



Structural Design Report

Raft Foundation Design

17 Park Road, Malmesbury,
SN16 0BX



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1. EXECUTIVE SUMMARY

This report presents the structural design for the proposed single-story rear and side (garage) extension at 17 Park Road, SN16 0BX. The design focuses on providing a robust foundation solution suitable for the site conditions and proposed superstructure loads.

The proposed foundation solution comprises a reinforced concrete raft foundation with thickened edge beams. This solution has been selected to safely distribute imposed and dead loads to the ground while mitigating potential differential settlement, considering the gentle fall of the site from front to rear.

The design has been carried out in accordance with current Eurocodes and relevant UK National Annexes. The calculations demonstrate that the proposed structural elements satisfy the requirements for ultimate and serviceability limit states.



2. PROJECT DESCRIPTION

Property Address:	17 Park Road, Malmesbury, SN16 0BX
Client:	Richard Parker (ppelectrical30@gmail.com)
Report Reference:	HWE-MMXXVI-0012_Revision 01
Inspection Date:	Not Applicable
Report Date:	11/01/2026

The project involves the construction of a single-story extension to the rear and side of the existing property. The extension will function as a garage and additional living space.

The site is characterized by a gentle fall from the front to the rear of the property. This topography has been accounted for in the foundation strategy, utilizing a raft slab construction to minimize excavation depths and provide a uniform bearing platform.



3. SCOPE OF WORK

This report covers the SUBSTRUCTURE DESIGN ONLY. The scope includes the design of the reinforced concrete raft foundation, including thickened edge beams and the internal ground bearing slab.

EXCLUSIONS

The following elements are explicitly excluded from this report and associated calculations:

- Superstructure masonry walls Roof structure (timber or steel)
- Lintels, beams, and structural openings
- Connection details between new and existing structures (above foundation level)

Please refer to Appendix B for detailed structural calculations supporting this design.



4. DESIGN STANDARDS AND CODES

The structural design has been prepared in accordance with the following European Standards and their UK National Annexes:

- BS EN 1990: Eurocode 0 - Basis of Structural Design
- BS EN 1991: Eurocode 1 - Actions on Structures (Dead and Imposed Loads)
- BS EN 1992: Eurocode 2 - Design of Concrete Structures
- BS EN 1997: Eurocode 7 - Geotechnical Design

5. DESIGN PARAMETERS

5.1 STRUCTURAL DIMENSIONS

Element	Dimension
Foundation Edge Beam Width	600 mm
Foundation Edge Beam Depth	600 mm
Internal Slab Thickness	200 mm
Foundation Depth	Minimum 800 mm below existing ground level

5.2 MATERIAL PROPERTIES

Material	Specification
Concrete Strength Class	C25/30
Reinforcement Steel	Grade 500 (High Yield), Class B or C
Exposure Class	XC2 (Buried concrete)

5.3 LOADING PARAMETERS

- Dead Loads:
 - Suspended Ground Floor: 4.50 kN/m²
 - Flat Roof: 1.40 kN/m²
 - External Walls (Cavity): 7.50 kN/m² per story
- Imposed (Live) Loads:
 - Domestic Floor: 1.50 kN/m²
 - Roof (Maintenance): 0.75 kN/m²

6. SPECIFICATIONS

6.1 MATERIALS

Concrete:

All concrete for the raft foundation shall be C25/30 strength class in accordance with BS EN 206 and BS 8500. Maximum aggregate size 20mm. Minimum cement content and maximum water-cement ratio to satisfy durability requirements for the ground conditions encountered.

Reinforcement:

All bar reinforcement shall be Grade 500B or 500C high yield deformed bars in accordance with BS 4449. Steel mesh fabric shall be Grade 500 in accordance with BS 4483. All reinforcement must be free from loose rust, oil, grease, or other deleterious matter.

Hardcore:

Well-compacted, non-frost susceptible granular sub-base (MOT Type 1 or similar approved) laid in layers not exceeding 150mm thickness.

6.2 CONSTRUCTION REQUIREMENTS

- Excavation: Excavations are to be taken down to competent natural strata. Any soft spots encountered at formation level must be removed and replaced with lean mix concrete or compacted granular fill.
- Cover: Minimum concrete cover to reinforcement shall be 40mm (nom.) to all faces against blinding/membrane.
- Curing: Concrete must be properly cured to prevent rapid drying and shrinkage cracking. Curing compounds or polythene sheeting should be used immediately after finishing.

7. REINFORCEMENT SCHEDULE

Reinforcement is to be provided as follows:

Element	Position	Reinforcement Detail
Edge Beam (600mm x 600mm)	Top	3 No. H16 Bars
	Bottom	3 No. H16 Bars
	Links (Shear)	H12 Links @ 350mm centres
Internal Slab (200mm thick)	Top	A393 Mesh (Main structural mesh)
	Bottom	None



8. DESIGN ASSUMPTIONS

The following assumptions have been made in the preparation of this design.

- Ground Investigation: An allowable bearing pressure of 50 kN/m² has been conservatively assumed for design purposes (typical of firm clay or medium-dense granular soils). No site-specific ground investigation has been carried out.
- Ground conditions consist of competent natural strata suitable for shallow foundations.
- The site is free from made ground, uncontrolled fill, peat, or organic material within the zone of influence.
- No significant shrinkable clay is present. The influence of nearby trees is considered negligible for this foundation design.
- Groundwater table is assumed to be below the formation level; no hydrostatic pressure design included.
- No underground services, existing foundations, or obstructions interfere with the proposed layout.
- Construction Phasing & Temporary Works: The safe sequence of construction, including stability of excavations and temporary support to existing structures, is the sole responsibility of the contractor.



9. CONSTRUCTION NOTES

- All dimensions are in millimeters unless noted otherwise.
- The contractor is to verify all dimensions on site before commencing work.
- All reinforcement is to be rigidly fixed and supported on approved plastic spacers or concrete blocks to ensure correct cover is maintained during concreting.
- Building Control Officer is to inspect the formation level prior to blinding and the reinforcement prior to concreting.



10. LIMITATIONS

The design contained herein is based on the architectural layouts provided. Any changes to the layout or loading must be referred back to the structural engineer. The design validity is contingent upon the accuracy of the assumed ground conditions. If the ground conditions encountered on site differ from those assumed (e.g., made ground, soft clay, high water table), work must cease and the engineer must be contacted immediately for a design review.



APPENDIX A – STRUCTURAL DRAWINGS

GENERAL NOTES

- 1. All dimensions are in millimetres unless noted otherwise.
- 2. Contractor to verify all dimensions on site prior to construction.
- 3. This drawing is to be read in conjunction with the Structural Design Report Ref: HWE-MMXXVI-0112 Rev 01 and relevant architectural drawings.
- 4. Any discrepancies, uncertainties, or changes to layout or loading must be referred to the Structural Engineer prior to construction.

FOUNDATION DESIGN

- 5. The foundation solution comprises a reinforced concrete raft foundation with thickened edge beams, designed in accordance with BS EN 1992 and BS EN 1997.
- 6. The proposed rear load-bearing wall is critical from a loading perspective.
- 7. The edge beam design has been governed by loading from the rear wall and has been uniformly applied to all perimeter edge beams as a conservative design approach.
- 8. No reduction in reinforcement or beam size is permitted without written approval from the Structural Engineer.

GEOTECHNICAL & FORMATION

- 9. No site investigation has been undertaken. An allowable bearing pressure of 50 kN/m² has been assumed.
- 10. Foundations shall be founded on competent natural strata only.
- 11. Any soft spots, made ground, organic material, or unexpected ground conditions encountered at formation level shall be removed and replaced with lean mix concrete or engineered granular fill.
- 12. The Structural Engineer must be notified immediately if ground conditions differ from those assumed.

CONCRETE & REINFORCEMENT

- 13. Concrete to foundations shall be C25/30, exposure class XC2, in accordance with BS EN 206 and BS 8500.
- 14. Reinforcement shall be Grade 500B or 500C high-yield steel to BS 4449.
- 15. Minimum nominal concrete cover to reinforcement shall be 40mm to all faces.
- 16. All reinforcement to be securely fixed and supported on approved spacers to maintain cover during concreting.

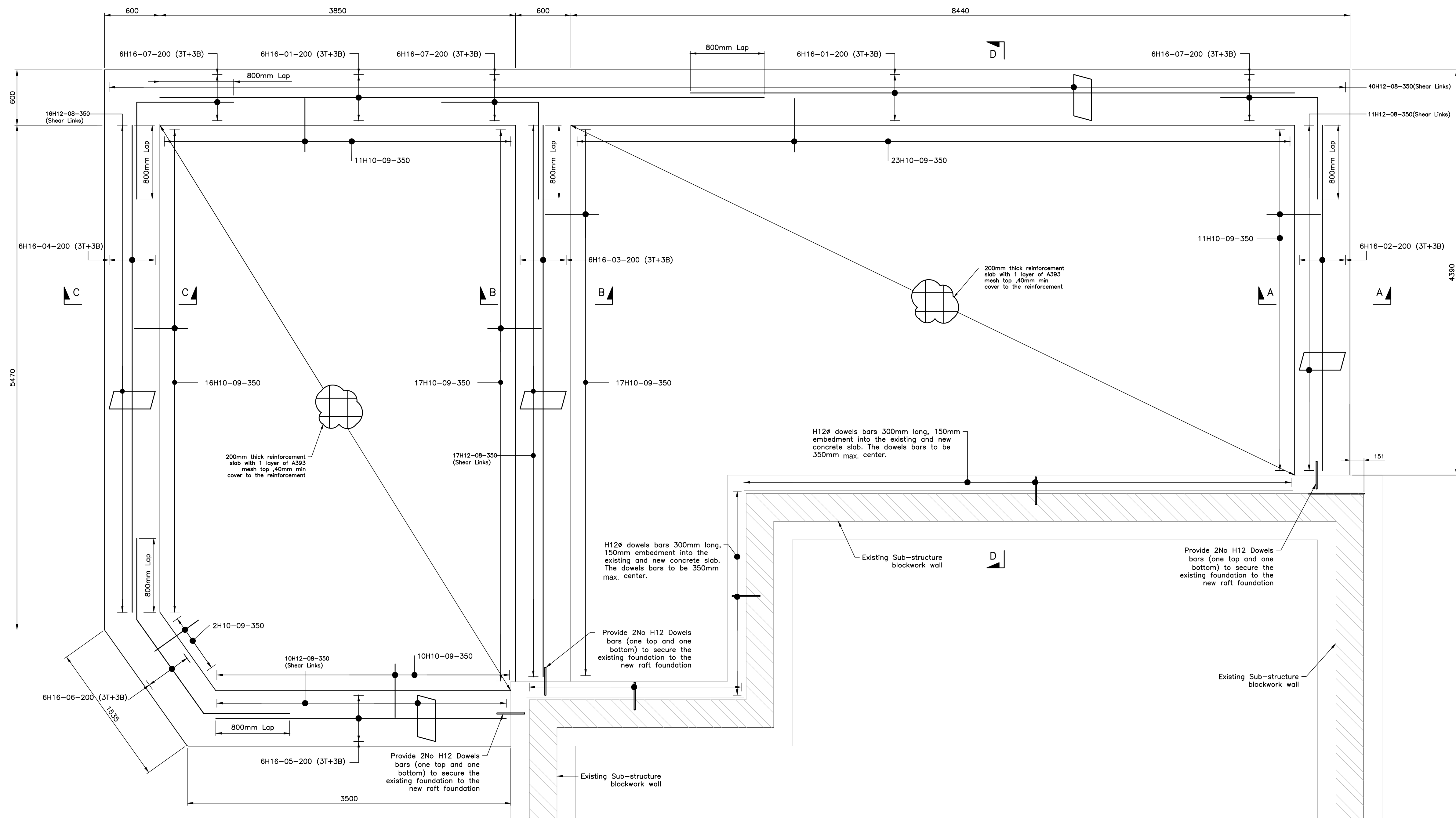
EDGE BEAMS

- 17. Edge beam size: 600mm wide × 600mm deep.
- 18. Edge beam reinforcement to be continuous around the perimeter of the raft.
- 19. Starter bars / continuity reinforcement to be maintained at corners and junctions.
- 20. All laps to comply with Eurocode requirements:
 - Bars: 640mm minimum
 - Mesh: 300mm minimum

CONSTRUCTION & INSPECTION

- 21. A Building Control inspection is required at the following stages:
 - Foundation excavation and formation
 - Reinforcement placement prior to concreting
- 22. Concrete shall not be poured until approval has been obtained from Building Control.
- 23. Concrete to be properly compacted and cured to prevent shrinkage cracking.

A	BM	JK	FOR CONSTRUCTION		10.01.26
Rev.	By	App.	Description	Date	
Project					
17 PARK ROAD					
Drawing Title					
STRUCTURAL DESIGN SPECIFICATIONS					
Job No.	Drawing No.	Revision	Scale	Issue Status	
0107	02	A		FOR CONSTRUCTION	
HOMEWISE ENGINEERING					
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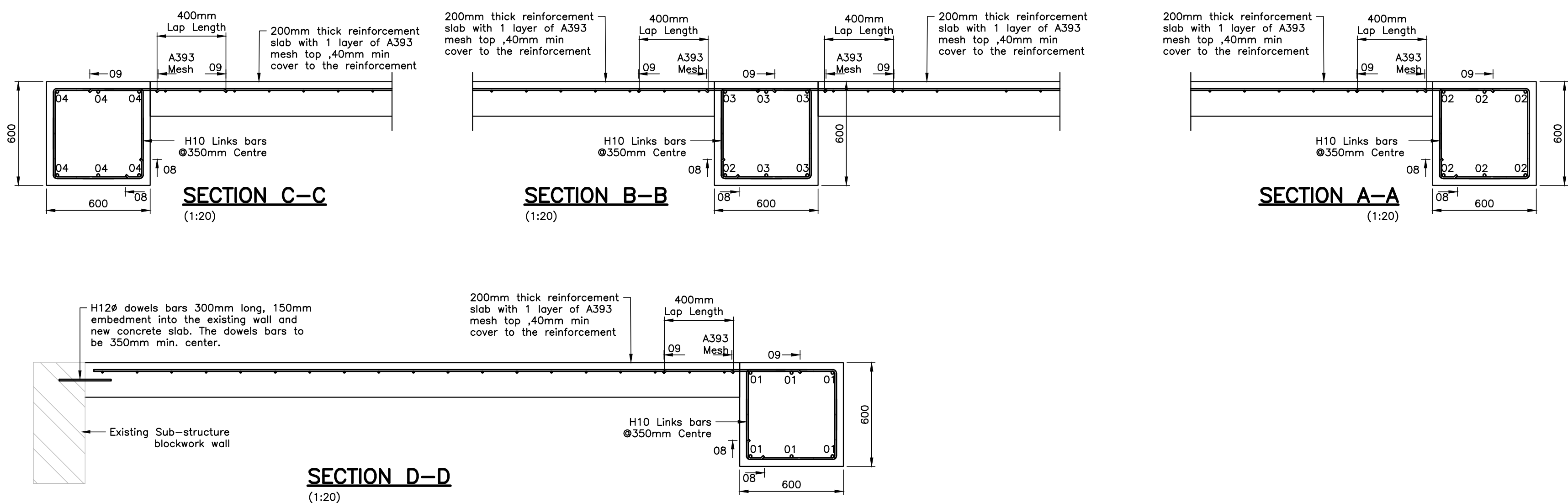


STRUCTURAL NOTES

- The drawing shall be read in conjunction with drawing number 001 and 002
- All concrete for foundations is to conform to BS EN 206, BS 8500-1 and BS8500-2.
Compressive strength class = C25/30
Minimum cement content = 340kg/m³
Maximum w/c ratio = 0.4
Maximum aggregate size = 20mm
Permitted cement type = CEM 1
Design Sulphate Class = DS-1 for Water soluble sulphate < 500mg/l
Aggressive Chemical Environment for Concrete = AC-1
Design Chemical Class = DC-1
Nominal cover to be 40mm to top and 40mm to all other faces.
- Minimum lap length: 40 x H₀.
- Bars prefixed 'H' are grade 500 in accordance with BS 4449:2000
- Surface flatness to be SR3 in accordance with SCIP300 10mm over 3m.
- All concrete to be placed in accordance with the recommendations of BS EN 13670 and BS EN 1992. Should the air temperature fall to 4° c or less, special precautions are to be taken, all to the approval of the engineer.

RAFT FOUNDATION AND SLAB REINFORCEMENT LAYOUT PLAN

(1:25)



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Bar schedule ref:

Rev letter

Site ref: 17 PARK ROAD

Date prepared: 11-Jan-26

Job no: 0107

Prepared by: BM

Checked by: JK

Member	Bar mark	Type and size	No. of mbrs	No. of bars in each	Total no.	Length of each bar ↑ mm	Shape code	A * mm	B * mm	C * mm	D * mm	E/R * mm	Rev letter
	01	H 16	1	12	12	6500	00	6500					
	02	H 16	1	6	6	3750	00	3750					
	03	H 16	1	6	6	6000	00	6000					
	04	H 16	1	6	6	5275	00	5275					
	05	H 16	1	6	6	3150	00	3150					
	06	H 16	1	6	6	3100	24	920	1250	920	1020		
	07	H 16	1	18	18	2075	11	1050	1050				
	08	H 12	1	95	95	2275	51	520	520				
	09	H 10	1	107	107	800	00	800					

Rev.	By	App.	Description	Date

17 PARK ROAD

Drawing Title

RAFT FOUNDATION REINFORCEMENT DETAIL

Job No.	Drawing No.	Revision	Scale	Issue Status
0107	03	A	AS SHOWN	FOR CONSTRUCTION

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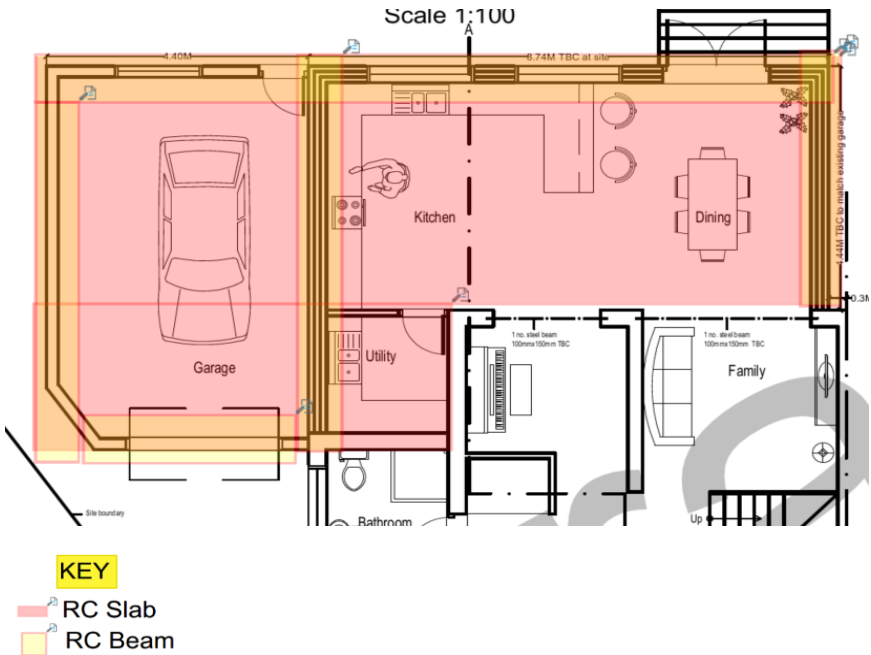
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APPENDIX B – STRUCTURAL CALCULATIONS

Project:	17 Park Road - SN16 0BX			
Document Ref.	HWE-MMXXVI-CAL-0112	Revision:	1	
Created by:	BM	Checked by:	JK	
Date:	10/01/2026	Date:	10/01/2026	
Reference	Calculations			Output
	1.0 INTRODUCTION This calculations present the proposed rear and side (garage) single-storey extension at 17 Park Road, SN16 0BX. The purpose of this report is to demonstrate the adequacy of the proposed substructure design only, in accordance with relevant British Standards and current engineering practice. The site is at a gentle fall from the front to the rear of the property, which has been taken into account in the foundation strategy. The proposed foundation solution comprises a reinforced concrete raft foundation, incorporating thickened edge and internal sections beneath the load-bearing walls of the extension. The raft is designed to safely distribute imposed and dead loads to the ground while limiting differential settlement. Superstructure elements are excluded from the scope of these calculations. 2.0 DESIGN ASSUMPTIONS 1. The structural design is limited to the substructure (raft foundation) only. 2. All dimensions and layouts are based on the latest architectural drawings received. 3. Construction is assumed to be carried out in accordance with good workmanship practices and relevant British Standards. 4. The ground conditions are assumed to consist of competent natural strata suitable for shallow foundations. 5. An allowable bearing pressure of 100 kN/m² has been assumed for design, typical of firm clay or medium-dense granular soils. 6. The ground is assumed to be free from made ground, uncontrolled fill, peat, or organic material within the zone of influence of the foundation. 7. No significant shrinkable clay is assumed to be present, and the influence of nearby trees on soil volume change is considered negligible. 8. The groundwater table is assumed to be below the level of the proposed foundation, with no hydrostatic pressure acting on the raft. 9. The ground is assumed to have uniform bearing capacity, with no abrupt changes in strata across the footprint of the extension. 10. The site is assumed to be free from contamination that could adversely affect concrete durability. 11. No underground services, existing foundations, or obstructions are assumed to interfere with the proposed foundation layout.			

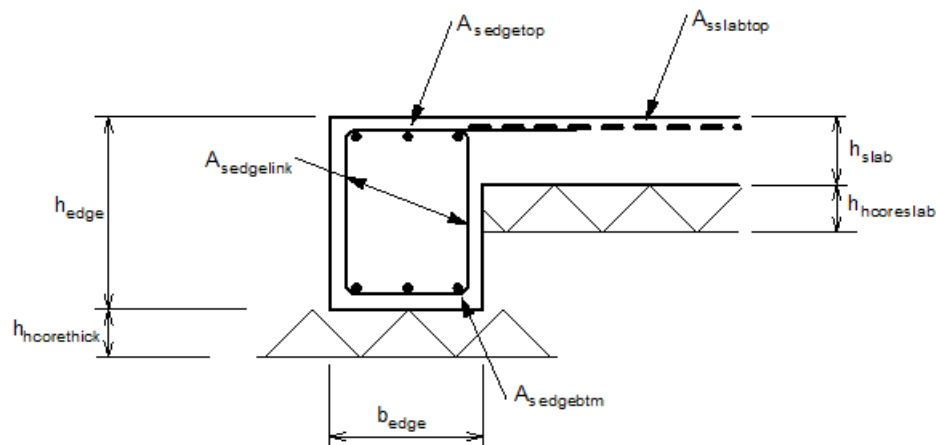
Project:	17 Park Road - SN16 0BX			
Document Ref.	HWE-MMXXVI-CAL-0112	Revision:	1	
Created by:	BM	Checked by:	JK	
Date:	10/01/2026	Date:	10/01/2026	
Reference	Calculations			Output
	3.0 ARCHITECTURAL DRAWING EXCERPT  4.0 DESIGN PARAMETERS Width of the foundation beam = 600 mm Depth of the foundation beam = 600 mm Slab thickness = 200 mm Bottom of foundation = 800 mm (from existing ground level) Proposed wall thickness = 300 mm Proposed wall height = 4000 mm Width of proposed rear flat roof = 4500 mm Width of proposed rear suspended floor = 4500 mm Note: The proposed rear wall is considered critical from a loading perspective. The foundation edge beam has therefore been designed based on the loads from this wall and applied to all edge beams, adopting a conservative design approach.			

Project:	17 Park Road - SN16 0BX												
Document Ref.	HWE-MMXXVI-CAL-0112		Revision:		1								
Created by:	BM	Checked by:	JK										
Date:	10/01/2026	Date:	10/01/2026										
Reference	Calculations			Output									
	5.0 LOADING Typical unfactored loading: <table><tr><th>Element</th><th>Dead Load (kN/m²)</th><th>Live Load (kN/m²)</th></tr><tr><td>*Suspended ground floor</td><td>4.50</td><td>1.50</td></tr><tr><td>Flat roof</td><td>1.40</td><td>0.75</td></tr></table> *RC slab/finishes has been assumed - conservative design approach. Standard cavity wall (external) = 7.50 kN/m per storey Width of roof/floor supported on wall = 4500/2 = 2250 mm Dead load Standard cavity wall (external) = 7.50 = 7.50 kN/m Suspended ground floor = 4.50* 2250/1000 = 10.13 kN/m Flat roof = 1.40* 2250/1000 = 3.15 kN/m Total Dead Load = 7.50+10.13+3.15 = 20.78 kN/m Live load Suspended ground floor = 1.50* 2250/1000 = 3.38 kN/m Flat roof = 0.75* 2250/1000 = 1.69 kN/m Total Live Load = 3.38+1.69 = 5.06 kN/m 6.3 DESIGN ANALYSIS For design calculations refer to Tekla Tedds software output below:			Element	Dead Load (kN/m ²)	Live Load (kN/m ²)	*Suspended ground floor	4.50	1.50	Flat roof	1.40	0.75	
Element	Dead Load (kN/m ²)	Live Load (kN/m ²)											
*Suspended ground floor	4.50	1.50											
Flat roof	1.40	0.75											

Project 17 Park Road - SN16 0BX				Job no. 0112	
Calcs for Raft Foundation				Start page no./Revision 1	
Calcs by BM	Calcs date 10/01/2026	Checked by JK	Checked date 10/01/2026	Approved by JK	Approved date 10/01/2026

RAFT FOUNDATION DESIGN (BS8110 : PART 1 : 1997)

Tedds calculation version 1.0.12



Soil and raft definition

Soil definition

Allowable bearing pressure
Number of types of soil forming sub-soil
Soil density
Depth of hardcore beneath slab
Depth of hardcore beneath thickenings
Density of hardcore
Basic assumed diameter of local depression
Diameter under slab modified for hardcore
Diameter under thickenings modified for hardcore

$$q_{\text{allow}} = 50.0 \text{ kN/m}^2$$

One type only

Firm to loose

$$h_{\text{hcoreslab}} = 200 \text{ mm} \text{ (Dispersal allowed for bearing pressure check)}$$

$$h_{\text{hcorethick}} = 200 \text{ mm} \text{ (Dispersal allowed for bearing pressure check)}$$

$$\gamma_{\text{hcore}} = 18.0 \text{ kN/m}^3$$

$$\phi_{\text{depbasic}} = 2000 \text{ mm}$$

$$\phi_{\text{dep slab}} = \phi_{\text{depbasic}} - h_{\text{hcoreslab}} = 1800 \text{ mm}$$

$$\phi_{\text{dep thick}} = \phi_{\text{depbasic}} - h_{\text{hcorethick}} = 1800 \text{ mm}$$

Raft slab definition

Max dimension/max dimension between joints
Slab thickness
Concrete strength
Poissons ratio of concrete
Slab mesh reinforcement strength
Partial safety factor for steel reinforcement
From C&CA document 'Concrete ground floors' Table 5
Minimum mesh required in top for shrinkage
Actual mesh provided in top
Mesh bar diameter
Cover to top reinforcement
Average effective depth of top reinforcement

$$l_{\text{max}} = 4.500 \text{ m}$$

$$h_{\text{slab}} = 200 \text{ mm}$$

$$f_{\text{cu}} = 25 \text{ N/mm}^2$$

$$\nu = 0.2$$

$$f_{\text{yslab}} = 500 \text{ N/mm}^2$$

$$\gamma_s = 1.15$$

$$\mathbf{A142}$$

$$\mathbf{A393 (A_{\text{slabtop}} = 393 \text{ mm}^2/\text{m})}$$

$$\phi_{\text{slabtop}} = 10 \text{ mm}$$

$$c_{\text{top}} = 40 \text{ mm}$$

$$d_{\text{slabav}} = h_{\text{slab}} - c_{\text{top}} - \phi_{\text{slabtop}} = 150 \text{ mm}$$

Project 17 Park Road - SN16 0BX				Job no. 0112	
Calcs for Raft Foundation				Start page no./Revision 2	
Calcs by BM	Calcs date 10/01/2026	Checked by JK	Checked date 10/01/2026	Approved by JK	Approved date 10/01/2026

Minimum effective depth of top reinforcement

$$d_{tslabmin} = d_{tslabav} - \phi_{slabtop}/2 = \mathbf{145 \text{ mm}}$$

Edge beam definition

Overall depth

$$h_{edge} = \mathbf{600 \text{ mm}}$$

Width

$$b_{edge} = \mathbf{600 \text{ mm}}$$

Strength of main bar reinforcement

$$f_y = \mathbf{500 \text{ N/mm}^2}$$

Strength of link reinforcement

$$f_{ys} = \mathbf{500 \text{ N/mm}^2}$$

Reinforcement provided in top

$$\mathbf{3 \text{ H16 bars } (A_{sedge\text{top}} = 603 \text{ mm}^2)}$$

Reinforcement provided in bottom

$$\mathbf{3 \text{ H16 bars } (A_{sedge\text{btm}} = 603 \text{ mm}^2)}$$

Link reinforcement provided

$$\mathbf{2 \text{ H12 legs at 350 ctrs } (A_{sv}/s_v = 0.646 \text{ mm})}$$

Bottom cover to links

$$C_{beam} = \mathbf{40 \text{ mm}}$$

Effective depth of top reinforcement

$$d_{edgetop} = h_{edge} - C_{top} - \phi_{slabtop} - \phi_{edgeline} - \phi_{edgetop}/2 = \mathbf{530 \text{ mm}}$$

Effective depth of bottom reinforcement

$$d_{edgebtm} = h_{edge} - C_{beam} - \phi_{edgeline} - \phi_{edgebtm}/2 = \mathbf{540 \text{ mm}}$$

Internal slab design checks

Basic loading

Slab self weight

$$W_{slab} = 24 \text{ kN/m}^3 \times h_{slab} = \mathbf{4.8 \text{ kN/m}^2}$$

Hardcore

$$W_{hcoreslab} = \gamma_{hcore} \times h_{hcoreslab} = \mathbf{3.6 \text{ kN/m}^2}$$

Applied loading

Uniformly distributed dead load

$$W_{Dudl} = \mathbf{2.5 \text{ kN/m}^2}$$

Uniformly distributed live load

$$W_{Ludl} = \mathbf{2.5 \text{ kN/m}^2}$$

Internal slab bearing pressure check

Total uniform load at formation level

$$W_{udl} = W_{slab} + W_{hcoreslab} + W_{Dudl} + W_{Ludl} = \mathbf{13.4 \text{ kN/m}^2}$$

PASS - $W_{udl} \leq q_{allow}$ - Applied bearing pressure is less than allowable

Internal slab bending and shear check

Applied bending moments

Effective span of slab

$$l_{slab} = (\phi_{depslab} + d_{tslabav})/2 = \mathbf{975 \text{ mm}}$$

Ultimate self weight udl

$$W_{swult} = 1.4 \times W_{slab} = \mathbf{6.7 \text{ kN/m}^2}$$

Approximate self weight cantilever moment at edge

$$M_{esw} = (W_{swult} \times \pi \times l_{slab}^2) \times (l_{slab}/3) / (2 \times \pi \times l_{slab}) = \mathbf{1.1 \text{ kNm/m}}$$

Self weight shear force at edge

$$V_{sw} = W_{swult} \times l_{slab} / 2 = \mathbf{3.3 \text{ kN/m}}$$

Moments due to applied uniformly distributed loads

Ultimate applied udl

$$W_{udlult} = 1.4 \times W_{Dudl} + 1.6 \times W_{Ludl} = \mathbf{7.5 \text{ kN/m}^2}$$

Approximate cantilever moment at edge

$$M_{eudl} = (W_{udlult} \times \pi \times l_{slab}^2) \times (l_{slab}/3) / (2 \times \pi \times l_{slab}) = \mathbf{1.2 \text{ kNm/m}}$$

Shear force at edge

$$V_{udl} = W_{udlult} \times l_{slab} / 2 = \mathbf{3.7 \text{ kN/m}}$$

Resultant moments and shears

Total moment at edge

$$M_{\Sigma e} = \mathbf{2.3 \text{ kNm/m}}$$

Total shear force

$$V_{\Sigma} = \mathbf{6.9 \text{ kN/m}}$$

Reinforcement required in top

K factor

$$K_{slabtop} = M_{\Sigma e} / (f_{cu} \times d_{tslabav}^2) = \mathbf{0.004}$$

Lever arm

$$Z_{slabtop} = d_{tslabav} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{slabtop}/0.9)}) = \mathbf{142.5 \text{ mm}}$$

Area of steel required for bending

$$A_{sslabtopbend} = M_{\Sigma e} / ((1.0/\gamma_s) \times f_{yslab} \times Z_{slabtop}) = \mathbf{36 \text{ mm}^2/\text{m}}$$

Minimum area of steel required

$$A_{sslabmin} = 0.0013 \times h_{slab} = \mathbf{260 \text{ mm}^2/\text{m}}$$

Area of steel required

$$A_{sslabtopreq} = \max(A_{sslabtopbend}, A_{sslabmin}) = \mathbf{260 \text{ mm}^2/\text{m}}$$

PASS - $A_{sslabtopreq} \leq A_{sslabtop}$ - Area of reinforcement provided in top to span local depressions is adequate

Project				Job no.	
17 Park Road - SN16 0BX				0112	
Calcs for				Start page no./Revision	
Raft Foundation				3	
Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
BM	10/01/2026	JK	10/01/2026	JK	10/01/2026

Shear check

Applied shear stress

$$v = V_s/d_{slabmin} = \mathbf{0.048 \text{ N/mm}^2}$$

Tension steel ratio

$$\rho = 100 \times A_{slabtop}/d_{slabmin} = \mathbf{0.271}$$

From BS8110-1:1997 - Table 3.8

Design concrete shear strength

$$v_c = \mathbf{0.527 \text{ N/mm}^2}$$

PASS - $v \leq v_c$ - Shear capacity of the slab is adequate

Internal slab deflection check

Basic allowable span to depth ratio

$$Ratio_{basic} = \mathbf{7.0}$$

Moment factor

$$M_{factor} = M_{\Sigma e}/d_{slabav}^2 = \mathbf{0.100 \text{ N/mm}^2}$$

Steel service stress

$$f_s = 2/3 \times f_{yslab} \times A_{slabtopbend}/A_{slabtop} = \mathbf{30.843 \text{ N/mm}^2}$$

Modification factor

$$MF_{slab} = \min(2.0, 0.55 + [(477 \text{ N/mm}^2 - f_s)/(120 \times (0.9 \text{ N/mm}^2 + M_{factor}))])$$

$$MF_{slab} = \mathbf{2.000}$$

Modified allowable span to depth ratio

$$Ratio_{allow} = Ratio_{basic} \times MF_{slab} = \mathbf{14.000}$$

Actual span to depth ratio

$$Ratio_{actual} = l_{slab}/d_{slabav} = \mathbf{6.500}$$

PASS - $Ratio_{actual} \leq Ratio_{allow}$ - Slab span to depth ratio is adequate

Edge beam design checks

Basic loading

Hardcore

$$W_{hcorethick} = \gamma_{hcore} \times h_{hcorethick} = \mathbf{3.6 \text{ kN/m}^2}$$

Edge beam self weight

$$W_{edge} = 24 \text{ kN/m}^3 \times h_{edge} \times b_{edge} = \mathbf{8.6 \text{ kN/m}}$$

Edge load number 1

Load type

Longitudinal line load

Dead load

$$W_{Dedge1} = \mathbf{12.9 \text{ kN/m}}$$

Live load

$$W_{Ledge1} = \mathbf{1.4 \text{ kN/m}}$$

Ultimate load

$$W_{ultedge1} = 1.4 \times W_{Dedge1} + 1.6 \times W_{Ledge1} = \mathbf{20.4 \text{ kN/m}}$$

Longitudinal line load width

$$b_{edge1} = \mathbf{140 \text{ mm}}$$

Centroid of load from outside face of raft

$$X_{edge1} = \mathbf{200 \text{ mm}}$$

Edge beam bearing pressure check

Effective bearing width of edge beam

$$b_{bearing} = b_{edge} = \mathbf{600 \text{ mm}}$$

Total uniform load at formation level

$$W_{udledge} = W_{Dudl} + W_{Ludl} + W_{edge}/b_{bearing} + W_{hcorethick} = \mathbf{23.0 \text{ kN/m}^2}$$

Centroid of longitudinal and equivalent line loads from outside face of raft

Load x distance for edge load 1

$$Moment_1 = W_{ultedge1} \times X_{edge1} = \mathbf{4.1 \text{ kN}}$$

Sum of ultimate longitud'l and equivalent line loads $\Sigma UDL = \mathbf{20.4 \text{ kN/m}}$

Sum of load x distances

$$\Sigma Moment = \mathbf{4.1 \text{ kN}}$$

Centroid of loads

$$X_{bar} = \Sigma Moment / \Sigma UDL = \mathbf{200 \text{ mm}}$$

Initially assume no moment transferred into slab due to load/reaction eccentricity

Sum of unfactored longitud'l and eff'tive line loads $\Sigma UDL_{sls} = \mathbf{14.3 \text{ kN/m}}$

Allowable bearing width

$$b_{allow} = 2 \times X_{bar} + 2 \times h_{hcoreslab} \times \tan(30) = \mathbf{631 \text{ mm}}$$

Bearing pressure due to line/point loads

$$q_{linepoint} = \Sigma UDL_{sls} / b_{allow} = \mathbf{22.7 \text{ kN/m}^2}$$

Total applied bearing pressure

$$q_{edge} = q_{linepoint} + W_{udledge} = \mathbf{45.7 \text{ kN/m}^2}$$

PASS - $q_{edge} \leq q_{allow}$ - Allowable bearing pressure is not exceeded

Edge beam bending check

Divider for moments due to udl's

$$\beta_{udl} = \mathbf{8.0}$$

Applied bending moments

Span of edge beam

$$l_{edge} = \phi_{depthick} + d_{edgetop} = \mathbf{2330 \text{ mm}}$$

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Ultimate self weight udl $W_{dult} = 1.4 \times W_{edge} = \mathbf{12.1 \text{ kN/m}}$
 Ultimate slab udl (approx) $W_{dgeslab} = \max(0 \text{ kN/m}, 1.4 \times W_{slab} \times ((\phi_{depth}/2 \times 3/4) - b_{edge})) = \mathbf{0.5 \text{ kN/m}}$
 Self weight and slab bending moment $M_{dgesw} = (W_{dgeult} + W_{dgeslab}) \times l_{edge}^2 / \beta_{udl} = \mathbf{8.6 \text{ kNm}}$
 Self weight shear force $V_{dgesw} = (W_{dgeult} + W_{dgeslab}) \times l_{edge} / 2 = \mathbf{14.7 \text{ kN}}$

Moments due to applied uniformly distributed loads

Ultimate udl (approx) $W_{dgeudl} = W_{dult} \times \phi_{depth} / 2 \times 3/4 = \mathbf{5.1 \text{ kN/m}}$
 Bending moment $M_{dgeudl} = W_{dgeudl} \times l_{edge}^2 / \beta_{udl} = \mathbf{3.4 \text{ kNm}}$
 Shear force $V_{dgeudl} = W_{dgeudl} \times l_{edge} / 2 = \mathbf{5.9 \text{ kN}}$

Moment and shear due to load number 1

Bending moment $M_{edge1} = W_{ultedge1} \times l_{edge}^2 / \beta_{udl} = \mathbf{13.8 \text{ kNm}}$
 Shear force $V_{edge1} = W_{ultedge1} \times l_{edge} / 2 = \mathbf{23.7 \text{ kN}}$

Resultant moments and shears

Total moment (hogging and sagging) $M_{\Sigma edge} = \mathbf{25.8 \text{ kNm}}$
 Maximum shear force $V_{\Sigma edge} = \mathbf{44.3 \text{ kN}}$

Reinforcement required in top

Width of section in compression zone $b_{edgetop} = b_{edge} = \mathbf{600 \text{ mm}}$
 Average web width $b_w = b_{edge} = \mathbf{600 \text{ mm}}$
 K factor $K_{edgetop} = M_{\Sigma edge} / (f_{cu} \times b_{edgetop} \times d_{edgetop}^2) = \mathbf{0.006}$
 Lever arm $Z_{edgetop} = d_{edgetop} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{edgetop}/0.9)}) = \mathbf{503 \text{ mm}}$
 Area of steel required for bending $A_{sedgetopbend} = M_{\Sigma edge} / ((1.0/\gamma_s) \times f_y \times Z_{edgetop}) = \mathbf{118 \text{ mm}^2}$
 Minimum area of steel required $A_{sedgetopmin} = 0.0013 \times 1.0 \times b_w \times h_{edge} = \mathbf{468 \text{ mm}^2}$
 Area of steel required $A_{sedgetopreq} = \max(A_{sedgetopbend}, A_{sedgetopmin}) = \mathbf{468 \text{ mm}^2}$
PASS - $A_{sedgetopreq} \leq A_{sedgetop}$ - Area of reinforcement provided in top of edge beams is adequate

Reinforcement required in bottom

Width of section in compression zone $b_{edgebtm} = b_{edge} + 0.1 \times l_{edge} = \mathbf{833 \text{ mm}}$
 K factor $K_{edgebtm} = M_{\Sigma edge} / (f_{cu} \times b_{edgebtm} \times d_{edgebtm}^2) = \mathbf{0.004}$
 Lever arm $Z_{edgebtm} = d_{edgebtm} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{edgebtm}/0.9)}) = \mathbf{513 \text{ mm}}$
 Area of steel required for bending $A_{sedgetmbend} = M_{\Sigma edge} / ((1.0/\gamma_s) \times f_y \times Z_{edgebtm}) = \mathbf{116 \text{ mm}^2}$
 Minimum area of steel required $A_{sedgetbmin} = 0.0013 \times 1.0 \times b_w \times h_{edge} = \mathbf{468 \text{ mm}^2}$
 Area of steel required $A_{sedgetbreq} = \max(A_{sedgetmbend}, A_{sedgetbmin}) = \mathbf{468 \text{ mm}^2}$
PASS - $A_{sedgetbreq} \leq A_{sedgetbmin}$ - Area of reinforcement provided in bottom of edge beams is adequate

Edge beam shear check

Applied shear stress $V_{edge} = V_{\Sigma edge} / (b_w \times d_{edgetop}) = \mathbf{0.139 \text{ N/mm}^2}$
 Tension steel ratio $\rho_{edge} = 100 \times A_{sedgetop} / (b_w \times d_{edgetop}) = \mathbf{0.190}$
 From BS8110-1:1997 - Table 3.8 $V_{cedge} = \mathbf{0.363 \text{ N/mm}^2}$
 Design concrete shear strength $V_{edge} \leq V_{cedge} + 0.4 \text{ N/mm}^2$ - Therefore minimum links required
 Link area to spacing ratio required $A_{sv_upon_Svreqedge} = 0.4 \text{ N/mm}^2 \times b_w / ((1.0/\gamma_s) \times f_{ys}) = \mathbf{0.552 \text{ mm}}$
 Link area to spacing ratio provided $A_{sv_upon_Svprovedge} = N_{edgelink} \times \pi \times \phi_{edgelink}^2 / (4 \times S_{vedge}) = \mathbf{0.646 \text{ mm}}$
PASS - $A_{sv_upon_Svreqedge} \leq A_{sv_upon_Svprovedge}$ - Shear reinforcement provided in edge beams is adequate

Corner design checks

Basic loading

Corner bearing pressure check

Total uniform load at formation level $W_{udlcorner} = W_{Dudl} + W_{Ludl} + W_{edge}/b_{bearing} + W_{hcorethick} = \mathbf{23.0 \text{ kN/m}^2}$

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PASS - $W_{udl\text{corner}} \leq q_{allow}$ - Applied bearing pressure is less than allowable

Corner beam bending check

Cantilever span of edge beam

$$l_{\text{corner}} = \phi_{\text{depth}}/\sqrt{2} + d_{\text{edgetop}}/2 = \mathbf{1538 \text{ mm}}$$

Moment and shear due to self weight

Ultimate self weight udl

$$W_{\text{edgeult}} = 1.4 \times W_{\text{edge}} = \mathbf{12.1 \text{ kN/m}}$$

Average ultimate slab udl (approx)

$$W_{\text{cornerslab}} = \max(0 \text{ kN/m}, 1.4 \times W_{\text{slab}} \times (\phi_{\text{depth}}/(\sqrt{2} \times 2) - b_{\text{edge}})) = \mathbf{0.2 \text{ kN/m}}$$

Self weight and slab bending moment

$$M_{\text{cornersw}} = (W_{\text{edgeult}} + W_{\text{cornerslab}}) \times l_{\text{corner}}^2/2 = \mathbf{14.6 \text{ kNm}}$$

Self weight and slab shear force

$$V_{\text{cornersw}} = (W_{\text{edgeult}} + W_{\text{cornerslab}}) \times l_{\text{corner}} = \mathbf{19.0 \text{ kN}}$$

Moment and shear due to udls

Maximum ultimate udl

$$W_{\text{cornerudl}} = ((1.4 \times W_{\text{Dudl}}) + (1.6 \times W_{\text{Ludl}})) \times \phi_{\text{depth}}/\sqrt{2} = \mathbf{9.5 \text{ kN/m}}$$

Bending moment

$$M_{\text{cornerudl}} = W_{\text{cornerudl}} \times l_{\text{corner}}^2/6 = \mathbf{3.8 \text{ kNm}}$$

Shear force

$$V_{\text{cornerudl}} = W_{\text{cornerudl}} \times l_{\text{corner}}/2 = \mathbf{7.3 \text{ kN}}$$

Resultant moments and shears

Total design moment

$$M_{\Sigma\text{corner}} = M_{\text{cornersw}} + M_{\text{cornerudl}} = \mathbf{18.4 \text{ kNm}}$$

Total design shear force

$$V_{\Sigma\text{corner}} = V_{\text{cornersw}} + V_{\text{cornerudl}} = \mathbf{26.3 \text{ kN}}$$

Reinforcement required in top of edge beam

K factor

$$K_{\text{corner}} = M_{\Sigma\text{corner}}/(f_{\text{cu}} \times b_{\text{edgetop}} \times d_{\text{edgetop}}^2) = \mathbf{0.004}$$

Lever arm

$$Z_{\text{corner}} = d_{\text{edgetop}} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{\text{corner}}/0.9)}) = \mathbf{503 \text{ mm}}$$

Area of steel required for bending

$$A_{\text{scornerbend}} = M_{\Sigma\text{corner}}/((1.0/\gamma_s) \times f_y \times Z_{\text{corner}}) = \mathbf{84 \text{ mm}^2}$$

Minimum area of steel required

$$A_{\text{scornerman}} = A_{\text{sedgetopmin}} = \mathbf{468 \text{ mm}^2}$$

Area of steel required

$$A_{\text{scorner}} = \max(A_{\text{scornerbend}}, A_{\text{scornerman}}) = \mathbf{468 \text{ mm}^2}$$

PASS - $A_{\text{scorner}} \leq A_{\text{sedgetop}}$ - Area of reinforcement provided in top of edge beams at corners is adequate

Corner beam shear check

Average web width

$$b_w = b_{\text{edge}} = \mathbf{600 \text{ mm}}$$

Applied shear stress

$$v_{\text{corner}} = V_{\Sigma\text{corner}}/(b_w \times d_{\text{edgetop}}) = \mathbf{0.083 \text{ N/mm}^2}$$

Tension steel ratio

$$\rho_{\text{corner}} = 100 \times A_{\text{sedgetop}}/(b_w \times d_{\text{edgetop}}) = \mathbf{0.190}$$

From BS8110-1:1997 - Table 3.8

Design concrete shear strength

$$v_{\text{ccorner}} = \mathbf{0.338 \text{ N/mm}^2}$$

$v_{\text{corner}} \leq v_{\text{ccorner}} + 0.4 \text{ N/mm}^2$ - Therefore minimum links required

Link area to spacing ratio required

$$A_{\text{sv_upon_Svreqcorner}} = 0.4 \text{ N/mm}^2 \times b_w/((1.0/\gamma_s) \times f_{ys}) = \mathbf{0.552 \text{ mm}}$$

Link area to spacing ratio provided

$$A_{\text{sv_upon_Svprovedge}} = N_{\text{edgeline}} \times \pi \times \phi_{\text{edgeline}}^2/(4 \times S_{\text{vedge}}) = \mathbf{0.646 \text{ mm}}$$

PASS - $A_{\text{sv_upon_Svreqcorner}} \leq A_{\text{sv_upon_Svprovedge}}$ - Shear reinforcement provided in edge beams at corners is adequate

Corner beam deflection check

Basic allowable span to depth ratio

$$\text{Ratio}_{\text{basiccorner}} = \mathbf{7.0}$$

Moment factor

$$M_{\text{factorcorner}} = M_{\Sigma\text{corner}}/(b_{\text{edgetop}} \times d_{\text{edgetop}}^2) = \mathbf{0.109 \text{ N/mm}^2}$$

Steel service stress

$$f_{\text{scorner}} = 2/3 \times f_y \times A_{\text{scornerbend}}/A_{\text{sedgetop}} = \mathbf{46.332 \text{ N/mm}^2}$$

Modification factor

$$MF_{\text{corner}} = \min(2.0, 0.55 + [(477 \text{ N/mm}^2 - f_{\text{scorner}})/(120 \times (0.9 \text{ N/mm}^2 + M_{\text{factorcorner}})]))$$

$$MF_{\text{corner}} = \mathbf{2.000}$$

Modified allowable span to depth ratio

$$\text{Ratio}_{\text{allowcorner}} = \text{Ratio}_{\text{basiccorner}} \times MF_{\text{corner}} = \mathbf{14.000}$$

Actual span to depth ratio

$$\text{Ratio}_{\text{actualcorner}} = l_{\text{corner}}/d_{\text{edgetop}} = \mathbf{2.901}$$

PASS - $\text{Ratio}_{\text{actualcorner}} \leq \text{Ratio}_{\text{allowcorner}}$ - Edge beam span to depth ratio is adequate

END OF REPORT