

BASEMENT IMPACT ASSESSMENT FOR A PROPOSED SUBTERRANEAN DEVELOPMENT

AT:

**LAND ADJACENT TO
2 ALROY ROAD,
LONDON,
N4 1EF**

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**RSA
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220921/BIA

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LAND ADJACENT TO 2 ALROY ROAD, LONDON, N4 1EF

1. INTRODUCTION

- 1.1. The following Basement Impact Assessment (BIA) has been prepared for the planning application submitted by General Practice Architecture + Design (GPAD) for the subterranean development proposed at 7 Endymion Road, London, N4. It is to be read in conjunction with all Architect's and other Consultant's documents submitted with the Planning Application.
- 1.2. The proposals comprise construction of a new two-storey residential building, with a basement under part of the footprint.
- 1.3. This BIA has been prepared to address the requirements of London Borough of Haringey's Planning Policy DM18 for Residential Basement Developments and Lightwells.
- 1.4. This BIA provides specific details of the excavation, the temporary works and the construction technique proposed for the development and investigates the potential impact of the subterranean development on the existing and neighbouring structures.
- 1.5. This BIA has been prepared by Dominykas Talandis MEng, Engineer at RSA Design and Ravi Azad MEng CEng MICE MStructE, Director at RSA Design.

2. EXISTING SITE

- 2.1. The site address is 7 Endymion Road, London, N4 1EF and is located at approximate National Grid Reference 531493E, 187878N.
- 2.2. The site is located within the London Borough of Haringey.
- 2.3. The area of proposed structural development within the site has approximate dimensions of 13m x 10m.
- 2.4. The land is currently undeveloped.
- 2.5. Some trees are present within the area of proposed works. Due to the depth of excavation, the proposed subterranean development will not be impacted by the trees.
- 2.6. There are no below ground tunnels on or close to the site.
- 2.7. Thames Water records have been obtained (Appendix D) which show no existing surface water or foul water public sewers on site. The proposed excavation is outside the zone of influence of the nearest public sewers.
- 2.8. The Environment Agency indicates that the site is in an area where there is a less than 0.1% chance of flooding from rivers and seas occurring each year. This is the same as Flood Zone 1, in England.
- 2.9. The site is shown to be in an area of low risk of flooding due to surface water where there is a less between 0.1% and 1.0% chance of flooding from surface water.
- 2.10. There are overground railway tracks approximately 50m away from the site.

3. GROUND CONDITIONS AND HYDRO-GEOLOGY

- 3.1. The topography of the site has a slight downwards slope towards the northern site boundary.
- 3.2. Geological information obtained from British Geological Survey shows the site ground profile comprises London Clay (which is present to significant depth).
- 3.3. London Clay is considered to be relatively impermeable and incapable of bearing water. Groundwater is therefore not expected to be present within the soil.
- 3.4. There are no licenced groundwater abstraction points within 1km radius of the site.
- 3.5. The site is not within any source protection zones.
- 3.6. There are no surface water features on site.
- 3.7. The increase in the proportion of hard surfaced areas on site will result in an increased surface water runoff. The additional volume of surface water runoff from the proposed developments works will be attenuated by green roof before discharging back into the public sewer.
- 3.8. The development is not considered to impact the surface water drainage regime of the adjacent sites.
- 3.9. There are no registered landfills or historic landfills within 250m of the site.
- 3.10. The underlying London Clay has low permeability and negligible significance for water supply or river base flow.

4. STRUCTURAL PROPOSALS

- 4.1. It is proposed to construct a detached two-storey residential buildings, which will have single storey basement under most of the ground floor footprint. Drawings for the proposed structure are provided in Appendix A.
- 4.2. The new basement structure is to be constructed using partial open cut and partial hit/miss construction sequence and comprise a reinforced concrete box structure formed from rc base slab, rc external retaining walls and ground floor rc suspended slab forming the 'lid' of the basement structure. Excavation spoil will be reinstated at the back face of the retaining walls upon completion of the basement structure.
- 4.3. The rc basement slab will comprise a two-way and one-way spanning reinforced concrete ground bearing raft slabs. The basement perimeter retaining walls will be propped at basement level by the rc base raft slab.
- 4.4. The rc ground floor suspended slab will act as a prop to the head of the retaining walls in the permanent condition. The Contractor is to ensure stability of the walls in the temporary condition.
- 4.5. The lightwell retaining walls will be designed as vertical cantilevers, propped only at the base. Due to minimal vertical load being transferred down the lightwell retaining walls, load will be transferred down to ground via the retaining wall footing only (ie not via a raft slab).
- 4.6. Above ground floor, all walls will be masonry cavity as shown on the structural drawings. The floor slabs above ground floor will be constructed using timber joists. Ground floor loadbearing walls will be supported on mass concrete strip footings, where not supported off rc retaining walls.

- 4.7. Above ground floor, vertical loads will be transferred through the new building via the timber joisted floors which span onto steel beams on masonry walls, which take loads down to formation level via the reinforced concrete retaining walls and strip foundations.
- 4.8. Lateral loads will be transferred through the building via diaphragm action of the timber floors and concrete floors, and these transfer loads to the vertical stability system of the masonry walls, which transfer the lateral forces to the ground in shear. The floors and roof also provide lateral restraint to the walls.
- 4.9. Lateral loads due to earth pressures, surcharge pressures and hydrostatic pressures are to be resisted by reinforced concrete retaining walls, propped at the base and the head (excl. lightwell retaining walls) in the permanent condition.
- 4.10. Heave uplift forces due to the unloading of the underlying soil are to be resisted by the self-weight of the structure. It is assumed that the condition of a hypothetical raised ground water level will not occur at this site due to the relative impermeability of the London Clay, which is incapable of bearing water.
- 4.11. The stiffness of the below ground structure ensures that ground movements are kept within acceptable defined limits.
- 4.12. Surcharge loading from the existing building at 2 Alroy Road has been taken into account in the design of the basement structure.
- 4.13. Given the ground conditions, depth of excavation and sequence of construction proposed, it is anticipated that the category of damage (as classified under Burland et al) from the proposed construction of the new basement will be no worse than Category 1 (Very Slight) as a result of the construction of the new basement.

4.14. The works are therefore not expected to cause any structural damage to any nearby buildings.

5. CONSTRUCTION METHODOLOGY

5.1. For the purposes of this report, the basement is to be constructed using a bottom-up method of construction, as outlined in the following construction sequence.

- i. Cast new r.c. retaining walls in max. 1000mm sections in a hit/miss sequence around the 3No. sides of the basement. Excavations are to be propped and shored temporarily and arisings are to be backfilled once each section of wall has been cast, before commencing excavation for the next wall section. Dowel bars to be pushed into the earth to allow for lapping of reinforcement in the slab.
- ii. On the south side, ground is to be graded back to enable wall to be cast as one monolithic element.
- iii. Once all perimeter wall sections have been cast, excavate down to approximately 0.5m below ground level over full footprint of basement. Spoil is to be removed from the side access road. Install waling beams and flying shore props over the full width of excavation to act as props to the head of the wall.
- iv. Excavate to 500mm above top of basement slab level over the full footprint. Install waling beams and flying shore props over the full width of excavation to act as props to the base of the retaining wall. Spoil to be removed from the side access road.
- v. Excavate to basement formation level over the full footprint. Spoil to be removed from the side access road.
- vi. Lay bottom reinforcement layer of basement raft slab. Install new below ground drainage.

- vii. Install top reinforcement layer in basement raft slab with starter bars protruding for all perimeter and internal reinforced concrete walls. Cast basement raft slab. Remove low level props.
- viii. Place internal wall reinforcement and cast walls to underside of high-level props. Once cured, install a new layer of waling beams and flying shore props to the top of the wall stem, just below existing high-level props (basement level temporary props can be re-used). Remove high-level top level props once installed.
- ix. Install remaining wall reinforcement and cast walls to full height. Props to retaining walls are to remain in place until completion of new ground floor slab.
- x. Lay reinforcement for ground floor suspended slab and cast slab. Once slab has cured, high level lateral propping can be removed.
- xi. Construct superstructure.

5.2. The Contractor is required to demonstrate a positive attitude and commitment toward minimising environmental disturbance to local residents. Impacts on local amenity due to construction will be strictly managed the Contractor.

6. NOISE, DUST AND VIBRATION

6.1. Noise, dust and vibration arising from construction activities will be controlled by employing Best Practical Means (BPM) as prescribed in the following legislative documents and the approved code of practice British Standards 5228-1&2 (2009):

- The Control of Pollution Act 1972
- The Health & Safety at Work Act 1974
- The Environmental Protection Act 1990
- Construction (Design and Management) Regulations 1994
- The Clean Air Act 1993

6.2. Generally, the proposals comprise excavation of soil over the full footprint of the proposed building.

6.3. Given the ground conditions it is envisaged that the excavation for the basement extension will be undertaken using an excavator with spoil removed from site via lorries.

6.4. New steel reinforcement will be fabricated off-site, cut and bent to size, and stored in the existing site, in readiness for fixing into place.

6.5. New structural steelwork will be fabricated off-site and bolted together on site, ensuring that no structural steel work will require cutting on site.

6.6. Working hours will be restricted as required by the Local Authority.

6.7. General measures to be adopted by the Contractor to reduce noise, dust and vibration include:

- Erection of site hoarding to act as a minor acoustic screen.
- Drop heights to be minimised during any demolition.

- Use of electricity-powered tools and machinery in preference to diesel-generator powered tools and machinery.
- Use of super-silenced plant where feasible.
- Use of well-maintained modern plant.
- Effective noise and vibration monitoring to be implemented.
- Reducing the need to adopt percussive and vibrating machinery.
- Vehicles not to be left idling.
- All loads entering and leaving site are to be covered.
- Measures to be adopted to prevent site runoff of water or mud.
- Water to be used as a dust suppressant.
- Cutting equipment to use water as suppressant or suitable local exhaust ventilation system.
- Use of agreed wet cleaning methods or mechanical road sweepers on all roads around the site.

6.8. A Chartered Engineer holding MICE or MIStructE accreditation from RSA Design will have an ongoing role on site to monitor that the works are being carried out generally in accordance with the structural design and specification. This role will typically involve weekly/fortnightly site visits throughout the duration of structural works on site.

7. TEMPORARY WORKS

- 7.1. Construction will proceed in bottom-up fashion.
- 7.2. Graded excavation will be required to formation level along one elevation.
Contractor to ensure stability in the temporary condition.
- 7.3. Temporary works required as part of the construction will provide:
- Support of the new reinforced concrete retaining walls prior to casting of the new basement and ground floor slabs.
- 7.4. For the temporary lateral support of the new reinforced concrete retaining walls, this will typically include steel waling beams fixed to the piles, with steel flying shores (beams) spanning between waling beams at the head. The base will be propped by the raft slab.
- 7.5. The temporary works are to be designed by a qualified and experienced Temporary Works Co-Ordinator in accordance with BS 5975 'Code of Practice for Temporary Works Procedures and the Permissible Stress Design of Falsework'.
- 7.6. Good workmanship will be required for the works to ensure ground movements due to wall deflection are suitably controlled.

8. CONSTRUCTION TRAFFIC MANAGEMENT PLAN

8.1. The following considerations have been made to mitigate the impacts on the local highways and highway safety:

- All access to the site will lead off Alroy Road.
- Traffic movements are to be scheduled to avoid periods of heavy traffic such as mornings and evenings.
- All deliveries are to be agreed with the Contractor in advance. Any unscheduled deliveries will be turned away.
- Banksman are to be provided for all site vehicle movements to ensure pedestrian and highway user safety and to ensure congestion is minimised.
- Vehicles are to be sized so as to be suitable for the local highways.
- It is anticipated that wheel washing facilities will be put in place by the Contractor on site to ensure that site muck is not tracked onto wheels of the vehicles leaving site.

9. NEIGHBOURING BUILDINGS AND PARTY WALL MATTERS

- 9.1. The new property is detached.
- 9.2. The nearest structure is approximately 1m away from the site boundary. The proposed basement structure will be situated minimum 1m away from any neighbouring buildings.
- 9.3. The works comprise the excavation for a new single storey (approximately 3.5m deep) basement and construction of one storey above ground.
- 9.4. The structural scheme adopted has been designed with due regard to maintaining the structural stability and integrity of surrounding land.
- 9.5. The structural form of the basement and the method of construction have been developed to ensure that lateral deflections and associated ground movements are kept within reasonable limits.
- 9.6. Given that the structural scheme adopted has been designed with due regard to maintaining the structural stability and integrity of neighbouring structures and surrounding land, it is considered that there will be negligible impact on nearby buildings as a result of the works.

10. EXECUTIVE SUMMARY

- 10.1. The structural proposals and construction methodology for the subterranean development at 7 Endymion Road, London have been developed with due regard to the existing site constraints, the local ground conditions, the local amenity and the local highways.
- 10.2. A desk study into local ground conditions has been undertaken and is well understood. Confirmation of site specific conditions will be carried out prior to commencement on site.
- 10.3. The site is in Flood Risk Zone 1 for sea and river flooding and at low risk from surface water flooding.
- 10.4. Water is not expected to be encountered during excavation due to the impermeable nature of the underlying London Clay. Any local seepages encountered during excavation can be dealt with by use of sump pumps.
- 10.5. The structure has been designed to maintain the stability and integrity of the surrounding land, the highway and below ground services.
- 10.6. Anticipated ground movements associated with the works can be limited to acceptable values by a combination of the stiffness of the proposed retaining structure, suitably designed temporary works, and good levels of workmanship.
- 10.7. It is anticipated that the category of damage (as classified under Burland et al) from the proposed construction of the new basement will be no worse than Category 1 (Very Slight), which is considered to be within acceptable limits for works of this nature.

- 10.8. The proposals comply with London Borough of Haringey's Planning Policy DM18 for Residential Basement Developments and Lightwells.
- 10.9. The subterranean development has no adverse impact on below ground drainage or other buried utilities near the site.
- 10.10. This BIA demonstrates that by adopting good construction practices the works can be executed in a safe manner while minimising any impact on the local amenity.
- 10.11. A Chartered Engineer holding MICE or MIStructE accreditation from RSA Design will have an ongoing role during the detailed design process, reviewing the Contractor's construction proposals, method statements and temporary works proposals, and also on site to monitor that the works are being carried out generally in accordance with the structural design and specification.



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Director

RSA Design

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APPENDIX A

STRUCTURAL DRAWINGS

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
DO NOT SCALE FROM THIS DRAWING.

KEY

NEW BRICKWORK

NEW BLOCKWORK

STRUCTURE UNDER

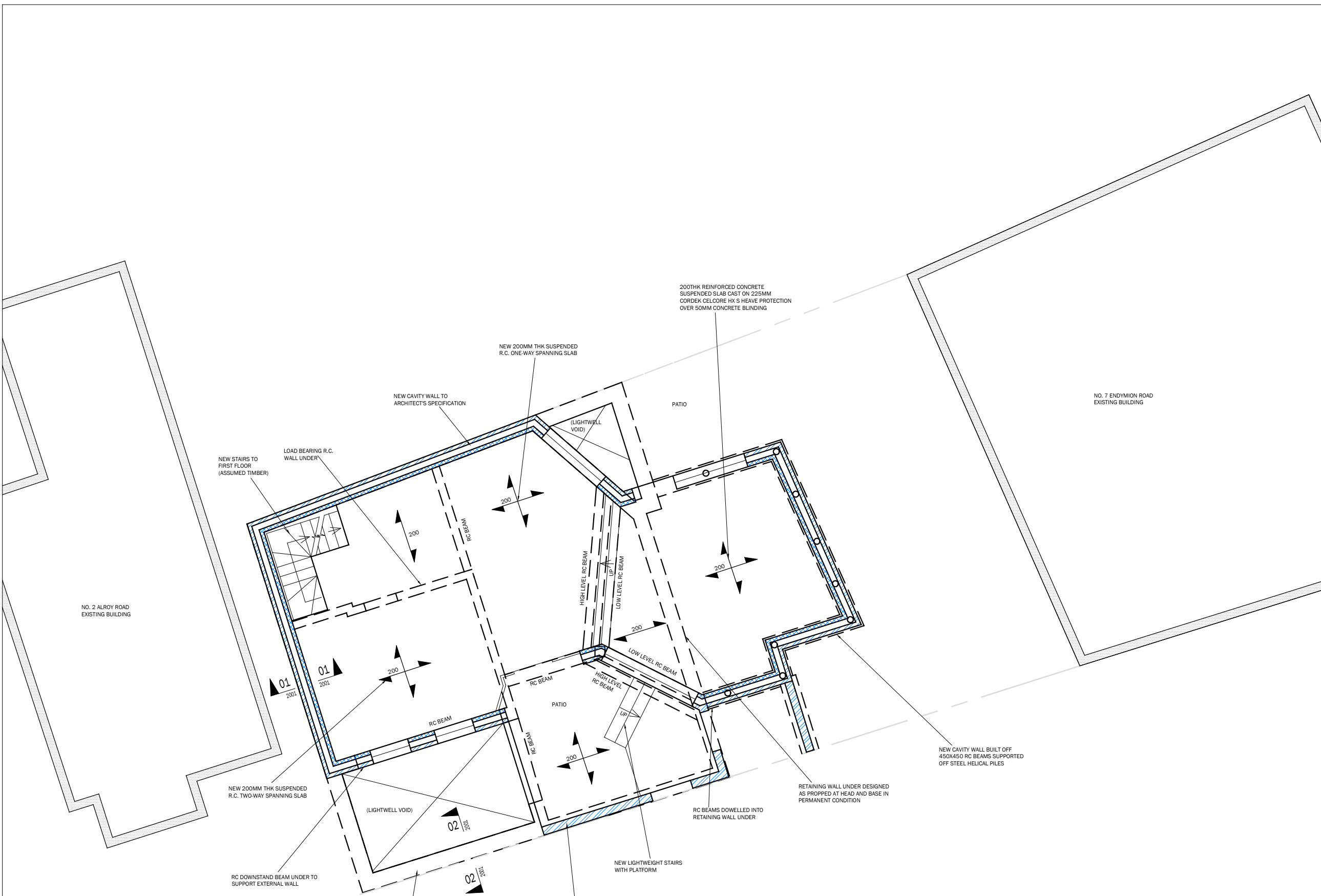
NEW REINFORCED CONCRETE

xxx

ONE-WAY SPANNING REINFORCED CONCRETE
SUSPENDED SLAB (THICKNESS AS SHOWN)

xxx

TWO-WAY SPANNING REINFORCED CONCRETE
SUSPENDED SLAB (THICKNESS AS SHOWN), WHERE
OVER GROUND CAST ON 225MM CORDEK CELLCORE
HX S HEAVE PROTECTION



C1	07/10/22	DT	PRELIMINARY ISSUE
REV	DATE	BY	DESCRIPTION

RSA

DESIGN

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www.rsadesignuk.com t: 0208 252 2270

project

LAND ADJACENT TO 2 ALROY ROAD,
N4 1EF

drawing title

PROPOSED GROUND
FLOOR PLAN

scale (s)

1:50 @A1, 1:100 @A3

date

07/10/2022

drawn

DT

drawing status

PRELIMINARY

drawing no

220921-RSA-00-DR-1000

revision

P1

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
DO NOT SCALE FROM THIS DRAWING.

KEY

NEW REINFORCED CONCRETE

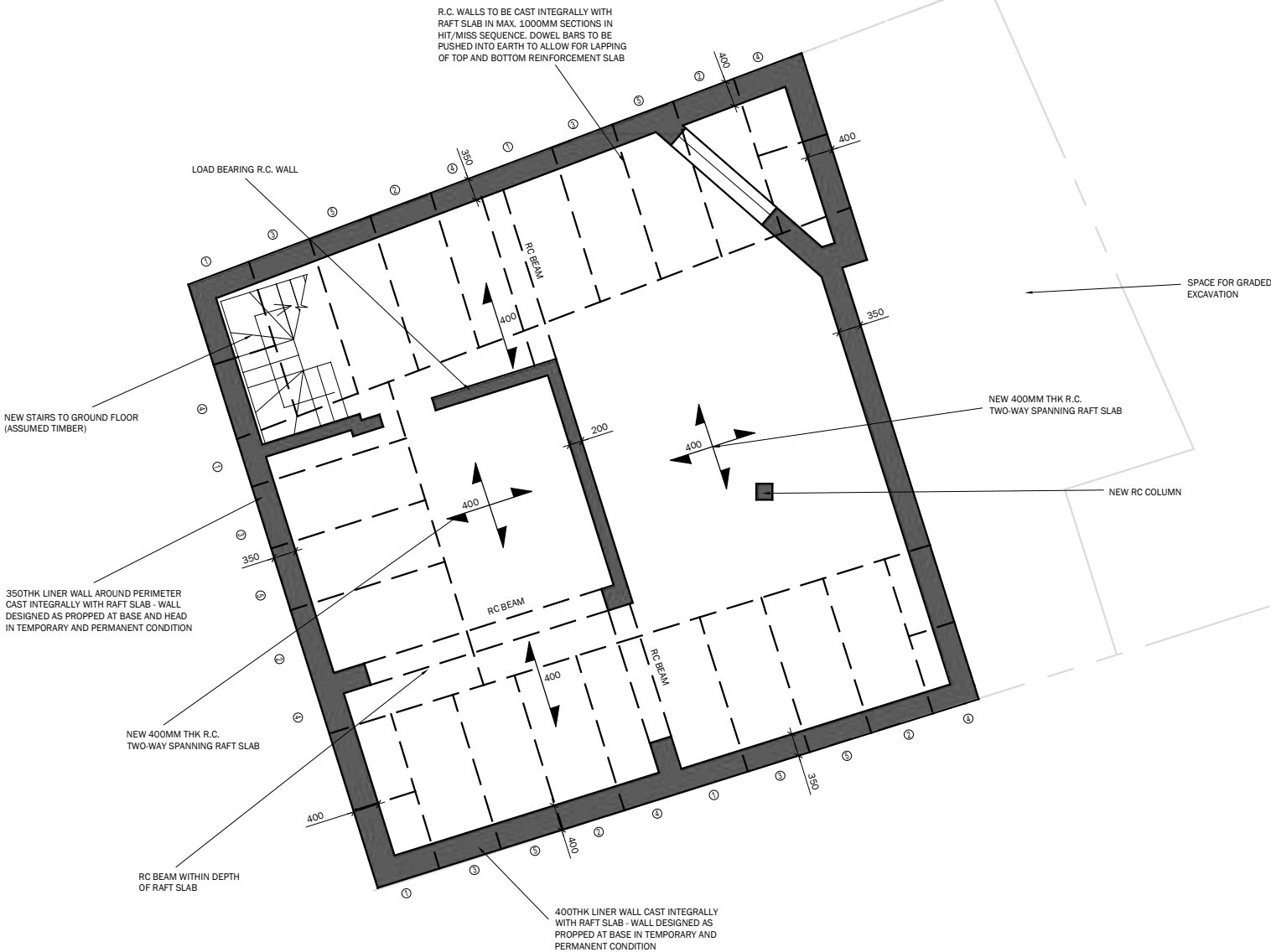
XXX

ONE-WAY SPANNING REINFORCED CONCRETE GROUND BEARING RAFT SLAB (THICKNESS AS SHOWN)

XXX

TWO-WAY SPANNING REINFORCED CONCRETE GROUND BEARING RAFT SLAB (THICKNESS AS SHOWN)

STRUCTURE UNDER



C1	07/10/22	DT	PRELIMINARY ISSUE
REV	DATE	BY	DESCRIPTION

RSA
DESIGN

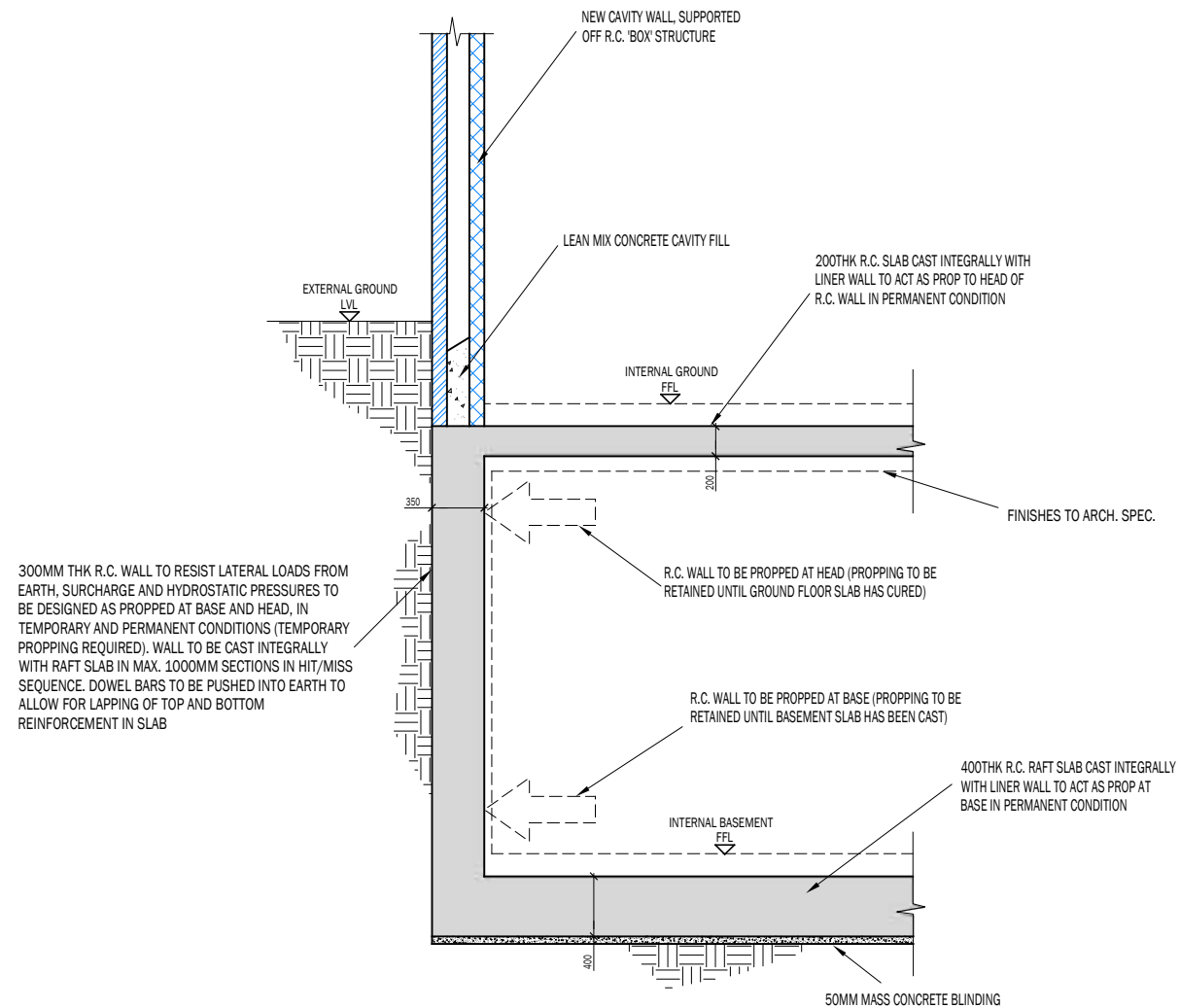
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project
LAND ADJACENT TO 2 ALROY ROAD,
N4 1EF
drawing title
PROPOSED BASEMENT
FLOOR PLAN

scale (s) date drawn
1:50 @A1, 1:100 @A3 07/10/2022 DT

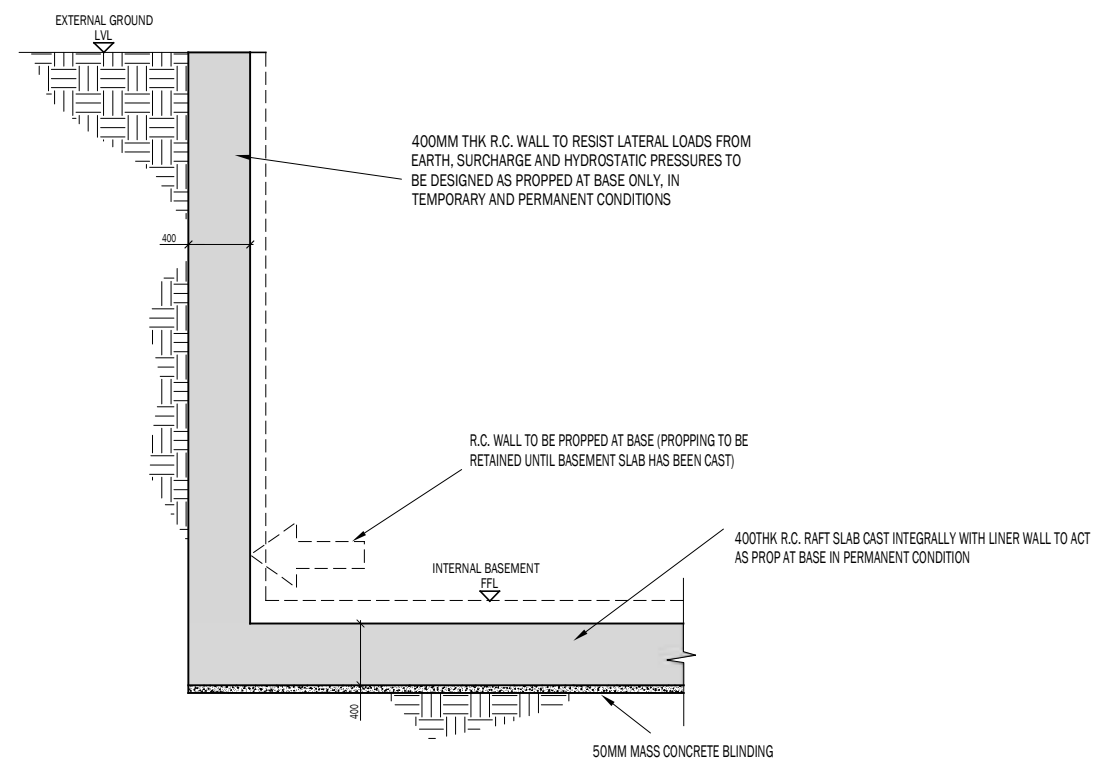
drawing status
PRELIMINARY

drawing no	revision
220921-RSA-B1-DR-1000	P1



SECTION 01-01

SCALE 1:50



SECTION 02-02

SCALE 1:50

This drawing is to be read in conjunction with the relevant architects, engineers and specialists drawings and specifications.

Do not scale from this drawing.

C1	07/10/22	DT	PRELIMINARY ISSUE
rev	date	description	



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project

LAND ADJACENT TO 2 ALROY ROAD,
N4 1EF

drawing title

PROPOSED DETAILS
SHEET 1

scale (s)	date	drawn
1:20 @A3	07/10/2022	DT

drawing status

PRELIMINARY

drawing no	revision
220921-RSA-SC-DR-2001	P1

**LAND ADJACENT TO
2 ALROY ROAD,
LONDON,
N4 1EF**

APPENDIX B

STRUCTURAL CALCULATIONS

Design loadings

Basement: dead load: 400mm thick slab = $25 \times 0.4 = 10 \text{ kN/m}^2$
 75mm screed = 1.8 kN/m^2
 finishes / w. proof = 0.5 kN/m^2

 12.3 kN/m^2

Live load: Domestic = 1.5 kN/m^2

Ground floor: Dead load: 200mm thick slab = $25 \times 0.2 = 5 \text{ kN/m}^2$
 75mm screed = 1.8 kN/m^2
 finishes / insulation = 0.5 kN/m^2

 7.3 kN/m^2

Live load: Domestic = 1.5 kN/m^2

First floor: Dead load: timber floor + joists = 0.6 kN/m^2

Live load: Domestic = 1.5 kN/m^2

Roof: Dead load: Green roof = 1.2 kN/m^2
 timber joists = 0.2 kN/m^2
 finishes = 0.1 kN/m^2

 1.5 kN/m^2

Live load: = 0.75 kN/m^2

Cavity walls: DL = 4.6 kN/m^2

Slab at ground floor

Loading:

$$SW = 0.2 \times 25 = 5 \text{ kN/m}^2$$

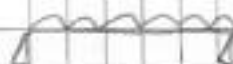
$$75 \text{ mm screed} = 1.8 \text{ kN/m}^2$$

$$\text{Finishes} = 0.5 \text{ kN/m}^2$$

$$\text{Dead} = 7.3 \text{ kN/m}^2$$

$$\text{Live} = 1.5 \text{ kN/m}^2$$

$$\text{Max clear span} = 4.5 \text{ m}$$



$$M_{ED} = (7.3 \times 1.35 + 1.5 \times 1.5) \times 4.5^2 / 8 = 30.7 \text{ kNm}$$

$$V_{ED} = (7.3 \times 1.35 + 1.5 \times 1.5) \times 4.5 / 2 = 27.3 \text{ kN}$$

Use: 200mm thick one-way spanning slab

- see TEOAS output

Project Alroy Road Mews House BIA				Job no. 220921	
Calcs for Ground floor slab				Start page no./Revision 1	
Calcs by DT	Calcs date 03/10/2022	Checked by	Checked date	Approved by	Approved date

RC SLAB DESIGN

In accordance with EN1992-1-1:2004 incorporating corrigendum January 2008 and the UK national annex

Tedds calculation version 1.0.21

Design summary

Description	Unit	Provided	Required	Utilisation	Result
Support 1					
Span 1					
Tension reinf.	mm ² /m	1005	473	0.471	PASS
Tension bar spacing	mm	200	300	0.667	PASS
Allow. span-to-depth ratio		28.66	40.00	0.717	PASS
Support 2					
Cover					
Min cover bottom	mm	35	26	0.743	PASS



Slab definition

Slab reference name	SLAB
Overall slab depth	h = 200 mm
Number of spans	N_{spans} = 1
First support	Simple
Last support	Simple

Nominal cover to bottom reinforcement	C_{nom_b} = 35 mm
---------------------------------------	----------------------------------

Loading

Ratio of quasi-permanent to ultimate load	r_q = 0.300
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Concrete properties

Concrete strength class	C32/40
Characteristic cylinder strength	f_{ck} = 32 N/mm²
Partial factor (Table 2.1N)	γ_C = 1.50
Compressive strength factor (cl. 3.1.6)	α_{cc} = 0.85
Design compressive strength (cl. 3.1.6)	f_{cd} = 18.1 N/mm²
Mean axial tensile strength (Table 3.1)	f_{ctm} = 0.30 N/mm² × (f_{ck} / 1 N/mm²)^{2/3} = 3.0 N/mm²
Maximum aggregate size	d_g = 20 mm

Reinforcement properties

Characteristic yield strength	f_{yk} = 500 N/mm²
Partial factor (Table 2.1N)	γ_S = 1.15
Design yield strength (fig. 3.8)	f_{yd} = f_{yk} / γ_S = 434.8 N/mm²

Concrete cover to reinforcement

Nominal cover to bottom reinforcement	C_{nom_b} = 35 mm
Fire resistance period to bottom of slab	R_{btm} = 60 min
Axis distance to bottom reinf (Table 5.8)	a_{fi_b} = 20 mm
Max bar diameter in bottom	φ_{max_b} = 16 mm
Min. btm cover requirement with regard to bond	C_{min,b_b} = φ_{max_b} = 16 mm

 RSA Design 2 Victoria Road Buckhurst Hill Essex IG9 5ES	Project Alroy Road Mews House BIA				Job no. 220921	
	Calcs for Ground floor slab				Start page no./Revision 2	
	Calcs by DT	Calcs date 03/10/2022	Checked by	Checked date	Approved by	Approved date

Reinforcement fabrication

Cover allowance for deviation

Min. required nominal cover to bottom reinf

Not subject to QA system

$\Delta C_{dev} = 10 \text{ mm}$

$C_{nom_b_min} = \max(a_{fi_b} - \phi_{max_b} / 2, C_{min_b_b} + \Delta C_{dev}) = 26.0 \text{ mm}$

PASS - There is sufficient cover to the bottom reinforcement

Bending design checks

Redistribution ratio

$\delta = 1.0$

Limiting value of K

$K' = 0.598 \times \delta - 0.18 \times \delta^2 - 0.21 = 0.208$

Reinforcement design at midspan of span 1 (cl.6.1)

Length of span 1

$l_1 = 4500 \text{ mm}$

Design bending moment

$M_{p1} = 30.7 \text{ kNm/m}$

Reinforcement provided

16 mm dia. bars at 200 mm centres

Area provided

$A_{sp1} = 1005 \text{ mm}^2/\text{m}$

Effective depth to tension reinforcement

$d_{p1} = h - C_{nom_b} - \phi_{p1} / 2 = 157.0 \text{ mm}$

K factor

$K = M_{p1} / (b \times d_{p1}^2 \times f_{ck}) = 0.039$

K < K' - Compression reinforcement is not required

Lever arm

$z = \min(0.95 \times d_{p1}, d_{p1} / 2 \times (1 + \sqrt{1 - 3.53 \times K}))$

$z = 149.2 \text{ mm}$

Area of reinforcement required for bending

$A_{sp1_m} = M_{p1} / (f_{yd} \times z) = 473 \text{ mm}^2/\text{m}$

Minimum area required

$A_{sp1_min} = \max(0.26 \times (f_{ctm}/f_{yk}), 0.0013) \times b \times d_{p1} = 247 \text{ mm}^2/\text{m}$

Area of reinforcement required

$A_{sp1_req} = \max(A_{sp1_m}, A_{sp1_min}) = 473 \text{ mm}^2/\text{m}$

PASS - Area of tension reinforcement provided is adequate (0.471)

Check reinforcement spacing

Reinforcement service stress

$\sigma_s = (f_{yk} / \gamma_s) \times \min((A_{sp1_m}/A_{sp1}), 1.0) \times r_q = 61.4 \text{ N/mm}^2$

Maximum allowable spacing (Table 7.3N)

$S_{max_p1} = 300 \text{ mm}$

Actual bar spacing

$S_{p1} = 200 \text{ mm}$

PASS - The reinforcement spacing is acceptable

Shear design checks

Shear resistance constant (cl. 6.2.2)

$C_{Rd,c} = 0.18 \text{ N/mm}^2 / \gamma_c = 0.12 \text{ N/mm}^2$

Shear capacity check at support 1

Shear force

$V_1 = 27.3 \text{ kN/m}$

Reinforcement provided

16 mm dia. bars at 200 mm centres

Area provided

$A_{sd1} = 1005 \text{ mm}^2/\text{m}$

Effective depth

$d_{d1} = h - C_{nom_b} - \phi_{d1} / 2 = 157.0 \text{ mm}$

Effective depth factor (cl. 6.2.2)

$k = \min(2.0, 1 + (200 \text{ mm} / d_{d1})^{0.5}) = 2.000$

Reinforcement ratio

$\rho_l = \min(0.02, A_{sd1} / (b \times d_{d1})) = 0.0064$

Minimum shear resistance (Exp. 6.3N)

$V_{Rd,c_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{d1}$

$V_{Rd,c_min} = 87.9 \text{ kN/m}$

Shear resistance (Exp. 6.2a)

$V_{Rd,c1} = \max(V_{Rd,c_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck} / 1 \text{ N/mm}^2))^{0.333} \times b \times d_{d1})$

$V_{Rd,c1} = 103.0 \text{ kN/m}$

PASS - Shear capacity is adequate (0.265)

Shear capacity check at support 2

Shear force

$V_2 = 27.3 \text{ kN/m}$

Reinforcement provided

16 mm dia. bars at 200 mm centres

Area provided

$A_{sd2} = 1005 \text{ mm}^2/\text{m}$

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Effective depth $d_{d2} = h - c_{nom_b} - \phi_{d2} / 2 = \mathbf{157.0 \text{ mm}}$
Effective depth factor (cl. 6.2.2) $k = \min(2.0, 1 + (200 \text{ mm} / d_{d2})^{0.5}) = \mathbf{2.000}$
Reinforcement ratio $\rho_l = \min(0.02, A_{sd2} / (b \times d_{d2})) = \mathbf{0.0064}$
Minimum shear resistance (Exp. 6.3N) $V_{Rd,c_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{d2}$
 $V_{Rd,c_min} = \mathbf{87.9 \text{ kN/m}}$
Shear resistance (Exp. 6.2a) $V_{Rd,c2} = \max(V_{Rd,c_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck} / 1 \text{ N/mm}^2))^{0.333} \times b \times d_{d2})$
 $V_{Rd,c2} = \mathbf{103.0 \text{ kN/m}}$
PASS - Shear capacity is adequate (0.265)

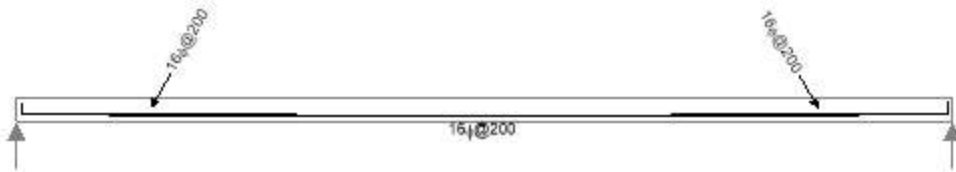
Deflection checks

Basic span-to-depth ratio deflection check span 1 (cl. 7.4.2)

Reference reinforcement ratio $\rho_0 = (f_{ck} / 1 \text{ N/mm}^2)^{0.5} / 1000 = \mathbf{0.0057}$
Required tension reinforcement ratio $\rho = \max(0.0035, A_{sp1_m} / (b \times d_{p1})) = \mathbf{0.0035}$
Required compression reinforcement ratio $\rho' = A_{scp1_req} / (b \times d_{p1}) = \mathbf{0.0000}$
Structural system factor (Table 7.4N) $K_\delta = \mathbf{1.0}$
Basic span-to-depth ratio limit $ratio_{lim1_bas} = K_\delta \times [11 + 1.5 \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times \rho_0 / \rho + 3.2 \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times (\rho_0 / \rho - 1)^{1.5}]$
(Exp. 7.16a) $ratio_{lim1_bas} = \mathbf{33.47}$
Modified span-to-depth ratio limit $ratio_{lim1} = \min(40 \times K_\delta, \min(1.5, (500 \text{ N/mm}^2 / f_{yk}) \times (A_{sp1} / A_{sp1_m})) \times ratio_{lim1_bas}) = \mathbf{40.00}$
Actual span-to-depth ratio $ratio_{act1} = l_1 / d_{p1} = \mathbf{28.66}$
PASS - Span-to-depth ratio is acceptable (0.717)

Reinforcement sketch

The following sketch is indicative only. Note that additional reinforcement may be required in accordance with clauses 9.2.1.2, 9.2.1.4 and 9.2.1.5 of EN 1992-1-1:2004 to meet detailing rules.



RC raft design

Site conditions and excavation:

Depth of basement = 3.5 m

Assume 400mm thick slab + 200mm allowance for finishes

∴ total depth of excavation = 4.1 m

Local boreholes and site investigation show London clay

Potential uplift to heave, no uplift due to hydrostatic pressure as in L. clay

Heave check

$$\text{Total unloading} = h \times \gamma = 20 \times 4.1 = 82 \text{ kN/m}^2$$

This will result in long + short term swelling of clay where 50% of heave is expected to occur instantaneously

$$\therefore \text{Heave acting on slab} = 82 \times 0.5 = 41 \text{ kN/m}^2$$

Additionally, 50% reduction in stress will occur due to stress dissipation through slab

$$\therefore \text{total heave slab} = 41 \times 0.5 = 20.5 \text{ kN/m}^2$$

Basement walls

$$\begin{aligned} \text{Loading: RC wall} &= (10 \times 2 + 4.9 \times 2 + 4.9 \times 3 \times 1 \times 0.3 + 25) \\ &\quad \times 0.6 \\ &= 13.4 \text{ kN/m}^2 \end{aligned}$$

$$\begin{aligned} \text{masonry walls} &= 1.6 \times 3.2 \times 45.8 / 0.6 = 7 \text{ kN/m}^2 \\ \text{ground floor} &= 7.3 \text{ kN/m}^2, \text{ 1st floor} = 0.6 \text{ kN/m}^2 \\ \text{Roof} &= 1.5 \text{ kN/m}^2 \end{aligned}$$

$$\begin{aligned} \text{Live GF} &= 1.5 \text{ kN/m}^2 \\ \text{FF} &= 1.5 \text{ kN/m}^2 \\ \text{Roof} &= 0.75 \text{ kN/m}^2 \end{aligned}$$

Load case 1 - EOU check

$$H_{\text{water}} = 20.5 \text{ kN/m}^2$$

Slab only = DL slab @ present + ground + walls =

$$12.3 + 13.4 + 7.5 = 37.7 \text{ kN/m}^2$$

∴ For EOU check

$$1.1 \text{ Gk} \text{ upper} < 0.9 \text{ Gk} \text{ for}$$

$$1.1 \times 20.5 < 0.9 \times 37.7$$

$$23 \text{ kN/m}^2 < 34 \text{ kN/m}^2 \quad \therefore \text{No uplift due to water}$$

Load Case 2 - STR check

(DL + LL)

$$DL = 12.3 + 13.4 + 7.5 + 2.3 + 0.6 + 1.5 = 42.1 \text{ kN/m}^2$$

$$LL = 1.5 + 2 + 0.75 + 1.5 = 5.3 \text{ kN/m}^2$$

Check 1, by inspection critical

$$1.35 \text{ Gk} + 1.5 \text{ Qk} \text{ unfavorable} - 1.0 \text{ Gk} \text{ favourable}$$

$$ULS = 1.35 \times 42.1 + 1.5 \times 5.3 - 1 \times 20.5 = 44.36 \text{ kN/m}^2$$

net force on slab

Net force is downwards, however soil will push back @ same pressure as design for top face rebar

Slab thickness = 400 mm

cover = 50 mm

Slab at basement floor (one way)

Max clear span = 4.7m

$$M_{Ed} = 44.3 \times 4.7^2 / 8 = 122.4 \text{ kNm}$$

$$V_{Ed} = 44.3 \times 4.7 / 2 = 104.1 \text{ kN}$$

UK: 400mm the one way spanning

- see TEODS output

H16 @ 150 c/c T+B in both directions
OK

Slab at basement floor (two way)

Max panel = 4.8 x 6.9m

for simplicity model edges as pinned restraint

$$l_x = 4600 \quad l_y / l_x = 1.44$$

$$l_y = 6900$$

Refer to TEODS output - H16 @ 150mm c/c T+B in both directions OK

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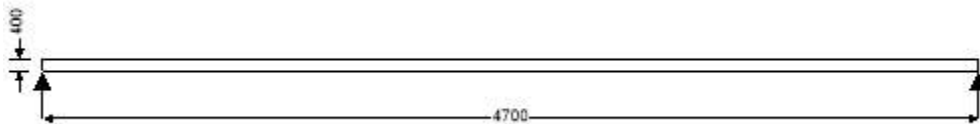
RC SLAB DESIGN

In accordance with EN1992-1-1:2004 incorporating corrigendum January 2008 and the UK national annex

Tedds calculation version 1.0.21

Design summary

Description	Unit	Provided	Required	Utilisation	Result
Support 1					
Span 1					
Tension reinf.	mm ² /m	1340	866	0.646	PASS
Tension bar spacing	mm	150	300	0.500	PASS
Allow. span-to-depth ratio		13.74	40.00	0.344	PASS
Support 2					
Cover					
Min cover bottom	mm	50	26	0.520	PASS



Slab definition

Slab reference name	SLAB
Overall slab depth	h = 400 mm
Number of spans	N_{spans} = 1
First support	Simple
Last support	Simple

Nominal cover to bottom reinforcement	C_{nom_b} = 50 mm
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Loading

Ratio of quasi-permanent to ultimate load	r_q = 0.300
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Concrete properties

Concrete strength class	C32/40
Characteristic cylinder strength	f_{ck} = 32 N/mm²
Partial factor (Table 2.1N)	γ_C = 1.50
Compressive strength factor (cl. 3.1.6)	α_{cc} = 0.85
Design compressive strength (cl. 3.1.6)	f_{cd} = 18.1 N/mm²
Mean axial tensile strength (Table 3.1)	f_{ctm} = 0.30 N/mm² × (f_{ck} / 1 N/mm²)^{2/3} = 3.0 N/mm²
Maximum aggregate size	d_g = 20 mm

Reinforcement properties

Characteristic yield strength	f_{yk} = 500 N/mm²
Partial factor (Table 2.1N)	γ_S = 1.15
Design yield strength (fig. 3.8)	f_{yd} = f_{yk} / γ_S = 434.8 N/mm²

Concrete cover to reinforcement

Nominal cover to bottom reinforcement	C_{nom_b} = 50 mm
Fire resistance period to bottom of slab	R_{btm} = 60 min
Axis distance to bottom reinf (Table 5.8)	a_{fi_b} = 20 mm
Max bar diameter in bottom	φ_{max_b} = 16 mm
Min. btm cover requirement with regard to bond	C_{min,b_b} = φ_{max_b} = 16 mm

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Reinforcement fabrication

Cover allowance for deviation

Min. required nominal cover to bottom reinf

Not subject to QA system

$\Delta C_{dev} = 10 \text{ mm}$

$C_{nom_b_min} = \max(a_{fi_b} - \phi_{max_b} / 2, C_{min_b_b} + \Delta C_{dev}) = 26.0 \text{ mm}$

PASS - There is sufficient cover to the bottom reinforcement

Bending design checks

Redistribution ratio

$\delta = 1.0$

Limiting value of K

$K' = 0.598 \times \delta - 0.18 \times \delta^2 - 0.21 = 0.208$

Reinforcement design at midspan of span 1 (cl.6.1)

Length of span 1

$l_1 = 4700 \text{ mm}$

Design bending moment

$M_{p1} = 122.4 \text{ kNm/m}$

Reinforcement provided

16 mm dia. bars at 150 mm centres

Area provided

$A_{sp1} = 1340 \text{ mm}^2/\text{m}$

Effective depth to tension reinforcement

$d_{p1} = h - C_{nom_b} - \phi_{p1} / 2 = 342.0 \text{ mm}$

K factor

$K = M_{p1} / (b \times d_{p1}^2 \times f_{ck}) = 0.033$

K < K' - Compression reinforcement is not required

Lever arm

$z = \min(0.95 \times d_{p1}, d_{p1} / 2 \times (1 + \sqrt{1 - 3.53 \times K}))$

$z = 324.9 \text{ mm}$

Area of reinforcement required for bending

$A_{sp1_m} = M_{p1} / (f_{yd} \times z) = 866 \text{ mm}^2/\text{m}$

Minimum area required

$A_{sp1_min} = \max(0.26 \times (f_{ctm}/f_{yk}), 0.0013) \times b \times d_{p1} = 538 \text{ mm}^2/\text{m}$

Area of reinforcement required

$A_{sp1_req} = \max(A_{sp1_m}, A_{sp1_min}) = 866 \text{ mm}^2/\text{m}$

PASS - Area of tension reinforcement provided is adequate (0.646)

Check reinforcement spacing

Reinforcement service stress

$\sigma_s = (f_{yk} / \gamma_s) \times \min((A_{sp1_m}/A_{sp1}), 1.0) \times r_q = 84.3 \text{ N/mm}^2$

Maximum allowable spacing (Table 7.3N)

$S_{max_p1} = 300 \text{ mm}$

Actual bar spacing

$S_{p1} = 150 \text{ mm}$

PASS - The reinforcement spacing is acceptable

Shear design checks

Shear resistance constant (cl. 6.2.2)

$C_{Rd,c} = 0.18 \text{ N/mm}^2 / \gamma_c = 0.12 \text{ N/mm}^2$

Shear capacity check at support 1

Shear force

$V_1 = 104.1 \text{ kN/m}$

Reinforcement provided

16 mm dia. bars at 150 mm centres

Area provided

$A_{sd1} = 1340 \text{ mm}^2/\text{m}$

Effective depth

$d_{d1} = h - C_{nom_b} - \phi_{d1} / 2 = 342.0 \text{ mm}$

Effective depth factor (cl. 6.2.2)

$k = \min(2.0, 1 + (200 \text{ mm} / d_{d1})^{0.5}) = 1.765$

Reinforcement ratio

$\rho_l = \min(0.02, A_{sd1} / (b \times d_{d1})) = 0.0039$

Minimum shear resistance (Exp. 6.3N)

$V_{Rd,c_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{d1}$

$V_{Rd,c_min} = 158.7 \text{ kN/m}$

Shear resistance (Exp. 6.2a)

$V_{Rd,c1} = \max(V_{Rd,c_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck} / 1 \text{ N/mm}^2))^{0.333} \times b \times d_{d1})$

$V_{Rd,c1} = 168.1 \text{ kN/m}$

PASS - Shear capacity is adequate (0.619)

Shear capacity check at support 2

Shear force

$V_2 = 104.1 \text{ kN/m}$

Reinforcement provided

16 mm dia. bars at 150 mm centres

Area provided

$A_{sd2} = 1340 \text{ mm}^2/\text{m}$

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Effective depth $d_{d2} = h - c_{nom_b} - \phi_{d2} / 2 = \mathbf{342.0 \text{ mm}}$
Effective depth factor (cl. 6.2.2) $k = \min(2.0, 1 + (200 \text{ mm} / d_{d2})^{0.5}) = \mathbf{1.765}$
Reinforcement ratio $\rho_l = \min(0.02, A_{sd2} / (b \times d_{d2})) = \mathbf{0.0039}$
Minimum shear resistance (Exp. 6.3N) $V_{Rd,c_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{d2}$
 $V_{Rd,c_min} = \mathbf{158.7 \text{ kN/m}}$
Shear resistance (Exp. 6.2a) $V_{Rd,c2} = \max(V_{Rd,c_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck} / 1 \text{ N/mm}^2))^{0.333} \times b \times d_{d2})$
 $V_{Rd,c2} = \mathbf{168.1 \text{ kN/m}}$
PASS - Shear capacity is adequate (0.619)

Deflection checks

Basic span-to-depth ratio deflection check span 1 (cl. 7.4.2)

Reference reinforcement ratio $\rho_0 = (f_{ck} / 1 \text{ N/mm}^2)^{0.5} / 1000 = \mathbf{0.0057}$
Required tension reinforcement ratio $\rho = \max(0.0035, A_{sp1_m} / (b \times d_{p1})) = \mathbf{0.0035}$
Required compression reinforcement ratio $\rho' = A_{scp1_req} / (b \times d_{p1}) = \mathbf{0.0000}$
Structural system factor (Table 7.4N) $K_\delta = \mathbf{1.0}$
Basic span-to-depth ratio limit $ratio_{lim1_bas} = K_\delta \times [11 + 1.5 \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times \rho_0 / \rho + 3.2 \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times (\rho_0 / \rho - 1)^{1.5}]$
(Exp. 7.16a) $ratio_{lim1_bas} = \mathbf{33.47}$
Modified span-to-depth ratio limit $ratio_{lim1} = \min(40 \times K_\delta, \min(1.5, (500 \text{ N/mm}^2 / f_{yk}) \times (A_{sp1} / A_{sp1_m})) \times ratio_{lim1_bas}) = \mathbf{40.00}$
Actual span-to-depth ratio $ratio_{act1} = l_1 / d_{p1} = \mathbf{13.74}$
PASS - Span-to-depth ratio is acceptable (0.344)

Reinforcement sketch

The following sketch is indicative only. Note that additional reinforcement may be required in accordance with clauses 9.2.1.2, 9.2.1.4 and 9.2.1.5 of EN 1992-1-1:2004 to meet detailing rules.



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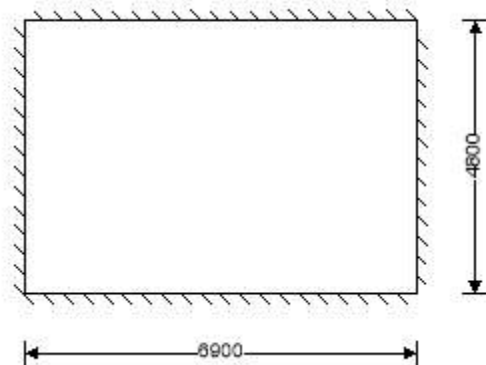
RC SLAB DESIGN

In accordance with EN1992-1-1:2004 incorporating corrigendum January 2008 and the UK national annex

Tedds calculation version 1.0.21

Design summary

Description	Unit	Provided	Required	Utilisation	Result
Short span					
Reinf. at midspan	mm ² /m	1340	1066	0.795	PASS
Bar spacing at midspan	mm	150	209	0.719	PASS
Shear at discont. supp	kN/m	168.1	155.5	0.925	PASS
Deflection ratio		14.04	40.00	0.351	PASS
Long span					
Reinf. at midspan	mm ² /m	1340	545	0.406	PASS
Bar spacing at midspan	mm	150	300	0.500	PASS
Shear at discont. supp	kN/m	164.5	155.5	0.945	PASS
Cover					
Min cover bottom	mm	50	26	0.520	PASS



Slab definition

Slab reference name

Type of slab

Overall slab depth

Shorter effective span of panel

Longer effective span of panel

Support conditions

SLAB

Two way spanning with unrestrained edges

$h = 400$ mm

$l_x = 4800$ mm

$l_y = 6900$ mm

Four edges simply supported

Bottom outer layer of reinforcement

Short span direction

Loading

Characteristic permanent action

$G_k = 42.1$ kN/m²

Characteristic variable action

$Q_k = 5.3$ kN/m²

Partial factor for permanent action

$\gamma_G = 1.35$

Partial factor for variable action

$\gamma_Q = 1.50$

Quasi-permanent value of variable action

$\psi_2 = 0.30$

Design ultimate load

$q = \gamma_G \times G_k + \gamma_Q \times Q_k = 64.8$ kN/m²

Quasi-permanent load

$q_{SLS} = 1.0 \times G_k + \psi_2 \times Q_k = 43.7$ kN/m²

Concrete properties

Concrete strength class

C32/40

Characteristic cylinder strength

$f_{ck} = 32$ N/mm²

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Partial factor (Table 2.1N)

$$\gamma_c = \mathbf{1.50}$$

Compressive strength factor (cl. 3.1.6)

$$\alpha_{cc} = \mathbf{0.85}$$

Design compressive strength (cl. 3.1.6)

$$f_{cd} = \mathbf{18.1 \text{ N/mm}^2}$$

Mean axial tensile strength (Table 3.1)

$$f_{ctm} = 0.30 \text{ N/mm}^2 \times (f_{ck} / 1 \text{ N/mm}^2)^{2/3} = \mathbf{3.0 \text{ N/mm}^2}$$

Maximum aggregate size

$$d_g = \mathbf{20 \text{ mm}}$$

Reinforcement properties

Characteristic yield strength

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

Partial factor (Table 2.1N)

$$\gamma_s = \mathbf{1.15}$$

Design yield strength (fig. 3.8)

$$f_{yd} = f_{yk} / \gamma_s = \mathbf{434.8 \text{ N/mm}^2}$$

Concrete cover to reinforcement

Nominal cover to outer bottom reinforcement

$$c_{nom_b} = \mathbf{50 \text{ mm}}$$

Fire resistance period to bottom of slab

$$R_{btm} = \mathbf{60 \text{ min}}$$

Axis distance to bottom reinf (Table 5.8)

$$a_{fi_b} = \mathbf{10 \text{ mm}}$$

Min. btm cover requirement with regard to bond

$$c_{min_b_b} = \mathbf{16 \text{ mm}}$$

Reinforcement fabrication

Not subject to QA system

Cover allowance for deviation

$$\Delta c_{dev} = \mathbf{10 \text{ mm}}$$

Min. required nominal cover to bottom reinf

$$c_{nom_b_min} = \mathbf{26.0 \text{ mm}}$$

PASS - There is sufficient cover to the bottom reinforcement

Reinforcement design at midspan in short span direction (cl. 6.1)

Bending moment coefficient

$$\alpha_{sx_p} = \mathbf{0.1009}$$

Design bending moment

$$M_{x_p} = \alpha_{sx_p} \times q \times l_x^2 = \mathbf{150.6 \text{ kNm/m}}$$

Reinforcement provided

$$\mathbf{16 \text{ mm dia. bars at } 150 \text{ mm centres}}$$

Area provided

$$A_{sx_p} = \mathbf{1340 \text{ mm}^2/\text{m}}$$

Effective depth to tension reinforcement

$$d_{x_p} = h - c_{nom_b} - \phi_{x_p} / 2 = \mathbf{342.0 \text{ mm}}$$

K factor

$$K = M_{x_p} / (b \times d_{x_p}^2 \times f_{ck}) = \mathbf{0.040}$$

Redistribution ratio

$$\delta = \mathbf{1.0}$$

K' factor

$$K' = 0.598 \times \delta - 0.18 \times \delta^2 - 0.21 = \mathbf{0.208}$$

K < K' - Compression reinforcement is not required

Lever arm

$$z = \min(0.95 \times d_{x_p}, d_{x_p}/2 \times (1 + \sqrt{1 - 3.53 \times K})) = \mathbf{324.9 \text{ mm}}$$

Area of reinforcement required for bending

$$A_{sx_p_m} = M_{x_p} / (f_{yd} \times z) = \mathbf{1066 \text{ mm}^2/\text{m}}$$

Minimum area of reinforcement required

$$A_{sx_p_min} = \max(0.26 \times (f_{ctm}/f_{yk}) \times b \times d_{x_p}, 0.0013 \times b \times d_{x_p}) = \mathbf{538 \text{ mm}^2/\text{m}}$$

Area of reinforcement required

$$A_{sx_p_req} = \max(A_{sx_p_m}, A_{sx_p_min}) = \mathbf{1066 \text{ mm}^2/\text{m}}$$

PASS - Area of reinforcement provided exceeds area required

Check reinforcement spacing

Reinforcement service stress

$$\sigma_{sx_p} = (f_{yk} / \gamma_s) \times \min((A_{sx_p_m}/A_{sx_p}), 1.0) \times q_{SLS} / q = \mathbf{233.2 \text{ N/mm}^2}$$

Maximum allowable spacing (Table 7.3N)

$$s_{max_x_p} = \mathbf{209 \text{ mm}}$$

Actual bar spacing

$$s_{x_p} = \mathbf{150 \text{ mm}}$$

PASS - The reinforcement spacing is acceptable

Reinforcement design at midspan in long span direction (cl. 6.1)

Bending moment coefficient

$$\alpha_{sy_p} = \mathbf{0.0491}$$

Design bending moment

$$M_{y_p} = \alpha_{sy_p} \times q \times l_x^2 = \mathbf{73.3 \text{ kNm/m}}$$

Reinforcement provided

$$\mathbf{16 \text{ mm dia. bars at } 150 \text{ mm centres}}$$

Area provided

$$A_{sy_p} = \mathbf{1340 \text{ mm}^2/\text{m}}$$

Effective depth to tension reinforcement

$$d_{y_p} = h - c_{nom_b} - \phi_{x_p} - \phi_{y_p} / 2 = \mathbf{326.0 \text{ mm}}$$

K factor

$$K = M_{y_p} / (b \times d_{y_p}^2 \times f_{ck}) = \mathbf{0.022}$$

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Redistribution ratio $\delta = 1.0$
K' factor $K' = 0.598 \times \delta - 0.18 \times \delta^2 - 0.21 = \mathbf{0.208}$
 $K < K' - \text{Compression reinforcement is not required}$
Lever arm $z = \min(0.95 \times d_{y_p}, d_{y_p}/2 \times (1 + \sqrt{1 - 3.53 \times K})) = \mathbf{309.7 \text{ mm}}$
Area of reinforcement required for bending $A_{sy_p_m} = M_{y_p} / (f_{yd} \times z) = \mathbf{545 \text{ mm}^2/\text{m}}$
Minimum area of reinforcement required $A_{sy_p_min} = \max(0.26 \times (f_{ctm}/f_{yk}) \times b \times d_{y_p}, 0.0013 \times b \times d_{y_p}) = \mathbf{513 \text{ mm}^2/\text{m}}$
Area of reinforcement required $A_{sy_p_req} = \max(A_{sy_p_m}, A_{sy_p_min}) = \mathbf{545 \text{ mm}^2/\text{m}}$
PASS - Area of reinforcement provided exceeds area required

Check reinforcement spacing

Reinforcement service stress $\sigma_{sy_p} = (f_{yk} / \gamma_s) \times \min((A_{sy_p_m}/A_{sy_p}), 1.0) \times q_{SLS} / q = \mathbf{119.1 \text{ N/mm}^2}$
Maximum allowable spacing (Table 7.3N) $s_{max_y_p} = \mathbf{300 \text{ mm}}$
Actual bar spacing $s_{y_p} = \mathbf{150 \text{ mm}}$
PASS - The reinforcement spacing is acceptable

Shear capacity check at short span discontinuous support

Shear force $V_{x_d} = q \times l_x / 2 = \mathbf{155.5 \text{ kN/m}}$
Reinforcement provided **16 mm dia. bars at 150 mm centres**
Area provided $A_{sx_d} = \mathbf{1340 \text{ mm}^2/\text{m}}$
Effective depth $d_{x_d} = h - C_{nom_b} - \phi_{x_d} / 2 = \mathbf{342.0 \text{ mm}}$
Effective depth factor $k = \min(2.0, 1 + (200 \text{ mm} / d_{x_d})^{0.5}) = \mathbf{1.765}$
Reinforcement ratio $\rho_l = \min(0.02, A_{sx_d} / (b \times d_{x_d})) = \mathbf{0.0039}$
Minimum shear resistance $V_{Rd,c_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{x_d}$
 $V_{Rd,c_min} = \mathbf{158.7 \text{ kN/m}}$
Shear resistance constant (cl. 6.2.2) $C_{Rd,c} = 0.18 \text{ N/mm}^2 / \gamma_c = \mathbf{0.12 \text{ N/mm}^2}$
Shear resistance $V_{Rd,c_x_d} = \max(V_{Rd,c_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck}/1 \text{ N/mm}^2))^{0.333} \times b \times d_{x_d}) = \mathbf{168.1 \text{ kN/m}}$
PASS - Shear capacity is adequate (0.925)

Shear capacity check at long span discontinuous support

Shear force $V_{y_d} = q \times l_x / 2 = \mathbf{155.5 \text{ kN/m}}$
Reinforcement provided **16 mm dia. bars at 150 mm centres**
Area provided $A_{sy_d} = \mathbf{1340 \text{ mm}^2/\text{m}}$
Effective depth $d_{y_d} = h - C_{nom_b} - \phi_{x_p} - \phi_{y_d} / 2 = \mathbf{326.0 \text{ mm}}$
Effective depth factor $k = \min(2.0, 1 + (200 \text{ mm} / d_{y_d})^{0.5}) = \mathbf{1.783}$
Reinforcement ratio $\rho_l = \min(0.02, A_{sy_d} / (b \times d_{y_d})) = \mathbf{0.0041}$
Minimum shear resistance $V_{Rd,c_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{y_d}$
 $V_{Rd,c_min} = \mathbf{153.7 \text{ kN/m}}$
Shear resistance constant (cl. 6.2.2) $C_{Rd,c} = 0.18 \text{ N/mm}^2 / \gamma_c = \mathbf{0.12 \text{ N/mm}^2}$
Shear resistance $V_{Rd,c_y_d} = \max(V_{Rd,c_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck}/1 \text{ N/mm}^2))^{0.333} \times b \times d_{y_d}) = \mathbf{164.5 \text{ kN/m}}$
PASS - Shear capacity is adequate (0.945)

Basic span-to-depth deflection ratio check (cl. 7.4.2)

Reference reinforcement ratio $\rho_0 = (f_{ck} / 1 \text{ N/mm}^2)^{0.5} / 1000 = \mathbf{0.0057}$
Required tension reinforcement ratio $\rho = \max(0.0035, A_{sx_p_req} / (b \times d_{x_p})) = \mathbf{0.0035}$
Required compression reinforcement ratio $\rho' = A_{scx_p_req} / (b \times d_{x_p}) = \mathbf{0.0000}$
Structural system factor (Table 7.4N) $K_\delta = \mathbf{1.0}$
Basic limit span-to-depth ratio (Exp. 7.16)

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$$\text{ratio}_{\text{lim}_x\text{bas}} = K_{\delta} \times [11 + 1.5 \times (f_{ck}/1 \text{ N/mm}^2)^{0.5} \times \rho_0/\rho + 3.2 \times (f_{ck}/1 \text{ N/mm}^2)^{0.5} \times (\rho_0/\rho - 1)^{1.5}] = \mathbf{33.47}$$

Mod span-to-depth ratio limit

$$\text{ratio}_{\text{lim}_x} = \min(40 \times K_{\delta}, \min(1.5, (500 \text{ N/mm}^2 / f_{yk}) \times (A_{sx_p} / A_{sx_p_m})) \times \text{ratio}_{\text{lim}_x\text{bas}}) = \mathbf{40.00}$$

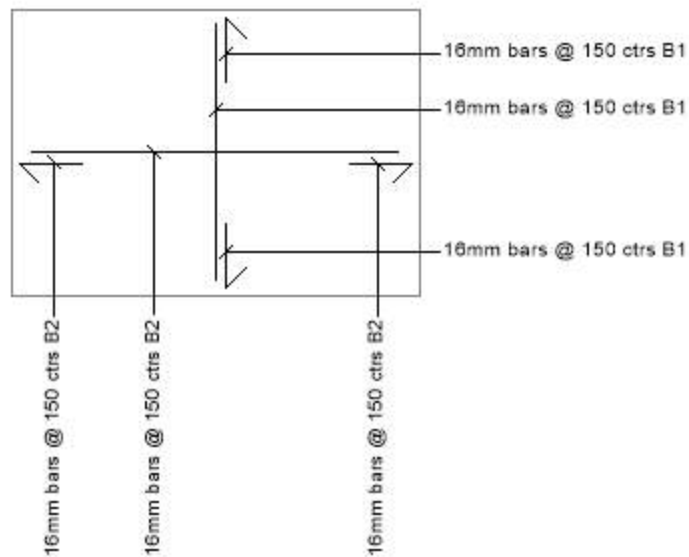
Actual span-to-eff. depth ratio

$$\text{ratio}_{\text{act}_x} = l_x / d_{x_p} = \mathbf{14.04}$$

PASS - Actual span-to-effective depth ratio is acceptable

Reinforcement sketch

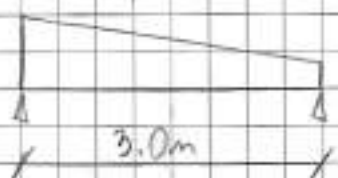
The following sketch is indicative only. Note that additional reinforcement may be required in accordance with clauses 9.2.1.2, 9.2.1.4 and 9.2.1.5 of EN 1992-1-1:2004 to meet detailing rules.



RC retaining wall

Conservatively model beam as pinned beam
Elem = 300 mm

Stem = 30 gms

 $K_0 = 1.14$ for OC days such as 4C

Concrete Boxment
by Concrete Centre

$S_{\text{max, charge}} = 10 \text{ kV/m}^2 \times 1.14 \times 11.9 \text{ V/m}^2$
 $\times S_{\text{earth}} = 0.6 \text{ W/m}^2 \rightarrow K_{\text{air}} \times h = 1.14 \times (20 - 10) \times 3.5 = 39.96 \text{ W/m}^2$
 $\times S_{\text{water}} = 0.6 \text{ W/m}^2 \rightarrow \gamma h = 10 \times 3.5 = 35 \text{ kV/m}^2$

2. Building Loading

$$DL = 6.06 \times 4.6 + 8.612 \times 3 \times 0.6 = 38.4 \text{ kN/m}$$

$$LL = 5.612 \times 3 \times 1.5 = 12.6 \text{ cm/m}$$



$$\sigma_h = K_0 \cos \sqrt{\left(\frac{B}{B+2A}\right)} q$$

$$K_0 = 1.14$$

$$\sqrt{12}$$

$$q_1 N_1 = 35.4 / 2.6 = 13.6 \text{ kN/m}^2$$

$$q_{\text{L}} = 12.6126 = 4.9 \text{ kNm}^2$$

$$\sigma_{h_{BL}} = 1.14 \times \cos 12^\circ \times \left(\frac{0.6}{0.6 + 2 \times 1} \right) \times 13.9 = 3.6 \text{ kN/m}^2$$

$$\Delta h_{1,2} = 1.14 + \cos 12^\circ \cdot (0.6 / (0.6 + 2 \cdot 1)) \times 4.9 = 1.3 \text{ eV/m}$$

Refer to TEOS output
→ Item OK @ 300 thl

$$M_{ED} = 39.1 \text{ kN}$$

$$V_{ED} = 101.8 \text{ kV} \rightarrow 146.3 \text{ kV}$$

Cont'd...

Since load from existing building is less than
surcharge of 10 kN/m² resulting from the adjacent
road, design for surcharge of 10 kN/m² only

From TEODS output use 350mm thick wall
with H20 @ 200mm/c reinforcement

ANALYSIS

Tedds calculation version 1.0.37

Results

Total base reactions

Load case/combination	Force	
	FX (kN)	FZ (kN)
SLS (Service)	0	162.6
ULS (Strength)	0	224.6

Element end forces

Load combination: SLS (Service)

Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	3	1	0	-65.2	0
		2	0	-97.3	0

Load combination: ULS (Strength)

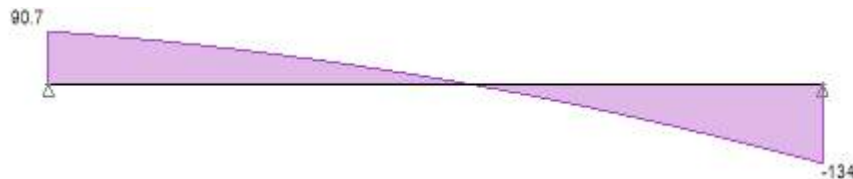
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	3	1	0	-90.7	0
		2	0	-134	0

Forces

Strength combinations - Moment envelope (kNm)



Strength combinations - Shear envelope (kN)



Element results

Envelope - Strength combinations

Element	Shear force		Moment			
	Pos (m)	Max abs (kN)	Pos (m)	Max (kNm)	Pos (m)	Min (kNm)
1	3	-134 (max abs)	1.641	85 (max)	0	0

Project Alroy Road Mews House BIA				Job no. 220921	
Calcs for Retaining Wall Stem				Start page no./Revision 1	
Calcs by DT	Calcs date 07/10/2022	Checked by	Checked date	Approved by	Approved date

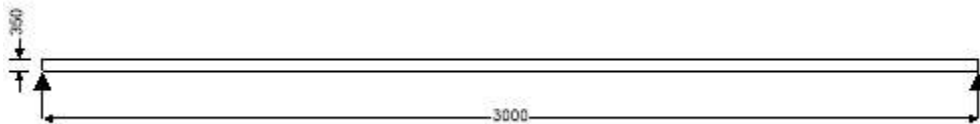
RC SLAB DESIGN

In accordance with EN1992-1-1:2004 incorporating corrigendum January 2008 and the UK national annex

Tedds calculation version 1.0.21

Design summary

Description	Unit	Provided	Required	Utilisation	Result
Support 1					
Span 1					
Tension reinf.	mm ² /m	1571	710	0.452	PASS
Tension bar spacing	mm	200	254	0.786	PASS
Allow. span-to-depth ratio		10.34	40.00	0.259	PASS
Support 2					
Cover					
Min cover bottom	mm	50	30	0.600	PASS



Slab definition

Slab reference name	Retaining Wall
Overall slab depth	h = 350 mm
Number of spans	N_{spans} = 1
First support	Simple
Last support	Simple

Nominal cover to bottom reinforcement	C_{nom_b} = 50 mm
---------------------------------------	----------------------------------

Loading

Ratio of quasi-permanent to ultimate load	r_q = 1.000
---	------------------------------

Concrete properties

Concrete strength class	C32/40
Characteristic cylinder strength	f_{ck} = 32 N/mm²
Partial factor (Table 2.1N)	γ_C = 1.50
Compressive strength factor (cl. 3.1.6)	α_{cc} = 0.85
Design compressive strength (cl. 3.1.6)	f_{cd} = 18.1 N/mm²
Mean axial tensile strength (Table 3.1)	f_{ctm} = 0.30 N/mm² × (f_{ck} / 1 N/mm²)^{2/3} = 3.0 N/mm²
Maximum aggregate size	d_g = 20 mm

Reinforcement properties

Characteristic yield strength	f_{yk} = 500 N/mm²
Partial factor (Table 2.1N)	γ_S = 1.15
Design yield strength (fig. 3.8)	f_{yd} = f_{yk} / γ_S = 434.8 N/mm²

Concrete cover to reinforcement

Nominal cover to bottom reinforcement	C_{nom_b} = 50 mm
Fire resistance period to bottom of slab	R_{btm} = 30 min
Axis distance to bottom reinf (Table 5.8)	a_{fi_b} = 10 mm
Max bar diameter in bottom	φ_{max_b} = 20 mm
Min. btm cover requirement with regard to bond	C_{min,b_b} = φ_{max_b} = 20 mm

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	Calcs for Retaining Wall Stem				Start page no./Revision 2	
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Reinforcement fabrication

Cover allowance for deviation

Min. required nominal cover to bottom reinf

Not subject to QA system

$\Delta C_{dev} = 10$ mm

$C_{nom_b_min} = \max(a_{fi_b} - \phi_{max_b} / 2, C_{min_b_b} + \Delta C_{dev}) = 30.0$ mm

PASS - There is sufficient cover to the bottom reinforcement

Bending design checks

Redistribution ratio

$\delta = 1.0$

Limiting value of K

$K' = 0.598 \times \delta - 0.18 \times \delta^2 - 0.21 = 0.208$

Reinforcement design at midspan of span 1 (cl.6.1)

Length of span 1

$l_1 = 3000$ mm

Design bending moment

$M_{p1} = 85.0$ kNm/m

Reinforcement provided

20 mm dia. bars at 200 mm centres

Area provided

$A_{sp1} = 1571$ mm²/m

Effective depth to tension reinforcement

$d_{p1} = h - C_{nom_b} - \phi_{p1} / 2 = 290.0$ mm

K factor

$K = M_{p1} / (b \times d_{p1}^2 \times f_{ck}) = 0.032$

K < K' - Compression reinforcement is not required

Lever arm

$z = \min(0.95 \times d_{p1}, d_{p1} / 2 \times (1 + \sqrt{1 - 3.53 \times K}))$

$z = 275.5$ mm

Area of reinforcement required for bending

$A_{sp1_m} = M_{p1} / (f_{yd} \times z) = 710$ mm²/m

Minimum area required

$A_{sp1_min} = \max(0.26 \times (f_{ctm}/f_{yk}), 0.0013) \times b \times d_{p1} = 456$ mm²/m

Area of reinforcement required

$A_{sp1_req} = \max(A_{sp1_m}, A_{sp1_min}) = 710$ mm²/m

PASS - Area of tension reinforcement provided is adequate (0.452)

Check reinforcement spacing

Reinforcement service stress

$\sigma_s = (f_{yk} / \gamma_s) \times \min((A_{sp1_m}/A_{sp1}), 1.0) \times r_q = 196.4$ N/mm²

Maximum allowable spacing (Table 7.3N)

$S_{max_p1} = 254$ mm

Actual bar spacing

$S_{p1} = 200$ mm

PASS - The reinforcement spacing is acceptable

Shear design checks

Shear resistance constant (cl. 6.2.2)

$C_{Rd,c} = 0.18$ N/mm² / $\gamma_c = 0.12$ N/mm²

Shear capacity check at support 1

Shear force

$V_1 = 134.0$ kN/m

Reinforcement provided

20 mm dia. bars at 200 mm centres

Area provided

$A_{sd1} = 1571$ mm²/m

Effective depth

$d_{d1} = h - C_{nom_b} - \phi_{d1} / 2 = 290.0$ mm

Effective depth factor (cl. 6.2.2)

$k = \min(2.0, 1 + (200 \text{ mm} / d_{d1})^{0.5}) = 1.830$

Reinforcement ratio

$\rho_l = \min(0.02, A_{sd1} / (b \times d_{d1})) = 0.0054$

Minimum shear resistance (Exp. 6.3N)

$V_{Rd,c_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{d1}$

$V_{Rd,c_min} = 142.2$ kN/m

Shear resistance (Exp. 6.2a)

$V_{Rd,c1} = \max(V_{Rd,c_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck} / 1 \text{ N/mm}^2))^{0.333} \times b \times d_{d1})$

$V_{Rd,c1} = 164.7$ kN/m

PASS - Shear capacity is adequate (0.814)

Shear capacity check at support 2

Shear force

$V_2 = 90.7$ kN/m

Reinforcement provided

20 mm dia. bars at 200 mm centres

Area provided

$A_{sd2} = 1571$ mm²/m

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Effective depth $d_{d2} = h - c_{nom_b} - \phi_{d2} / 2 = \mathbf{290.0 \text{ mm}}$
 Effective depth factor (cl. 6.2.2) $k = \min(2.0, 1 + (200 \text{ mm} / d_{d2})^{0.5}) = \mathbf{1.830}$
 Reinforcement ratio $\rho_l = \min(0.02, A_{sd2} / (b \times d_{d2})) = \mathbf{0.0054}$
 Minimum shear resistance (Exp. 6.3N) $V_{Rd,c_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{d2}$
 $V_{Rd,c_min} = \mathbf{142.2 \text{ kN/m}}$
 Shear resistance (Exp. 6.2a) $V_{Rd,c2} = \max(V_{Rd,c_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck} / 1 \text{ N/mm}^2))^{0.333} \times b \times d_{d2})$
 $V_{Rd,c2} = \mathbf{164.7 \text{ kN/m}}$
PASS - Shear capacity is adequate (0.551)

Deflection checks

Basic span-to-depth ratio deflection check span 1 (cl. 7.4.2)

Reference reinforcement ratio $\rho_0 = (f_{ck} / 1 \text{ N/mm}^2)^{0.5} / 1000 = \mathbf{0.0057}$
 Required tension reinforcement ratio $\rho = \max(0.0035, A_{sp1_m} / (b \times d_{p1})) = \mathbf{0.0035}$
 Required compression reinforcement ratio $\rho' = A_{scp1_req} / (b \times d_{p1}) = \mathbf{0.0000}$
 Structural system factor (Table 7.4N) $K_\delta = \mathbf{1.0}$
 Basic span-to-depth ratio limit $ratio_{lim1_bas} = K_\delta \times [11 + 1.5 \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times \rho_0 / \rho + 3.2 \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times (\rho_0 / \rho - 1)^{1.5}]$
 (Exp. 7.16a) $ratio_{lim1_bas} = \mathbf{33.47}$
 Modified span-to-depth ratio limit $ratio_{lim1} = \min(40 \times K_\delta, \min(1.5, (500 \text{ N/mm}^2 / f_{yk}) \times (A_{sp1} / A_{sp1_m})) \times ratio_{lim1_bas}) = \mathbf{40.00}$
 Actual span-to-depth ratio $ratio_{act1} = l_1 / d_{p1} = \mathbf{10.34}$
PASS - Span-to-depth ratio is acceptable (0.259)

Reinforcement sketch

The following sketch is indicative only. Note that additional reinforcement may be required in accordance with clauses 9.2.1.2, 9.2.1.4 and 9.2.1.5 of EN 1992-1-1:2004 to meet detailing rules.



RC Retaining wall (next to Leyland)



Surcharge = 10 kN/m²

$\gamma = 20 \text{ kN/m}^3$

water table @ GL

Refer to TENDS Output

Wall OK

 RSA Design 2 Victoria Road Buckhurst Hill IG9 5ES	Project Alroy Road Mews House BIA				Job no. 220921	
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RETAINING WALL ANALYSIS

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.9.14

Retaining wall details

Stem type	Cantilever
Stem height	$h_{\text{stem}} = 3500 \text{ mm}$
Stem thickness	$t_{\text{stem}} = 400 \text{ mm}$
Angle to rear face of stem	$\alpha = 90 \text{ deg}$
Stem density	$\gamma_{\text{stem}} = 25 \text{ kN/m}^3$
Toe length	$l_{\text{toe}} = 2600 \text{ mm}$
Base thickness	$t_{\text{base}} = 400 \text{ mm}$
Base density	$\gamma_{\text{base}} = 25 \text{ kN/m}^3$
Height of retained soil	$h_{\text{ret}} = 3500 \text{ mm}$
Angle of soil surface	$\beta = 0 \text{ deg}$
Depth of cover	$d_{\text{cover}} = 0 \text{ mm}$

Retained soil properties

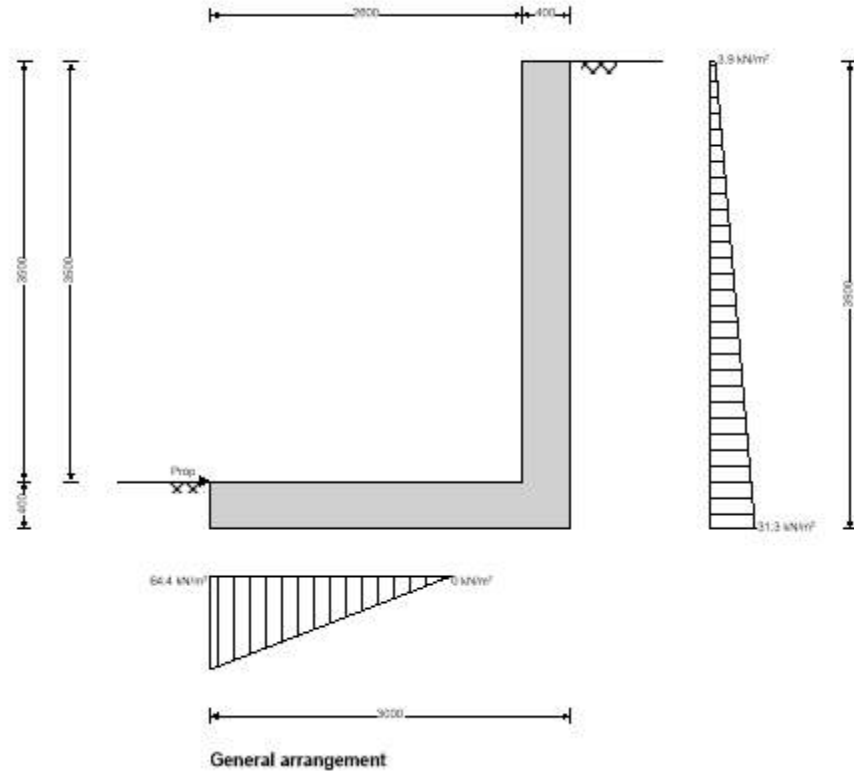
Soil type	Firm clay
Moist density	$\gamma_{\text{mr}} = 18 \text{ kN/m}^3$
Saturated density	$\gamma_{\text{sr}} = 18 \text{ kN/m}^3$
Characteristic effective shear resistance angle	$\phi'_{\text{r,k}} = 22 \text{ deg}$
Characteristic wall friction angle	$\delta_{\text{r,k}} = 15 \text{ deg}$

Base soil properties

Soil type	Stiff clay
Soil density	$\gamma_{\text{b}} = 20 \text{ kN/m}^3$
Characteristic effective shear resistance angle	$\phi'_{\text{b,k}} = 22 \text{ deg}$
Characteristic wall friction angle	$\delta_{\text{b,k}} = 15 \text{ deg}$
Characteristic base friction angle	$\delta_{\text{bb,k}} = 15 \text{ deg}$
Presumed bearing capacity	$P_{\text{bearing}} = 150 \text{ kN/m}^2$

Loading details

Variable surcharge load	Surcharge _Q = 10 kN/m ²
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Calculate retaining wall geometry

Base length

$$l_{base} = l_{toe} + t_{stem} = 3000 \text{ mm}$$

Moist soil height

$$h_{moist} = h_{soil} = 3500 \text{ mm}$$

Length of surcharge load

$$l_{sur} = l_{heel} = 0 \text{ mm}$$

- Distance to vertical component

$$x_{sur_v} = l_{base} - l_{heel} / 2 = 3000 \text{ mm}$$

Effective height of wall

$$h_{eff} = h_{base} + d_{cover} + h_{ret} = 3900 \text{ mm}$$

- Distance to horizontal component

$$x_{sur_h} = h_{eff} / 2 = 1950 \text{ mm}$$

Area of wall stem

$$A_{stem} = h_{stem} \times t_{stem} = 1.4 \text{ m}^2$$

- Distance to vertical component

$$x_{stem} = l_{toe} + t_{stem} / 2 = 2800 \text{ mm}$$

Area of wall base

$$A_{base} = l_{base} \times t_{base} = 1.2 \text{ m}^2$$

- Distance to vertical component

$$x_{base} = l_{base} / 2 = 1500 \text{ mm}$$

Using Coulomb theory

Active pressure coefficient

$$K_A = \frac{\sin(\alpha + \phi'_{r,k})^2}{(\sin(\alpha)^2 \times \sin(\alpha - \delta_{r,k}) \times [1 + \sqrt{(\sin(\phi'_{r,k} + \delta_{r,k}) \times \sin(\phi'_{r,k} - \beta))}]^2)} = 0.405$$

Passive pressure coefficient

$$K_P = \frac{\sin(90 - \phi'_{b,k})^2}{(\sin(90 + \delta_{b,k}) \times [1 - \sqrt{(\sin(\phi'_{b,k} + \delta_{b,k}) \times \sin(\phi'_{b,k} - \beta))}]^2)} = 3.331$$

Bearing pressure check

Vertical forces on wall

Wall stem

$$F_{stem} = A_{stem} \times \gamma_{stem} = 35 \text{ kN/m}$$

Wall base

$$F_{base} = A_{base} \times \gamma_{base} = 30 \text{ kN/m}$$

Total

$$F_{total_v} = F_{stem} + F_{base} = 65 \text{ kN/m}$$

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Horizontal forces on wall

Surcharge load	$F_{sur_h} = K_A \times \cos(\delta_{r,k}) \times \text{Surcharge}_Q \times h_{eff} = \mathbf{15.2 \text{ kN/m}}$
Moist retained soil	$F_{moist_h} = K_A \times \cos(\delta_{r,k}) \times \gamma_{mr} \times h_{eff}^2 / 2 = \mathbf{53.5 \text{ kN/m}}$
Base soil	$F_{pass_h} = -K_P \times \cos(\delta_{b,k}) \times \gamma_b \times (d_{cover} + h_{base})^2 / 2 = \mathbf{-5.1 \text{ kN/m}}$
Total	$F_{total_h} = F_{sur_h} + F_{moist_h} + F_{pass_h} = \mathbf{63.6 \text{ kN/m}}$

Moments on wall

Wall stem	$M_{stem} = F_{stem} \times X_{stem} = \mathbf{98 \text{ kNm/m}}$
Wall base	$M_{base} = F_{base} \times X_{base} = \mathbf{45 \text{ kNm/m}}$
Surcharge load	$M_{sur} = -F_{sur_h} \times X_{sur_h} = \mathbf{-29.7 \text{ kNm/m}}$
Moist retained soil	$M_{moist} = -F_{moist_h} \times X_{moist_h} = \mathbf{-69.6 \text{ kNm/m}}$
Total	$M_{total} = M_{stem} + M_{base} + M_{sur} + M_{moist} = \mathbf{43.7 \text{ kNm/m}}$

Check bearing pressure

Propping force	$F_{prop_base} = F_{total_h} = \mathbf{63.6 \text{ kN/m}}$
Distance to reaction	$\bar{x} = M_{total} / F_{total_v} = \mathbf{673 \text{ mm}}$
Eccentricity of reaction	$e = \bar{x} - l_{base} / 2 = \mathbf{-827 \text{ mm}}$
Loaded length of base	$l_{load} = 3 \times \bar{x} = \mathbf{2018 \text{ mm}}$
Bearing pressure at toe	$q_{toe} = 2 \times F_{total_v} / l_{load} = \mathbf{64.4 \text{ kN/m}^2}$
Bearing pressure at heel	$q_{heel} = \mathbf{0 \text{ kN/m}^2}$
Factor of safety	$FoS_{bp} = P_{bearing} / \max(q_{toe}, q_{heel}) = \mathbf{2.329}$

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

RETAINING WALL DESIGN

In accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 2.9.14

Concrete details - Table 3.1 - Strength and deformation characteristics for concrete

Concrete strength class	C32/40
Characteristic compressive cylinder strength	$f_{ck} = \mathbf{32 \text{ N/mm}^2}$
Characteristic compressive cube strength	$f_{ck,cube} = \mathbf{40 \text{ N/mm}^2}$
Mean value of compressive cylinder strength	$f_{cm} = f_{ck} + 8 \text{ N/mm}^2 = \mathbf{40 \text{ N/mm}^2}$
Mean value of axial tensile strength	$f_{ctm} = 0.3 \text{ N/mm}^2 \times (f_{ck} / 1 \text{ N/mm}^2)^{2/3} = \mathbf{3.0 \text{ N/mm}^2}$
5% fractile of axial tensile strength	$f_{ctk,0.05} = 0.7 \times f_{ctm} = \mathbf{2.1 \text{ N/mm}^2}$
Secant modulus of elasticity of concrete	$E_{cm} = 22 \text{ kN/mm}^2 \times (f_{cm} / 10 \text{ N/mm}^2)^{0.3} = \mathbf{33346 \text{ N/mm}^2}$
Partial factor for concrete - Table 2.1N	$\gamma_C = \mathbf{1.50}$
Compressive strength coefficient - cl.3.1.6(1)	$\alpha_{cc} = \mathbf{0.85}$
Design compressive concrete strength - exp.3.15	$f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_C = \mathbf{18.1 \text{ N/mm}^2}$
Maximum aggregate size	$h_{agg} = \mathbf{20 \text{ mm}}$
Ultimate strain - Table 3.1	$\epsilon_{cu2} = \mathbf{0.0035}$
Shortening strain - Table 3.1	$\epsilon_{cu3} = \mathbf{0.0035}$
Effective compression zone height factor	$\lambda = \mathbf{0.80}$
Effective strength factor	$\eta = \mathbf{1.00}$
Bending coefficient k_1	$K_1 = \mathbf{0.40}$
Bending coefficient k_2	$K_2 = 1.00 \times (0.6 + 0.0014 / \epsilon_{cu2}) = \mathbf{1.00}$
Bending coefficient k_3	$K_3 = \mathbf{0.40}$
Bending coefficient k_4	$K_4 = 1.00 \times (0.6 + 0.0014 / \epsilon_{cu2}) = \mathbf{1.00}$

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Reinforcement details

Characteristic yield strength of reinforcement

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

Modulus of elasticity of reinforcement

$$E_s = 200000 \text{ N/mm}^2$$

Partial factor for reinforcing steel - Table 2.1N

$$\gamma_s = 1.15$$

Design yield strength of reinforcement

$$f_{yd} = f_{yk} / \gamma_s = 435 \text{ N/mm}^2$$

Cover to reinforcement

Front face of stem

$$C_{sf} = 35 \text{ mm}$$

Rear face of stem

$$C_{sr} = 75 \text{ mm}$$

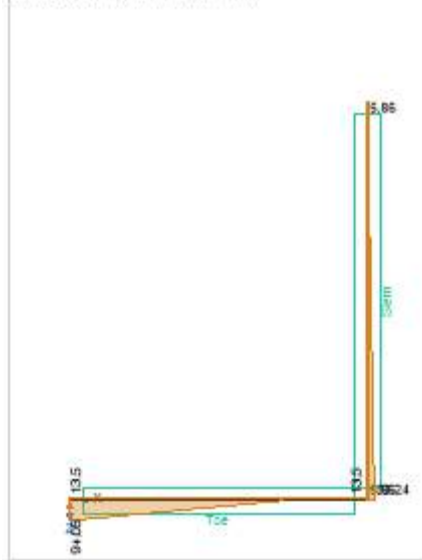
Top face of base

$$C_{bt} = 50 \text{ mm}$$

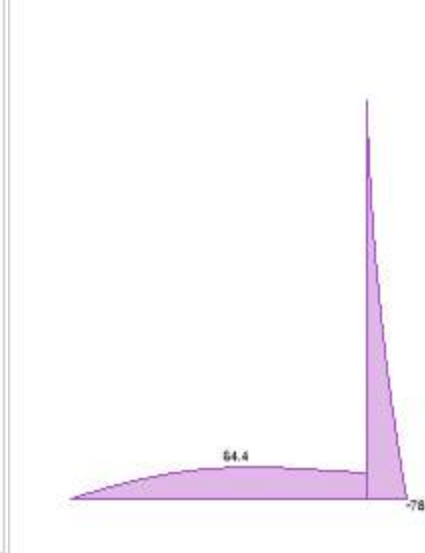
Bottom face of base

$$C_{bb} = 75 \text{ mm}$$

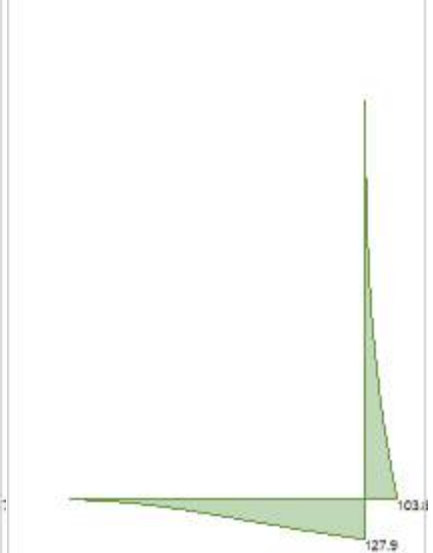
Loading details - Combination No.1 - kN/m



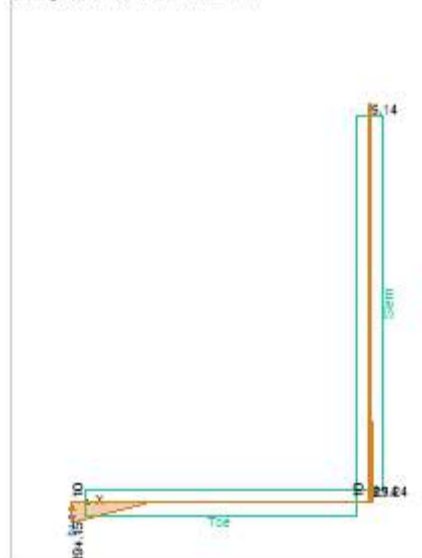
Shear force - Combination No.1 - kN/m



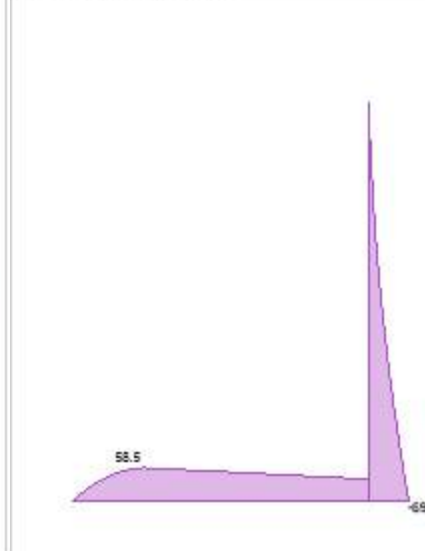
Bending moment - Combination No.1 - kNm/m



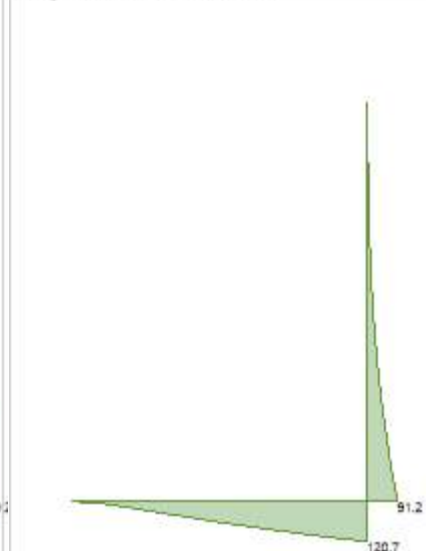
Loading details - Combination No.2 - kN/m



Shear force - Combination No.2 - kN/m



Bending moment - Combination No.2 - kNm/m



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Check stem design at base of stem

Depth of section $h = 400$ mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 $M = 103.8$ kNm/m

Depth to tension reinforcement $d = h - C_{sr} - \phi_{sr} / 2 = 317$ mm

$$K = M / (d^2 \times f_{ck}) = 0.032$$

$$K' = (2 \times \eta \times \alpha_{cc} / \gamma_c) \times (1 - \lambda \times (\delta - K_1) / (2 \times K_2)) \times (\lambda \times (\delta - K_1) / (2 \times K_2))$$

$$K' = 0.207$$

$K' > K$ - No compression reinforcement is required

Lever arm $z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_c))^{0.5}, 0.95) \times d = 301$ mm

Depth of neutral axis $x = 2.5 \times (d - z) = 40$ mm

Area of tension reinforcement required $A_{sr,req} = M / (f_{yd} \times z) = 793$ mm²/m

Tension reinforcement provided 16 dia.bars @ 150 c/c

Area of tension reinforcement provided $A_{sr,prov} = \pi \times \phi_{sr}^2 / (4 \times s_{sr}) = 1340$ mm²/m

Minimum area of reinforcement - exp.9.1N $A_{sr,min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d = 498$ mm²/m

Maximum area of reinforcement - cl.9.2.1.1(3) $A_{sr,max} = 0.04 \times h = 16000$ mm²/m

$$\max(A_{sr,req}, A_{sr,min}) / A_{sr,prov} = 0.591$$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single output

Deflection control - Section 7.4

Reference reinforcement ratio $\rho_0 = \sqrt{f_{ck} / 1 \text{ N/mm}^2} / 1000 = 0.006$

Required tension reinforcement ratio $\rho = A_{sr,req} / d = 0.003$

Required compression reinforcement ratio $\rho' = A_{sr,2,req} / d_2 = 0.000$

Structural system factor - Table 7.4N $K_b = 0.4$

Reinforcement factor - exp.7.17 $K_s = \min(500 \text{ N/mm}^2 / (f_{yk} \times A_{sr,req} / A_{sr,prov}), 1.5) = 1.5$

Limiting span to depth ratio - exp.7.16.a $\min(K_s \times K_b \times [11 + 1.5 \times \sqrt{f_{ck} / 1 \text{ N/mm}^2}] \times \rho_0 / \rho + 3.2 \times \sqrt{f_{ck} / 1 \text{ N/mm}^2}) \times (\rho_0 / \rho - 1)^{3/2}, 40 \times K_b) = 16$

Actual span to depth ratio $h_{stem} / d = 11$

PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3

Limiting crack width $w_{max} = 0.3$ mm

Variable load factor - EN1990 – Table A1.1 $\psi_2 = 0.3$

Serviceability bending moment $M_{sls} = 57.5$ kNm/m

Tensile stress in reinforcement $\sigma_s = M_{sls} / (A_{sr,prov} \times z) = 142.3$ N/mm²

Load duration Long term

Load duration factor $k_t = 0.4$

Effective area of concrete in tension $A_{c,eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$

$$A_{c,eff} = 120125 \text{ mm}^2/\text{m}$$

Mean value of concrete tensile strength $f_{ct,eff} = f_{ctm} = 3.0$ N/mm²

Reinforcement ratio $\rho_{p,eff} = A_{sr,prov} / A_{c,eff} = 0.011$

Modular ratio $\alpha_e = E_s / E_{cm} = 5.998$

Bond property coefficient $k_1 = 0.8$

Strain distribution coefficient $k_2 = 0.5$

$$k_3 = 3.4$$

$$k_4 = 0.425$$

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Maximum crack spacing - exp.7.11

$$s_{r,max} = k_3 \times c_{sr} + k_1 \times k_2 \times k_4 \times \phi_{sr} / \rho_{p,eff} = \mathbf{499 \text{ mm}}$$

Maximum crack width - exp.7.8

$$w_k = s_{r,max} \times \max(\sigma_s - k_t \times (f_{ct,eff} / \rho_{p,eff}) \times (1 + \alpha_e \times \rho_{p,eff}), 0.6 \times \sigma_s) / E_s$$

$$w_k = \mathbf{0.213 \text{ mm}}$$

$$w_k / w_{max} = \mathbf{0.71}$$

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force

$$V = \mathbf{78.7 \text{ kN/m}}$$

$$C_{Rd,c} = 0.18 / \gamma_c = \mathbf{0.120}$$

$$k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2) = \mathbf{1.794}$$

Longitudinal reinforcement ratio

$$\rho_l = \min(A_{sr,prov} / d, 0.02) = \mathbf{0.004}$$

$$v_{min} = 0.035 \text{ N}^{1/2}/\text{mm} \times k^{3/2} \times f_{ck}^{0.5} = \mathbf{0.476 \text{ N/mm}^2}$$

Design shear resistance - exp.6.2a & 6.2b

$$V_{Rd,c} = \max(C_{Rd,c} \times k \times (100 \text{ N}^2/\text{mm}^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$$

$$V_{Rd,c} = \mathbf{162.6 \text{ kN/m}}$$

$$V / V_{Rd,c} = \mathbf{0.484}$$

PASS - Design shear resistance exceeds design shear force

Horizontal reinforcement parallel to face of stem - Section 9.6

Minimum area of reinforcement – cl.9.6.3(1)

$$A_{sx,req} = \max(0.25 \times A_{sr,prov}, 0.001 \times t_{stem}) = \mathbf{400 \text{ mm}^2/\text{m}}$$

Maximum spacing of reinforcement – cl.9.6.3(2)

$$s_{sx,max} = \mathbf{400 \text{ mm}}$$

Transverse reinforcement provided

$$\mathbf{12 \text{ dia.bars @ } 200 \text{ c/c}}$$

Area of transverse reinforcement provided

$$A_{sx,prov} = \pi \times \phi_{sx}^2 / (4 \times s_{sx}) = \mathbf{565 \text{ mm}^2/\text{m}}$$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Check base design at toe

Depth of section

$$h = \mathbf{400 \text{ mm}}$$

Rectangular section in flexure - Section 6.1

Design bending moment combination 1

$$M = \mathbf{127.9 \text{ kNm/m}}$$

Depth to tension reinforcement

$$d = h - c_{bb} - \phi_{bb} / 2 = \mathbf{317 \text{ mm}}$$

$$K = M / (d^2 \times f_{ck}) = \mathbf{0.040}$$

$$K' = (2 \times \eta \times \alpha_{cc} / \gamma_c) \times (1 - \lambda \times (\delta - K_1) / (2 \times K_2)) \times (\lambda \times (\delta - K_1) / (2 \times K_2))$$

$$K' = \mathbf{0.207}$$

K' > K - No compression reinforcement is required

Lever arm

$$z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_c))^{0.5}, 0.95) \times d = \mathbf{301 \text{ mm}}$$

Depth of neutral axis

$$x = 2.5 \times (d - z) = \mathbf{40 \text{ mm}}$$

Area of tension reinforcement required

$$A_{bb,req} = M / (f_{yd} \times z) = \mathbf{977 \text{ mm}^2/\text{m}}$$

Tension reinforcement provided

$$\mathbf{16 \text{ dia.bars @ } 125 \text{ c/c}}$$

Area of tension reinforcement provided

$$A_{bb,prov} = \pi \times \phi_{bb}^2 / (4 \times s_{bb}) = \mathbf{1608 \text{ mm}^2/\text{m}}$$

Minimum area of reinforcement - exp.9.1N

$$A_{bb,min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d = \mathbf{498 \text{ mm}^2/\text{m}}$$

Maximum area of reinforcement - cl.9.2.1.1(3)

$$A_{bb,max} = 0.04 \times h = \mathbf{16000 \text{ mm}^2/\text{m}}$$

$$\max(A_{bb,req}, A_{bb,min}) / A_{bb,prov} = \mathbf{0.608}$$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single output

Crack control - Section 7.3

Limiting crack width

$$w_{max} = \mathbf{0.3 \text{ mm}}$$

Variable load factor - EN1990 – Table A1.1

$$\psi_2 = \mathbf{0.3}$$

Serviceability bending moment

$$M_{sIs} = \mathbf{91.5 \text{ kNm/m}}$$

Tensile stress in reinforcement

$$\sigma_s = M_{sIs} / (A_{bb,prov} \times z) = \mathbf{188.8 \text{ N/mm}^2}$$

Load duration

$$\mathbf{\text{Long term}}$$

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Load duration factor

$$k_t = 0.4$$

Effective area of concrete in tension

$$A_{c,eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$$

$$A_{c,eff} = 120125 \text{ mm}^2/\text{m}$$

Mean value of concrete tensile strength

$$f_{ct,eff} = f_{ctm} = 3.0 \text{ N/mm}^2$$

Reinforcement ratio

$$\rho_{p,eff} = A_{bb,prov} / A_{c,eff} = 0.013$$

Modular ratio

$$\alpha_e = E_s / E_{cm} = 5.998$$

Bond property coefficient

$$k_1 = 0.8$$

Strain distribution coefficient

$$k_2 = 0.5$$

$$k_3 = 3.4$$

$$k_4 = 0.425$$

Maximum crack spacing - exp.7.11

$$s_{r,max} = k_3 \times C_{bb} + k_1 \times k_2 \times k_4 \times \phi_{bb} / \rho_{p,eff} = 458 \text{ mm}$$

Maximum crack width - exp.7.8

$$w_k = s_{r,max} \times \max(\sigma_s - k_t \times (f_{ct,eff} / \rho_{p,eff}) \times (1 + \alpha_e \times \rho_{p,eff}), 0.6 \times \sigma_s) / E_s$$

$$w_k = 0.26 \text{ mm}$$

$$w_k / w_{max} = 0.865$$

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force

$$V = 64.4 \text{ kN/m}$$

$$C_{Rd,c} = 0.18 / \gamma_c = 0.120$$

$$k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2) = 1.794$$

Longitudinal reinforcement ratio

$$\rho_l = \min(A_{bb,prov} / d, 0.02) = 0.005$$

$$v_{min} = 0.035 \text{ N}^{1/2}/\text{mm} \times k^{3/2} \times f_{ck}^{0.5} = 0.476 \text{ N/mm}^2$$

Design shear resistance - exp.6.2a & 6.2b

$$V_{Rd,c} = \max(C_{Rd,c} \times k \times (100 \text{ N}^2/\text{mm}^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$$

$$V_{Rd,c} = 172.8 \text{ kN/m}$$

$$V / V_{Rd,c} = 0.372$$

PASS - Design shear resistance exceeds design shear force

Secondary transverse reinforcement to base - Section 9.3

Minimum area of reinforcement – cl.9.3.1.1(2)

$$A_{bx,req} = 0.2 \times A_{bb,prov} = 322 \text{ mm}^2/\text{m}$$

Maximum spacing of reinforcement – cl.9.3.1.1(3)

$$s_{bx,max} = 450 \text{ mm}$$

Transverse reinforcement provided

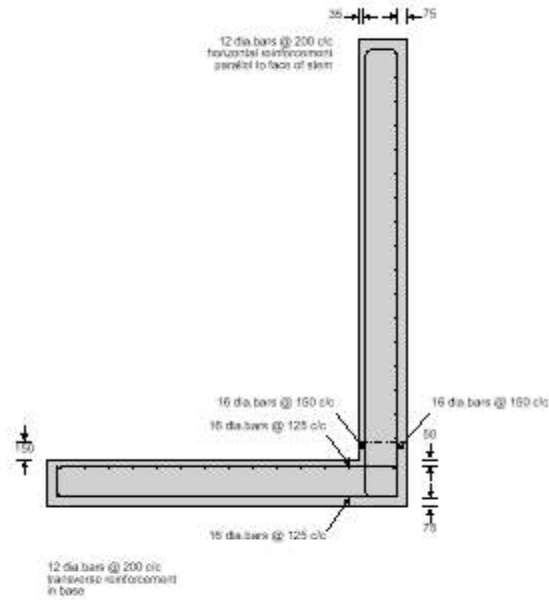
$$12 \text{ dia.bars @ } 200 \text{ c/c}$$

Area of transverse reinforcement provided

$$A_{bx,prov} = \pi \times \phi_{bx}^2 / (4 \times s_{bx}) = 565 \text{ mm}^2/\text{m}$$

PASS - Area of reinforcement provided is greater than area of reinforcement required

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Reinforcement details

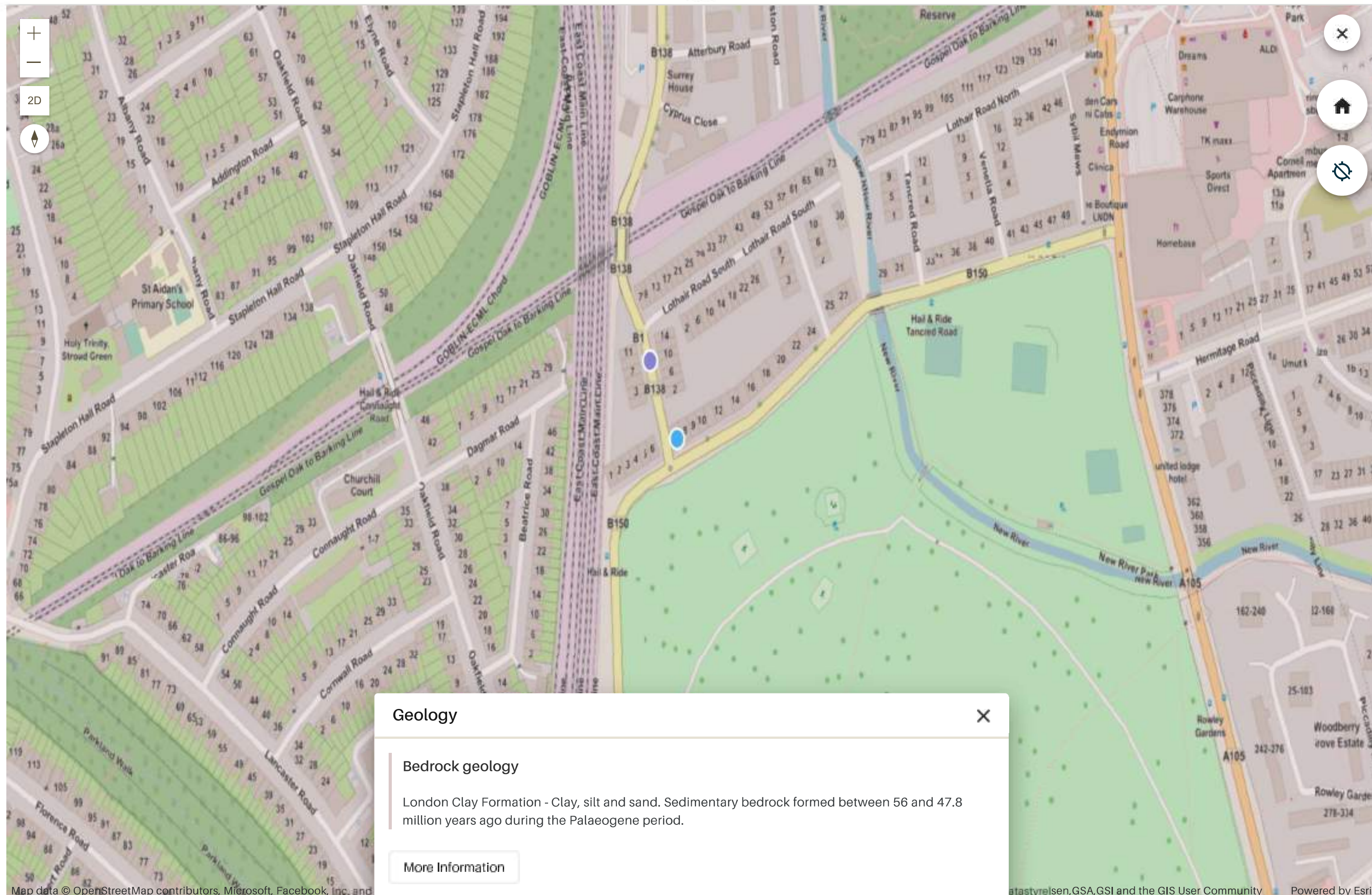
**LAND ADJACENT TO
2 ALROY ROAD,
LONDON,
N4 1EF**

APPENDIX C

**GEOLOGICAL AND HYDROLOGICAL
INFORMATION**



Geology Viewer

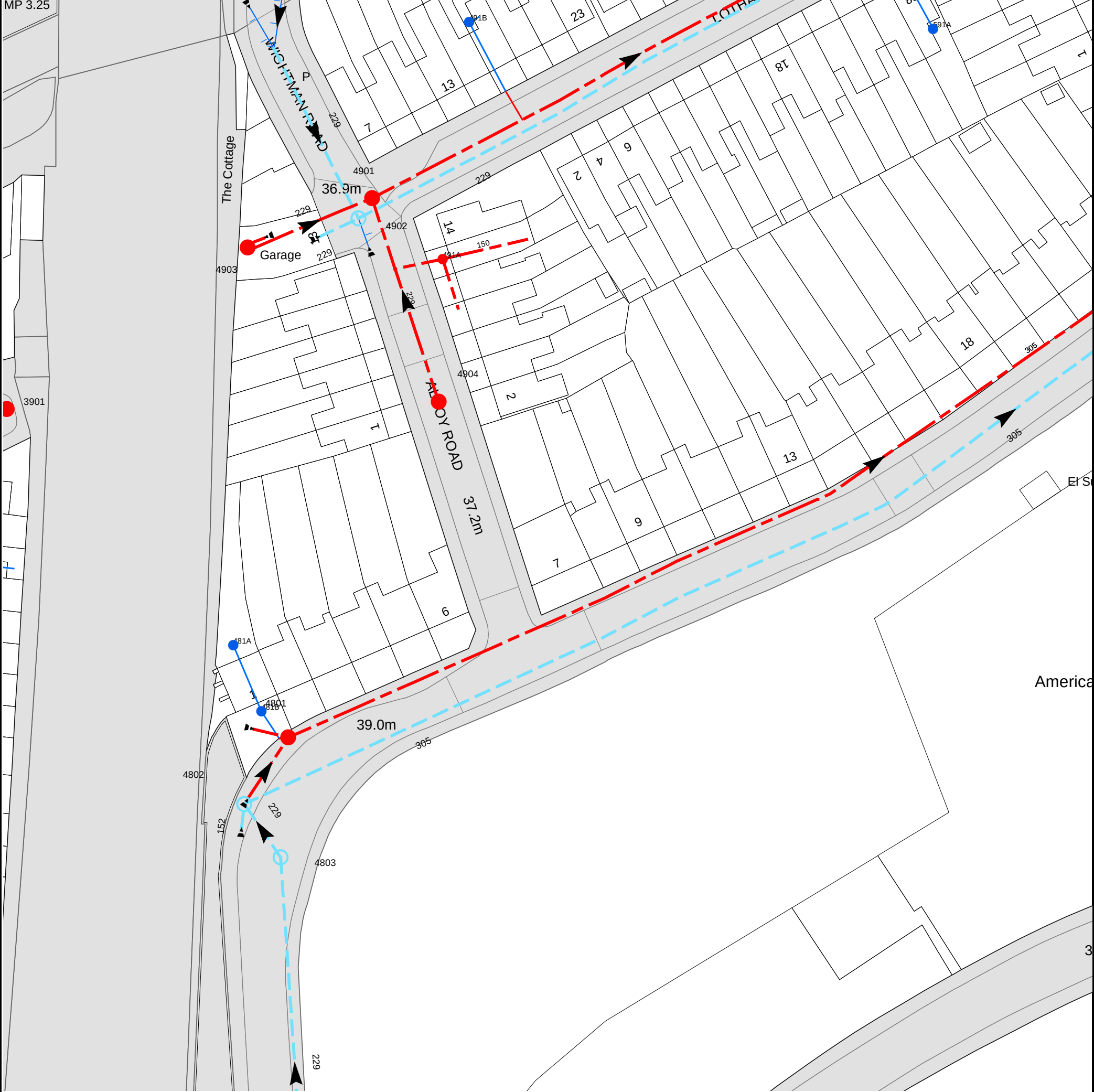


**LAND ADJACENT TO
2 ALROY ROAD,
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APPENDIX D

**THAMES WATER ASSET
LOCATION SEARCH**

Asset Location Search Sewer Map - ALS/ALS Standard/2022 4727968



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 531490,187876

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

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NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
3901	38.57	37.06
481A	n/a	n/a
4802	39.58	37.09
4903	36.83	32.84
481B	n/a	n/a
4803	39.6	37.77
4801	39.18	34.36
4902	36.43	34.7
4901	36.39	31.87
4904	36.88	33.24
491A	n/a	n/a
491B	n/a	n/a
591A	n/a	n/a
The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.		



Asset Location Search - Sewer Key

Public Sewer Types (Operated and maintained by Thames Water)

	Foul Sewer: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.
	Surface Water Sewer: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.
	Combined Sewer: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.
	Storm Sewer
	Sludge Sewer
	Foul Trunk Sewer
	Surface Trunk Sewer
	Combined Trunk Sewer
	Foul Rising Main
	Surface Water Rising Main
	Combined Rising Main
	Vacuum
	Thames Water Proposed
	Vent Pipe
	Gallery

Other Sewer Types (Not operated and maintained by Thames Water)

	Sewer
	Culverted Watercourse
	Proposed
	Decommissioned Sewer
	Content of this drainage network is currently unknown
	Ownership of this drainage network is currently unknown

Notes:

- 1) All levels associated with the plans are to Ordnance Datum Newlyn.
- 2) All measurements on the plan are metric.
- 3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate the direction of flow.
- 4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

	Air Valve		Meter
	Dam Chase		Vent
	Fitting		

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

	Ancillary		Drop Pipe
	Control Valve		Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol. Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

	Inlet		Outfall
	Undefined End		

Other Symbols

Symbols used on maps which do not fall under other general categories.

	Change of Characteristic Indicator		Public / Private Pumping Station
	Invert Level		Summit

Areas

Lines denoting areas of underground surveys, etc.

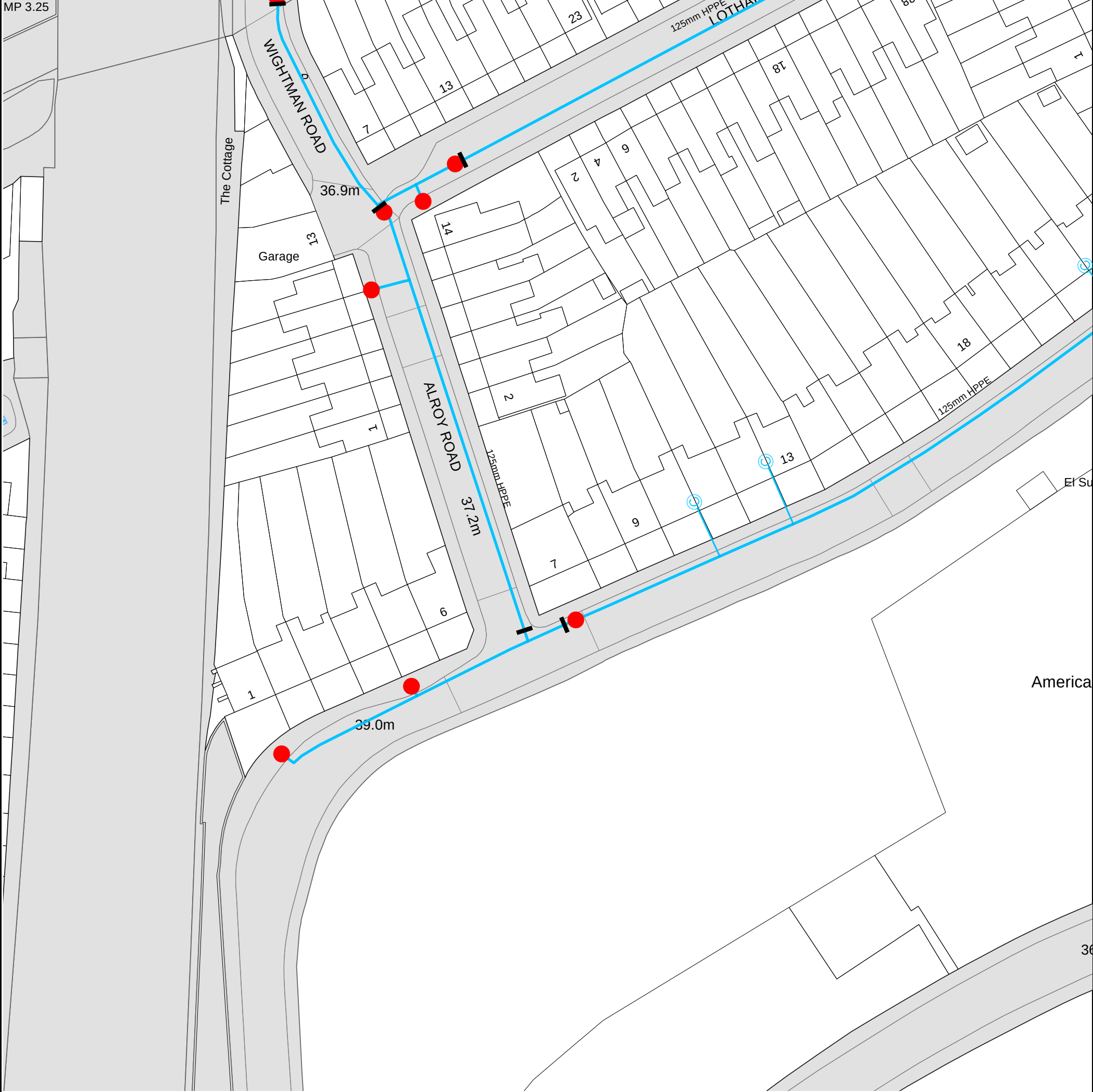
	Agreement
	Chamber
	Operational Site

Ducts or Crossings

	Casement	Ducts may contain high voltage cables. Please check with Thames Water.
	Conduit Bridge	
	Subway	
	Tunnel	

5) 'na' or '0' on a manhole indicates that data is unavailable.

6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimeters. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology, please contact Property Searches on 0800 009 4540.



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 531490, 187876.

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

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Asset Location Search - Water Key

Water Pipes (Operated & Maintained by Thames Water)

- Distribution Main:** The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.
- Trunk Main:** A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.
- Supply Main:** A supply main indicates that the water main is used as a supply for a single property or group of properties.
- Fire Main:** Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.
- Metered Pipe:** A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.
- Transmission Tunnel:** A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.
- Proposed Main:** A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 6")
600mm and bigger (24" plus)	1200mm (4')

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger
- Casement:** Ducts may contain high voltage cables. Please check with Thames Water.

Other Water Pipes (Not Operated or Maintained by Thames Water)

- Other Water Company Main:** Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.
- Private Main:** Indicates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

**LAND ADJACENT TO
2 ALROY ROAD,
LONDON,
N4 1EF**

APPENDIX E

**FLOOD RISK
LOCATION SEARCH**

Flood map for planning

Your reference

Flood map 7 Endymion

Location (easting/northing)

531450/187918

Created

4 Oct 2022 16:13

Your selected location is in flood zone 1, an area with a low probability of flooding.

You will need to do a flood risk assessment if your site is **any of the following:**

- bigger than 1 hectare (ha)
- In an area with critical drainage problems as notified by the Environment Agency
- identified as being at increased flood risk in future by the local authority's strategic flood risk assessment
- at risk from other sources of flooding (such as surface water or reservoirs) and its development would increase the vulnerability of its use (such as constructing an office on an undeveloped site or converting a shop to a dwelling)

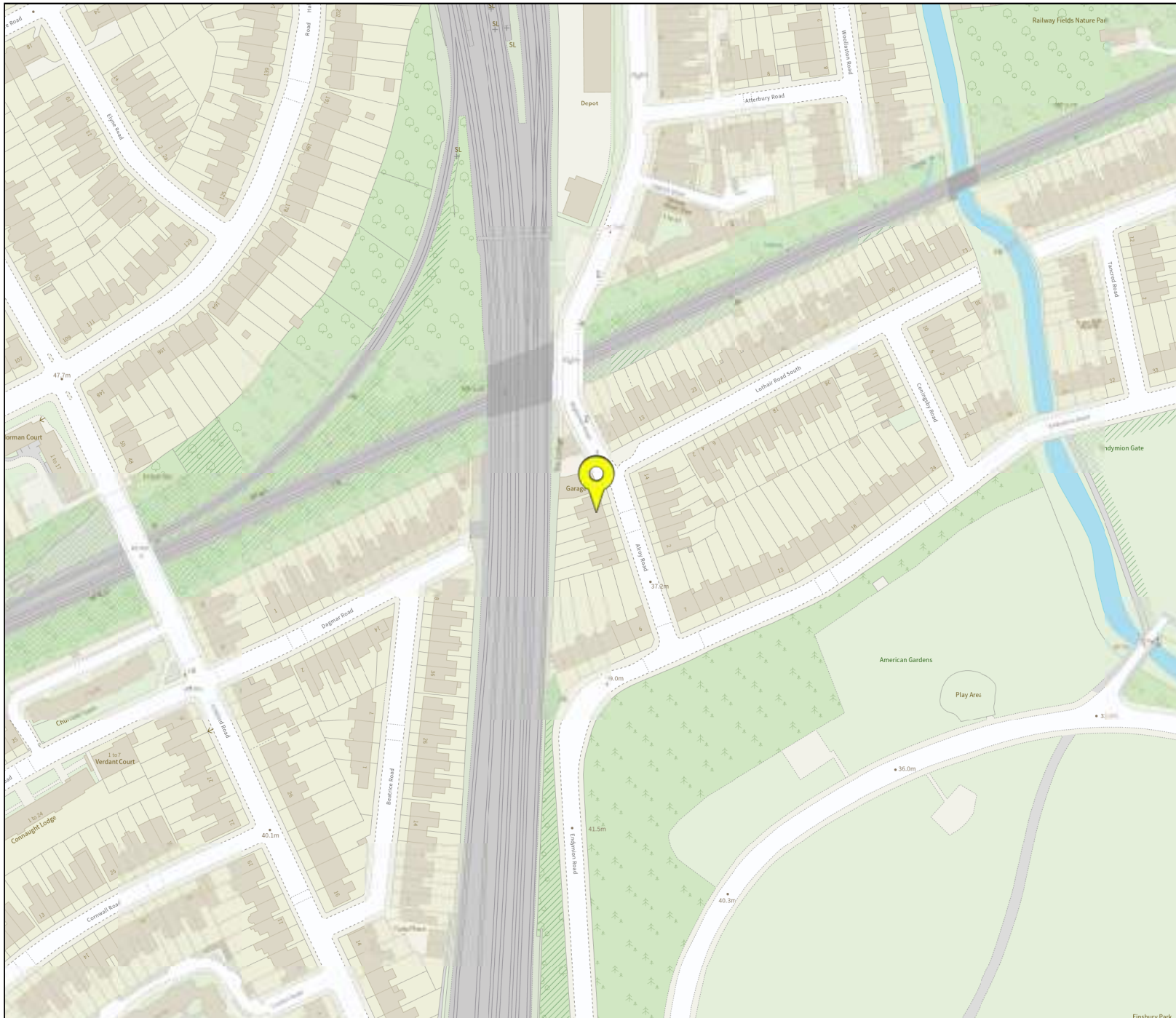
Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

Flood risk data is covered by the Open Government Licence **which** sets out the terms and conditions for using government data. <https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

Use of the address and mapping data is subject to Ordnance Survey public viewing terms under Crown copyright and database rights 2021 OS 100024198. <https://flood-map-for-planning.service.gov.uk/os-terms>



Flood map for planning

Your reference

Flood map 7 Endymion

Location (easting/northing)

531450/187918

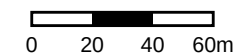
Scale

1:2500

Created

4 Oct 2022 16:13

-  Selected point
-  Flood zone 3
-  Flood zone 3: areas benefiting from flood defences
-  Flood zone 2
-  Flood zone 1
-  Flood defence
-  Main river
-  Water storage area



Contents

☒ Historic Flood Map

 Topographic



Esri Community Maps Contributors, Esri UK, Esri