

Keith Farquharson Associates

Structural Calculations for

The White House,
41 Eastern Avenue,
Reading.

March 2023
Project Reference S/032314

Keith Farquharson Associates
14 Sandhurst Lane,
Blackwater,
GU17 0DH.

Tel: 07768 782336
Email mike@kfgeotechnical.co.uk

Notes

These calculations and design responsibility relate to the elements mentioned only. Building regulation approval should be obtained prior to any works commencing or materials being ordered.

These calculations have been based on details supplied and/or a non intrusive visual survey. They should be read in conjunction with all relevant architect's drawings and specifications. Further detail may be required as the construction progresses and the contractor should inform the engineer of any discrepancies or omissions uncovered.

The design lengths used within these calculations are for design purposes only and do not relate directly to the lengths of the structural elements required. All materials should be specified from site measurements.

Any discrepancies should be reported prior to the ordering of materials

The contractor will be responsible for the temporary works necessary to undertake the scheme in a safe manner

Any existing walls surcharged by the proposals are to have their foundations exposed and checked for adequacy.

Any existing structural members subject to revised loading by the proposals are to be exposed and checked for adequacy.

Pad stones where specified are in the format length x depth x width,

All proprietary products are to be installed in accordance with their manufacturer's instructions.

Any variations to this design must be agreed in writing prior to implementation of the changes on site.

Keith Farquharson Associates

**14 Sandhurst Lane,
Blackwater,
GU17 0DH.**

Tel: 07768 782336

Email mike@kfgeotechnical.co.uk

Keith Farquharson Associates

Calculation Sheet

Site Address. 41 Eastern Avenue.

Ref S/032314

Sheet 1

Part Structural Details.

Date Mar. 23

Consider the piled foundation for the new boundary wall at the above address as indicated on Richard Fenn designs Ltd Drg AA.13

Loading

Brick work $22 \times 0.22 \times 2.1 = 10.1$ kN/m run

Piers $22 \times 0.22 \times 2.1 \times 0.45 = 4.6$ kN

600x300 ground beam $24 \times 0.6 \times 0.3 = 4.3$ kN/m run.

See analysis sheets 2 – 7

Providing pairs of piles at 3510mm centres

Max Pile Load = 35 kN

$M_{max} = 18.7 \times 1.4 = 26.2$ kNm

$V_{max} = 30.5 \times 1.4 = 42.7$ kN

Provide 500x300 ground beam reinforced top and bottom with 4 No. H12 with H10 links 150mm c/c

Keith Farquharson Associates. 14 Sandhurst Lane, Blackwater, GU17 0DH	Project				Job Ref.	
	41 Eastern Avenue.				S/032314	
	Section				Sheet no./rev.	
	Ground Beam				2	
	Calc. by	Date	Chk'd by	Date	App'd by	Date
		08/03/2023				

CONCRETE BEAM ANALYSIS

Concrete beam dimensions:-

Beam width $b = 500 \text{ mm}$

Beam depth $h = 300 \text{ mm}$

Cross-section area $A = b \times h = 150000 \text{ mm}^2$

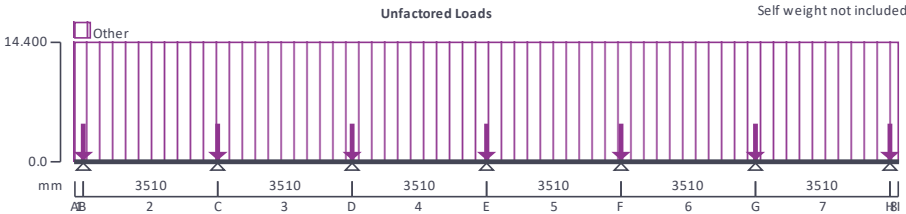
Major axis second moment of area $I_{xx} = b \times h^3 / 12 = 1.12 \times 10^9 \text{ mm}^4$

$f_{cu} = 35 \text{ N/mm}^2$

$E = 20 \text{ kN/mm}^2 + 200 \times f_{cu} = 27.0 \text{ kN/mm}^2$

Ref BS8110:1985:Pt 2 - Eq 17

$\rho = \rho_{C,norm} = 2400 \text{ kg/m}^3$



CONTINUOUS BEAM ANALYSIS - INPUT

BEAM DETAILS

Number of spans = 8

Material Properties:

Modulus of elasticity = 27 kN/mm²

Material density = 2400 kg/m³;

Support Conditions:

Support A; Vertically "Free"

Rotationally "Free";

Support B; Vertically "Restrained"

Rotationally "Free";

Support C; Vertically "Restrained"

Rotationally "Free";

Support D; Vertically "Restrained"

Rotationally "Free";

Support E; Vertically "Restrained"

Rotationally "Free";

Support F; Vertically "Restrained"

Rotationally "Free";

Support G; Vertically "Restrained"

Rotationally "Free";

Support H; Vertically "Restrained"

Rotationally "Free";

Support I; Vertically "Free"

Rotationally "Free";

Span Definitions:

Span 1; Length = 220 mm

Cross-sectional area = 150000 mm²;

Moment of inertia = 1.12 × 10⁹ mm⁴;

Span 2; Length = 3510 mm

Cross-sectional area = 150000 mm²;

Moment of inertia = 1.12 × 10⁹ mm⁴;

Span 3; Length = 3510 mm

Cross-sectional area = 150000 mm²;

Moment of inertia = 1.12 × 10⁹ mm⁴;

Span 4; Length = 3510 mm

Cross-sectional area = 150000 mm²;

Moment of inertia = 1.12 × 10⁹ mm⁴;

Span 5; Length = 3510 mm

Cross-sectional area = 150000 mm²;

Moment of inertia = 1.12 × 10⁹ mm⁴;

Span 6; Length = 3510 mm

Cross-sectional area = 150000 mm²;

Moment of inertia = 1.12 × 10⁹ mm⁴;

Span 7; Length = 3510 mm

Cross-sectional area = 150000 mm²;

Moment of inertia = 1.12 × 10⁹ mm⁴;

Span 8; Length = 220 mm

Cross-sectional area = 150000 mm²;

Moment of inertia = 1.12 × 10⁹ mm⁴;

LOADING DETAILS

Keith Farquharson Associates. 14 Sandhurst Lane, Blackwater, GU17 0DH	Project				Job Ref.	
	41 Eastern Avenue.				S/032314	
	Section				Sheet no./rev.	
	Ground Beam				3	
	Calc. by	Date	Chk'd by	Date	App'd by	Date
		08/03/2023				

Beam Loads:

Load 1;	UDL Other load 14.4 kN/m
Load 2;	Point Other load 4.6 kN at 0.220 m
Load 3;	Point Other load 4.6 kN at 3.730 m
Load 4;	Point Other load 4.6 kN at 7.240 m
Load 5;	Point Other load 4.6 kN at 10.750 m
Load 6;	Point Other load 4.6 kN at 14.260 m
Load 7;	Point Other load 4.6 kN at 17.770 m
Load 8;	Point Other load 4.6 kN at 21.280 m

Support B loads:

Load 2: Beam pointOther Load 4.6 kN

Support D loads:

Load 4: Beam pointOther Load 4.6 kN

Support E loads:

Load 5: Beam pointOther Load 4.6 kN

Support F loads:

Load 6; Beam pointOther Load 4.6 kN

Support G loads:

Load 7: Beam pointOther Load 4.6 kN

Support H loads:

Load 8: Beam pointOther Load 4.6 kN

LOAD COMBINATIONS

Load combination 1

Span 1;	1xOther
Span 2;	1xOther
Span 3;	1xOther
Span 4;	1xOther
Span 5;	1xOther
Span 6;	1xOther
Span 7;	1xOther
Span 8;	1xOther
Support B;	1xOther
Support D;	1xOther
Support E;	1xOther
Support F;	1xOther
Support G;	1xOther
Support H;	1xOther

CONTINUOUS BEAM ANALYSIS - RESULTS

Unfactored support reactions

	Other (kN)							
Support A;	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support B;	-27.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support C;	-61.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support D;	-53.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support E;	-56.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support F;	-53.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Keith Farquharson Associates. 14 Sandhurst Lane, Blackwater, GU17 0DH	Project				Job Ref.	
	41 Eastern Avenue.				S/032314	
	Section				Sheet no./rev.	
	Ground Beam				4	
	Calc. by	Date	Chk'd by	Date	App'd by	Date
		08/03/2023				

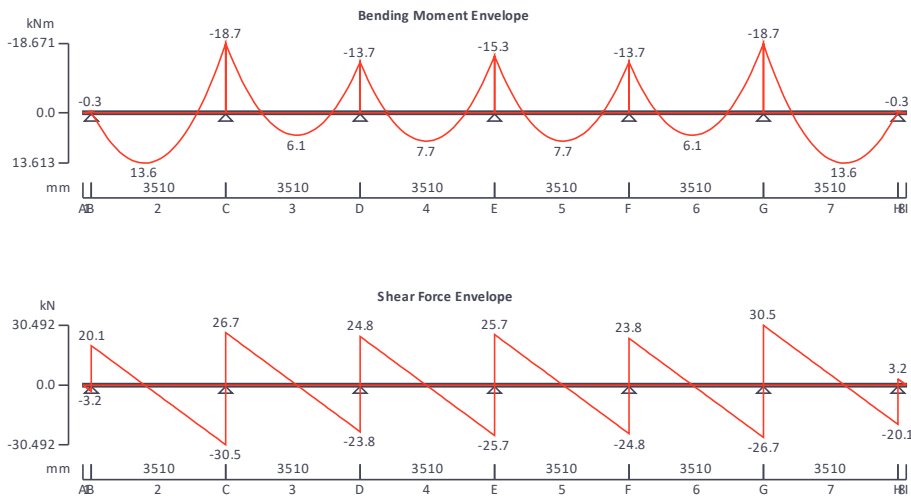
Support G;	-61.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support H;	-27.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support I;	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Support Reactions - Combination Summary

Support A;	Max react = 0.0 kN	Min react = 0.0 kN;	Max mom = 0.0 kNm;	Min mom = 0.0 kNm;
Support B;	Max react = -27.8 kN	Min react = -27.8 kN;	Max mom = 0.0 kNm;	Min mom = 0.0 kNm;
Support C;	Max react = -61.8 kN	Min react = -61.8 kN;	Max mom = 0.0 kNm;	Min mom = 0.0 kNm;
Support D;	Max react = -53.2 kN	Min react = -53.2 kN;	Max mom = 0.0 kNm;	Min mom = 0.0 kNm;
Support E;	Max react = -56.1 kN	Min react = -56.1 kN;	Max mom = 0.0 kNm;	Min mom = 0.0 kNm;
Support F;	Max react = -53.2 kN	Min react = -53.2 kN;	Max mom = 0.0 kNm;	Min mom = 0.0 kNm;
Support G;	Max react = -61.8 kN	Min react = -61.8 kN;	Max mom = 0.0 kNm;	Min mom = 0.0 kNm;
Support H;	Max react = -27.8 kN	Min react = -27.8 kN;	Max mom = 0.0 kNm;	Min mom = 0.0 kNm;
Support I;	Max react = 0.0 kN	Min react = 0.0 kN;	Max mom = 0.0 kNm;	Min mom = 0.0 kNm;

Beam Max/Min results - Combination Summary

Maximum shear = 30.5 kN	Minimum shear;F _{min} = -30.5 kN;
Maximum moment = 13.6 kNm	Minimum moment = -18.7 kNm;
Maximum deflection = 0.5 mm	Minimum deflection = -0.1 mm;



Keith Farquharson Associates 14 Sandhurst Lane, Blackwater, GU17 0DH	Project				Job Ref.	
	41 Eastern Avenue.				S/032314	
	Section				Sheet no./rev.	
	Ground Beam				5	
	Calc. by	Date	Chk'd by	Date	App'd by	Date
		08/03/2023				

REINFORCED CONCRETE BEAM DESIGN (BS8110:PART 1:1997)

TEDDS calculation version 1.0.04

Fire resistance

Period of fire resistance required **None**

Concrete details

Concrete grade **C35**
 Maximum aggregate size $h_{agg} = 20 \text{ mm}$

Reinforcement details

Characteristic strength of main reinforcement $f_y = 500 \text{ N/mm}^2$
 Type of reinforcement used **Type 2**
 Characteristic strength of shear reinforcement $f_{yv} = 500 \text{ N/mm}^2$

Nominal cover to reinforcement

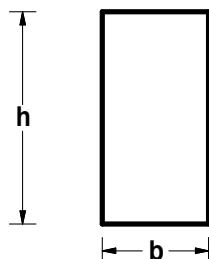
Minimum cover required for fire resistance $C_{fire} = 20 \text{ mm}$
 Nominal cover to top reinforcement $C_{top} = 50 \text{ mm}$
 Nominal cover to bottom reinforcement $C_{bot} = 50 \text{ mm}$

PASS - Nominal cover exceeds the requirements for fire resistance

Design section - 1755 mm along continuous span

Span details

Span type **Continuous**
 Span length $L_s = 3510 \text{ mm}$



Section details

Section type **Rectangular**
 Section width $b = 600 \text{ mm}$
 Section depth $h = 300 \text{ mm}$

Sagging moment design

Design moment $M = M_{max} = 30.000 \text{ kNm}$

Effective depth of reinforcement

Depth of tension reinforcement $d = h - C_{bot} - \phi_v - (N_{bl} \times \phi_{bp} / 2) - ((N_{bl} - 1) \times s_b / 2) = 234 \text{ mm}$
 Depth of compression reinforcement $d' = C_{top} + \phi_v + (N_{tl} \times \phi_{tp} / 2) + ((N_{tl} - 1) \times s_t / 2) = 66 \text{ mm}$

Design formula for rectangular beams (cl 3.4.4.4)

Moment redistribution ratio $\beta_b = 1.00$
 $K = M / (b \times d^2 \times f_{cu}) = 0.026$
 $K' = 0.156$

$K < K'$ compression reinforcement is not required

Keith Farquharson Associates 14 Sandhurst Lane, Blackwater, GU17 0DH	Project 41 Eastern Avenue.				Job Ref. S/032314	
	Section Ground Beam				Sheet no./rev. 6	
	Calc. by	Date 08/03/2023	Chk'd by	Date	App'd by	Date

Calculate depth of neutral axis

Lever arm $z = \min(d \times [0.5 + \sqrt{(0.25 - K / 0.9)}], 0.95 \times d) = \mathbf{222.3 \text{ mm}}$
Depth to neutral axis $x = (d - z) / 0.45 = \mathbf{26.0 \text{ mm}}$

Area of reinforcement required

Area of tension reinforcement required $A_{s_req} = M / (0.87 \times f_y \times z) = \mathbf{310 \text{ mm}^2}$
Minimum area of tension reinforcement required $A_{s_min} = 0.0013 \times b \times h = \mathbf{234 \text{ mm}^2}$
Tension reinforcement provided **4H12**
Area of tension reinforcement provided $A_{s_prov} = \mathbf{452 \text{ mm}^2}$

PASS - Adequate tension reinforcement has been provided

Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension $S = (b - 2 \times (C_{bot} + \phi_v) - (N_{bp} \times \phi_{bp} + N_{bs} \times \phi_{bs})) / (N_{bp} + N_{bs} - 1) = \mathbf{144 \text{ mm}}$

Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension $S_{min} = h_{agg} + 5 \text{ mm} = \mathbf{25 \text{ mm}}$

PASS - Satisfies the minimum spacing criteria

Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress $f_s = 2 \times f_y \times A_{s_req} / (3 \times A_{s_prov} \times \beta_b) = \mathbf{228.591 \text{ N/mm}^2}$
Maximum distance between bars in tension $S_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = \mathbf{206 \text{ mm}}$

PASS - Satisfies the maximum spacing criteria

Shear stress in beam (cl 3.4.5.2)

Design shear force $V = \max(F_{max}, \text{Abs}(F_{min})) = \mathbf{45.000 \text{ kN}}$
Design shear stress $v = V / (b \times d) = \mathbf{0.321 \text{ N/mm}^2}$
Allowable design shear stress $v_{max} = \min(0.8 \text{ N/mm}^2 \times \sqrt{f_{cu} / 1 \text{ N/mm}^2}, 5 \text{ N/mm}^2) = \mathbf{4.733 \text{ N/mm}^2}$

PASS - Design shear stress does not exceed allowable shear stress

From BS 8110:Part 1:1997 - Table 3.8

Design concrete shear stress $v_c = \mathbf{0.554 \text{ N/mm}^2}$

Shear reinforcement (cl 3.4.5.3)

From BS 8110:Part 1:1997 - Table 3.7

Design shear resistance required $0.5 \times v_c < v < (v_c + 0.4 \text{ N/mm}^2)$
 $v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = \mathbf{0.400 \text{ N/mm}^2}$
Area of shear reinforcement required $A_{sv_req} = v_s \times b / (0.87 \times f_{yv}) = \mathbf{552 \text{ mm}^2/\text{m}}$
Shear reinforcement provided **2H10 legs @ 150 centres**
Area of shear reinforcement provided $A_{sv_prov} = \mathbf{1047 \text{ mm}^2/\text{m}}$

PASS - Shear reinforcement is adequate

Check maximum spacing of links (cl 3.4.5.5)

Maximum spacing of links $S_{limit} = 0.75 \times d = \mathbf{175 \text{ mm}}$

PASS - Spacing of links does not exceed $0.75 \times d$

Check slenderness limits (cl 3.4.1.6)

Clear distance between lateral restraints $l = \mathbf{3510 \text{ mm}}$
Limiting distance between restraints $l_{lim} = \min(60 \times b, 250 \times b^2 / d) = \mathbf{36000 \text{ mm}}$

PASS - Section satisfies the slenderness criteria

Basic span/effective depth ratio (cl 3.4.6.3)

From BS8110 : Part 1 : 1997 - Table 3.9

Basic span/effective depth ratio $\text{ratio}_{basic} = \mathbf{26.0}$

Keith Farquharson Associates 14 Sandhurst Lane, Blackwater, GU17 0DH	Project				Job Ref.	
	41 Eastern Avenue.				S/032314	
	Section				Sheet no./rev.	
	Ground Beam				7	
	Calc. by	Date	Chk'd by	Date	App'd by	Date
		08/03/2023				

Modification of span/effective depth ratio for tension reinforcement (cl 3.4.6.5)

From BS8110 : Part 1 : 1997 - Table 3.10

Modification factor for tension reinforcement $\text{factor}_{\text{tens}} = 1.692$

Modification of span/effective depth ratio for compression reinforcement (cl 3.4.6.6)

From BS8110 : Part 1 : 1997 - Table 3.11

Modification factor for compression reinforcement $\text{factor}_{\text{comp}} = 1.097$

Check span/effective depth ratio (cl 3.4.6.1)

Allowable span/effective depth ratio $\text{ratio}_{\text{adm}} = \text{ratio}_{\text{basic}} \times \text{factor}_{\text{tens}} \times \text{factor}_{\text{comp}} = 48.250$

Actual span/effective depth ratio $\text{ratio}_{\text{act}} = L_s / d = 15.000$

PASS - Span/effective depth ratio is adequate

Beam reinforcement summary

Design section 1 - 1755 mm along continuous span 1

Beam section	Rectangular section 600 wide x 300 deep
Top reinforcement	4H12 (452 mm²)
Bottom reinforcement	4H12 (452 mm²)
Shear reinforcement	2H10 legs @ 150 centres (1047 mm²/m)

Keith Farquharson Associates

Sketch Sheet

Site Address. 41 Eastern Avenue.

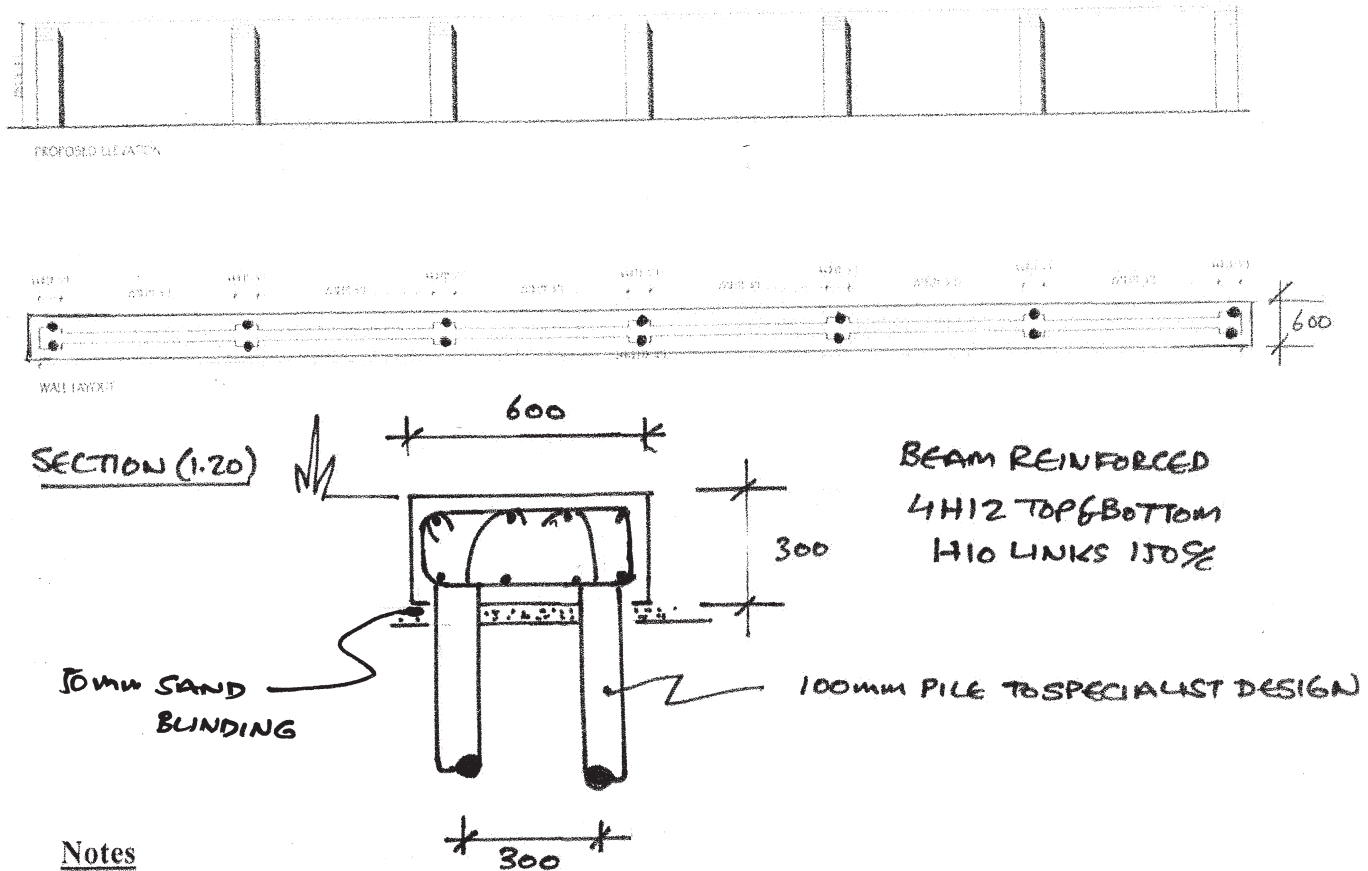
Ref S/032314

Sheet 1

Part Structural Details.

Date Mar. 23

Garden Wall Foundation



Notes

1. All dimensions in mm are approximate do not scale from this drawing
2. All concrete to be 35N/mm^2 , max agg 20mm, min cement 330 kg/m^3 .
To be compacted by immersion vibrator.
3. Piles to be min 100mm to specialist design with a minimum factor of safety of 3 with a safe working load of 35 kN

All piles reinforced for full depth reinforcement to project 600mm from cut off.
4. Cover to reinforcement 50 mm all round, min splice 650mm. Pile to project 40mm in to ground beam.
5. Anti heave precautions to be provided to piles and ground beam if required.