steel:	143 mm^2/m
Slab Steel Grade:	500 MPa
Concrete Compressive Strength f'c:	20 MPa
Concrete Tensile Strength Hogging:	1.8 MPa
Concrete Tensile Strength Sagging:	2.7 MPa
Young's Modulus of Concrete:	15000 MPa
Requested Mu/Mcr Ratio Hogging:	1.5
Requested Mu/Mcr Ratio Sagging:	1.5
Slab Panel Width:	1300 mm

Additional Properties

Soil Edge Heave:	55 mm
Beam Side Friction:	25 kPa

OUTPUT - Raft Footing

Footing Analysis by: SLOG

Site: 5 Athos Place PARADISE
Reference: ATH3836-1
Date: 26/07/19

Required Capacities per Beam

Centre Heave	**Long Span**		**Short Span**	
Ultimate Negative Moment:	-195.4	kNm	-215.5	kNm
Ultimate Positive Moment:	14.5	kNm	0.0	kNm
Max Shear:	-72.3	kN	-91.7	kN
Required Stiffness:	102.478	MNm^2	84.017	MNm^2
Edge Heave				
Ultimate Negative Moment:	-1.3	kNm	-20.6	kNm
Ultimate Positive Moment:	17.3	kNm	11.5	kNm
Max Shear:	-20.1	kN	37.0	kN
Required Stiffness:	2.940	MNm^2	3.521	MNm^2

RAFT REQUIREMENTS

Sub-beams:	300	**mm wide x**	750	**mm deep**		
Slab:	100	**mm**	143	**mm^2/m Steel**	500	**MPa**
Subbeam top bars:	600	**mm^2 Steel**	500	**MPa**		
Subbeam bottom bars:	600	**mm^2 Steel**	500	**MPa**		
Concrete:	20	**MPa**				

Actual Capacities per Beam

	Centre Heave		**Edge Heave**	
Sub-beam depth:	750	mm	750	mm
Input top bars	600	mm^2		
Input bottom bars			600	mm^2
Ultimate Moment Mu:	259.6	kNm	203.4	kNm
Cracking Moment Mcr:	117.4	kNm	102.0	kNm
Mu/M* =	1.51		14.69	
Mu/Mcr =	2.21		1.99	
Stiffness:	120.118	MNm^2	269.141	MNm^2

STEEL LINTEL – SL1

GEOMETRY

SPAN L = **2.41** m

UPPER WALL HEIGHT h = **4.30** m

LOADS

UPPER WALL Dead

Double Leaf Masonry	4.40 kPa

$\omega_{DL,Wall}$ = 4.40 kPa × h = **18.92** kN/m

TRY 150×12 THICK STEM + 300×10 THICK LEDGE TEE-SECTION

CALCULATION OF SECTION PROPERTIES

Tedds calculation version 2.0.07

Area

A = **4800.00** mm²

2nd moment of area

I_u = **22.5×10⁶** mm⁴ I_v = **10.6×10⁶** mm⁴ I_x = **10.6×10⁶** mm⁴ I_y = **22.5×10⁶** mm⁴

Radius of gyration

r_u = **68.5** mm r_v = **47.0** mm r_x = **47.0** mm r_y = **68.5** mm

Plastic section modulus (only shapes with all rectangles at 90 degs)

S_x = **149.×10³** mm³ S_y = **230.×10³** mm³

Distance to combined centroid

X_e = **0.0** mm Y_e = **0.0** mm

Distance to equal axis area (only shapes with all rectangles at 90 degs)

X_p = **0.0** mm Y_p = **27.0** mm

Elastic section modulus

Z_x = **84.8×10³** mm³ Z_y = **150.×10³** mm³

ANALYSIS

Young's Modulus	E = **200** × **10³** MPa
Moment of Inertia	I_x = **10.6×10⁶** mm⁴
Self-Weight	ω_{SW} = A × 76.9 kN/m³ = **0.37** kN/m
Design Load	ω^* = 1.35 × (ω_{SW} + $\omega_{DL,Wall}$) = **26.04** kN/m
Design Moment	M^* = ω^* × L^2 / 8 = **18.91** kNm
Design Reaction	R^* = ω^* × L / 2 = **31.38** kN
Dead Load Deflection	Δ_{DL} = (5/384) × (ω_{SW} + $\omega_{DL,Wall}$) × L^4 / (E × I_x) = **4.0** mm — L / **603**

STEEL DESIGN (AS4100-1998)

Section & Material Properties

Web Thickness	$t_w = d_2 =$ **12** mm
Web Depth	$b_w = T_2 =$ **150** mm
Flange Thickness	$t_f = T_1 =$ **10** mm
Flange Width	$b_f = d_1 =$ **300** mm
Moment of Inertia X-axis	$I_x =$ **9.24×10^6** mm^4
Y-axis	$I_y =$ **22.5×10^6** mm^4
Elastic Section Modulus	$Z_x =$ **72.00×10^3** mm^3
Plastic Section Modulus	$S_x =$ **126.0×10^3** mm^3
Effective Section Modulus for a Compact Section	$Z_c = \min(1.5 \times Z_x , S_x) =$ **$108. \times 10^3$** mm^3
Torsion Constant	$J = \mathrm{sum}(b_w \times t_w^3, b_f \times t_f^3) / 3 =$ **$186. \times 10^3$** mm^4
Young's Modulus	$E =$ **200×10^3** MPa
Shear Modulus	$G =$ **80×10^3** MPa
Yield Strength	$f_y =$ **250** MPa

Section Slenderness (5.2.2)

Web only is subject to compression.
By Table 5.2 for a Heavily Welded member,

Plasticity Slenderness Limit	$\lambda_{ep} =$ **8**
Yield Slenderness Limit	$\lambda_{ey} =$ **22**
Web Slenderness	$\lambda_{ew} = (b_w / t_w) \times \sqrt{(f_y / 250)} =$ **13** — **Web is Non-Compact**

Sectional Moment Capacity (5.2.1 5.2.2)

Effective Section Modulus	$Z_e = Z_x + ((\lambda_{ey} - \lambda_{ew}) / (\lambda_{ey} - \lambda_{ep})) \times (Z_c - Z_x) =$ **96.4×10^3** mm^3
Sectional Moment Capacity	$M_s = f_y \times Z_e =$ **24.1** kNm

Member Moment Capacity (*without full lateral restraint*) (5.6)

Moment Modification Factor	$\alpha_m =$ **1.13** (Table 5.6.1)
Effective Length of Member	$l_e = L \times 1.1 =$ **2.7** m
Reference Buckling Moment	$M_o = \sqrt{((\pi^2 \times E \times I_y / l_e^2) \times (G \times J))} =$ **307.0** kNm
Slenderness Reduction Factor	$\alpha_s = 0.6 \times (\sqrt{((M_s / M_o)^2 + 3)} - (M_s / M_o)) =$ **0.993**
Member Moment Capacity	$M_b = \min(\alpha_m \times \alpha_s \times M_s, M_s) =$ **24.1** kNm
Capacity Reduction Factor	$\phi =$ **0.9**
Design Moment	$M^* =$ **7.3** kNm

$M^* / (\phi \times M_b) =$ **0.335** ***OK***

SELECT 150 × 12 THICK STEM + 300 × 10 THICK LEDGE TEE-SECTION

MINIMUM 200mm BEARING EACH END

WELD 300mm CONTINUOUS 6mm FILLET WELD EACH END
THEN MISS 150mm, WELD 100mm etc. SEAL WELD BETWEEN

LINTEL – SL2

GEOMETRY

SPAN $L = \mathbf{3.60}$ m

EXTERNAL WALL HEIGHT $h = \mathbf{1.40}$ m

LOADS

WALL Permanent

Clay Bricks	2.10 kPa

$\omega_{DL,Wall}$ = 2.10 kPa × h = **2.94** kN/m

ANALYSIS

Try 150x100x10 UA

Young's Modulus $E = \mathbf{200} \times \mathbf{10^3}$ MPa

Moment of Inertia $I_n = \mathbf{5.29 \times 10^6}$ mm^4

Self-Weight $\omega_{SW} = A_g \times 76.9$ kN/m^3 = **0.18** kN/m

Design Load $\omega^* = 1.35 \times (\omega_{SW} + \omega_{DL,Wall})$ = **4.21** kN/m

Design Moment $M^* = \omega^* \times L^2 / 8$ = **6.82** kNm

Design Reaction $R^* = \omega^* \times L / 2$ = **7.57** kN

Dead Load Deflection $\Delta_{DL} = (5/384) \times (\omega_{SW} + \omega_{DL,Wall}) \times L^4 / (E \times I_n)$ = **6.4** mm L / **559**

STEEL DESIGN (AS4100-1998)

Section & Material Properties

Web Thickness	$t_w = t =$ **9.5** mm
Web Depth	$b_w = b_1 =$ **150** mm
Flange Thickness	$t_f = t =$ **9.5** mm
Flange Width	$b_f = b_2 =$ **100** mm
Moment of Inertia n-Axis	$I_n =$ **5.29×10⁶** mm^4
p-Axis	$I_p =$ **1.91×10⁶** mm^4
Elastic Section Modulus	$Z_{nT} =$ **51.90×10³** mm^3
Plastic Section Modulus	$S_n =$ **94.00×10³** mm^3
Torsion Constant	$J =$ **68.73×10³** mm^4
Effective Section Modulus for a Compact Section	$Z_c = \min(1.5 \times Z_{nT}, S_n) =$ **77.8×10³** mm^3
Young's Modulus	$E =$ **200 × 10³** MPa
Shear Modulus	$G =$ **80 × 10³** MPa
Yield Strength	$f_y =$ **300** MPa

Section Slenderness (5.2.2)

Web is subject to compression at unsupported edge.
By Table 5.2 for a Hot Rolled member,

Plasticity Slenderness Limit	$\lambda_{ep} =$ **9**	
Yield Slenderness Limit	$\lambda_{ey} =$ **25**	
Web Slenderness	$\lambda_{ew} = ((b_w - t_f) / t_w) \times \sqrt{(f_y / 250)} =$ **16**	**Web is Non-Compact**

Sectional Moment Capacity (5.2.1 5.2.2)

Effective Section Modulus	$Z_e = Z_{nT} + ((\lambda_{ey} - \lambda_{ew}) / (\lambda_{ey} - \lambda_{ep})) \times (Z_c - Z_{nT}) =$ **66.2×10³** mm^3
Sectional Moment Capacity	$M_s = f_y \times Z_e =$ **19.9** kNm

Member Moment Capacity (*without full lateral restraint*) (5.6)

Moment Modification Factor	$\alpha_m =$ **1.13**	(Table 5.6.1)
Effective Length of Member	$l_e = L \times 1.1 =$ **4.0** m	
Reference Buckling Moment	$M_o = \sqrt{((\pi^2 \times E \times I_p / l_e^2) \times (G \times J))} =$ **36.3** kNm	
Slenderness Reduction Factor	$\alpha_s = 0.6 \times (\sqrt{((M_s / M_o)^2 + 3)} - (M_s / M_o)) =$ **0.762**	
Member Moment Capacity	$M_b = \min(\alpha_m \times \alpha_s \times M_s, M_s) =$ **17.1** kNm	
Capacity Reduction Factor	$\phi =$ **0.9**	
Design Moment	$M^* =$ **6.8** kNm	

$M^* / (\phi \times M_b) =$ **0.443** ***OK***

SELECT 150 × 100 × 10 UA

MINIMUM 200mm BEARING EACH END