

STRUCTURAL METHOD STATEMENT TO ACCOMPANY THE BIA FOR

253 GOLDHURST TERRACE LONDON NW6 3EP

REF:24078/SR-001/SN REV P2 MAY 2025

The Institution of **StructuralEngineers**

DOCUMENT CONTROL SHEET

Section

| Project Title: 253 Goldhurst Terrace | 1.0 | Introduction |
|--|-----|----------------------|
| Report Title: Structural Method Statement to Accompany Basement Impact Assessment | 2.0 | Site Investigation/D |
| Summary: Structural Engineer's Construction Methodology, initial calculations and structural scheme to be included | 3.0 | Construction Metho |
| with a Basement Impact Assessment for submission to the Planning Authorities relevant to the proposed works at 256 | | |
| Goldhurst Terrace, NW6 3EP. <u>Control Date:</u> 6th May 2025 - This report has been amended further to comments received by Campell Reith Consulting | 4.0 | Initial Scheme Draw |
| Engineers, via their Basement Impact Assessment Audit, dated April 2025 (report reference 14291-19). This revision | 5.0 | Monitoring |
| pertains to query No. 6, as described in paragraphs 4.20 & 5.10 of the aforementioned BIA Audit report. Specifically, | 6.0 | Preliminary Calculat |
| | | |

Record of Issue

report.

| Issue | Status | Author | Date | Check | Date | Authorised | Date |
|--------|-------------------|--------------------|------------|---------------|------------|------------------|------------|
| Rev P1 | Issued for Review | Stephanos Nicolaou | 13.12.2024 | Ryan Seagreen | 13.12.2024 | Antonis Savvides | 13.12.2024 |
| Rev P2 | Issued for Review | Stephanos Nicolaou | 06.05.2025 | Ryan Seagreen | 06.05.2025 | Antonis Savvides | 06.05.2025 |
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| | | | | | | | |

retaining wall RW3 has been redesigned (both in the Temporary and Permanent conditions) with a value of the

designed shear strength of 24° which is more conservative. The relevant ameded calculations are included in this

Distribution

| Organisation | Contact | Copies |
|--------------|------------------------|------------------|
| SF Architect | Silvia Ferrario | Electronic / pdf |
| Client | Matteo & Anna Falivene | Electronic / pdf |
| | | |
| | | |



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253 GOLDHURST TERRACE LONDON NW6 3EP

1.0 INTRODUCTION / NON TECHNICAL SUMMARY

1.0 INTRODUCTION

We, ads consultancy, were requested by SF ARCHITECT to compile a structural report consisting of a Construction Methodology / Method Statement to accompany a Basement Impact Assessment (BIA) for the proposed basement at 253 Goldhurst Terrace to supplement the planning application for the proposed development at the aforementioned site. A Basement Impact Assessment has been carried out and compiled by "ground&water" (report reference GWPR6303/BIA&GIR/December 2024) and which includes the Desk Study, Screening and Scoping etc. This report is to compliment that BIA with a Construction Methodology and an initial Structural Scheme. We are Chartered Engineers (Engineering Council UK) and Members of both the Institution of Structural Engineers and the Institution of Engineering and Technology. We have considerable experience in the design and construction of new build and retro-fitted basements in London and have worked on several prestigious basement developments with the UK's top basement Contractors as both Design and Build Engineers and Project Engineers for the Client.

1.1 SITE DESCRIPTION - EXISTING ARRANGEMENT

The site is situated on 253 Goldhurst Terrace, and comprises a four storey semidetached residential property, which includes a basement, ground, first, second and third floors. The northern boundary is formed by Goldhurst Terrace, the southern boundary is formed by gardens. To the east is No.251 with which there is a shared Party Wall, and to the West is No. 255 which is detached. The site is circa 500m East of South Hampstead Overground Station and circa 800m West of Kilburn High Road Overground Station.

1.2 SCHEME PROPOSAL

The scheme consists of the extension of the existing basement to the rear, side (i.e. to suit the existing ground floor flank masonry wall towards No. 255) and partly towards the front of the property, i.e. up to and under the existing ground floor wall between the kitchen and bedroom 1. The level of the extended basement will remain the same as the existing basement's level. An opening within the existing ground floor kitchen will also be created to accommodate a new staircase between the basement and ground floors. The proposed scheme also includes rebuilding the existing conservatory to the rear of the ground floor in cavity wall construction, as well as creating an opening through the ground floor wall between the rear reception and the corridor. The latter will require some new steel structure (i.e. a box frame around or steel beam over the new opening).

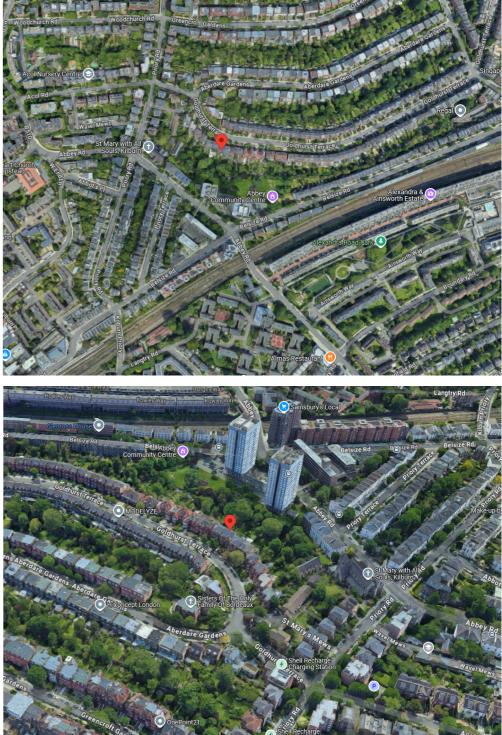
The new basement extension will be formed of new reinforced concrete retaining walls, constructed in underpinning sequence. The underpins will be constructed in circa 1.0m sections and in a typical staggered underpinning sequence similar to that of typical underpinning. This would negate the need for major temporary works to the existing building. None of the existing Party Walls (i.e. with No. 251) will be underpinned as the proposed extension is inside the boundaries with any of the adjacent properties. A new reinforced concrete ground bearing slab will form the floor of the new basement areas and a mix of timber joists and flat slabs will form the new ground floor to the footprint of the new basement.

Please refer to the attached drawings and sketches in the Drawing Appendix at the rear of this report.

1.4 WORKS PROGRAMME

• The total anticipated construction length will be circa 9-12 months.







• The total duration of the basement works will be circa 5-6 months.

Aerial views of 253 Goldhurst Terrace from Google Maps

253 GOLDHURST TERRACE LONDON NW6 3EP

2.0 SITE INVESTIGATION / DESK STUDY / SCREENING / SCOPING

2.0 SITE INVESTIGATION

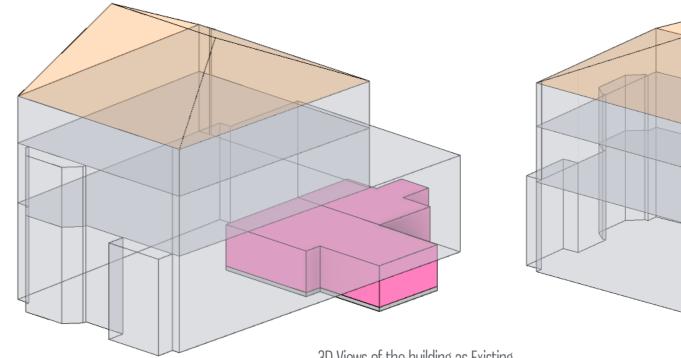
A detailed site investigation had been carried out on site on 7th November 2024 by "ground & water" who are specialist geotechnical engineers, to determine the structural characteristics of the soil along with hydrogeology characteristics. A Basement Impact Assessment report has been prepared by ground&water (report no. GWPR6303/ BIA&GIR dated December 2024) which includes their findings which we summarise below.

From consultation with the British Geological Survey (BGS) maps and the recent site investigation report prepared by "ground & water", it appears that the site is located over the London clay formation, with no superficial deposits or made ground found within 250m of the site.

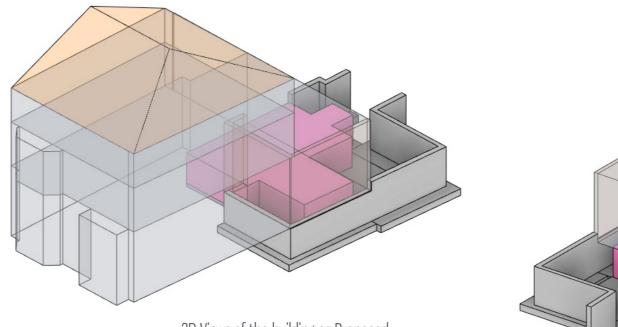
(http://mapapps.bgs.ac.uk/geologyofbritain/home.html)

<u>2.1 DESK STUDY / SCREENING / SCOPING</u>

These have been included in the BIA report prepared by ground&water (report no. GWPR6303/BIA&GIR dated December 2024) - this report compliments the aforementioned BIA with a Construction Methodology / Method Statement and an Initial Structural Scheme.

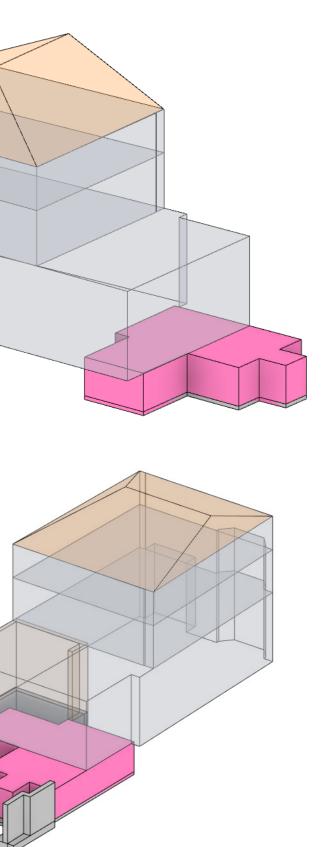






3D Views of the building as Proposed





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253 GOLDHURST TERRACE London NW6 3EP

2.0 SITE INVESTIGATION / DESK STUDY / SCREENING / SCOPING

2.2 FLOOD RISK

The flood risk of the site has been assessed in the Basement Impact Assessment prepared by "ground&water" (report no. GWPR6303/BIA&GIR dated December 2024) and summarised below - for more details please refer to the aforementioned BIA report.

2.2.1 From rivers and sea

The site lies within Flood Zone 1

2.2.2 From reservoirs

The site is not considered to be at risk of flooring from reservoirs, even when rivers are flooded.

2.2.3 From Surface Water

The site is at very low risk of flooding from surface water.

2.2.4 From Groundwater

The site is not in an area with increased susceptibility of elevated ground water. Some properties around and withing 250m from the site have historical issues with flooding from groundwater though.

2.2.5 From Sewers

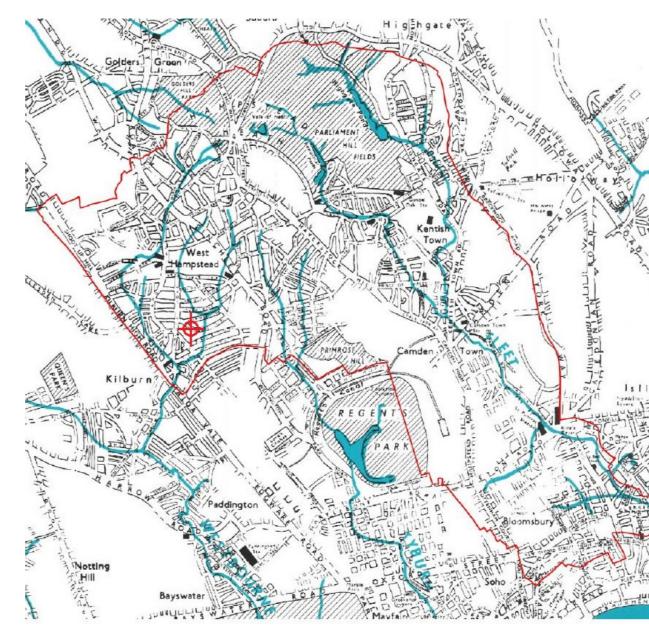
Some records of internal and external sewer flooding have been recorder within the site's postcode area.

2.2.6 Old Rivers

The site does not lie on any old / lost rivers. Streams which join the Westbourne are to the West and East of the site.

<u>2.2.7 Critical Drainage Areas/Local Flood risk</u> <u>Areas</u>

Please refer to Basement Impact Assessment report no. GWPR6303/BIA&GIR dated December 2024, prepared by ground&water for more details on local flood incidents etc.



Source - Barton, Lost Rivers of London



BASEMENT IMPACT ASSESSMENT



Camden Geological, Hydrogeological and Hydrological Study Watercourses

253 GOLDHURST TERRACE London NW6 3EP

3.0 CONSTRUCTION METHODOLOGY / METHOD STATEMENT

3.0 Construction Methodology

1) Once the site has been made safe, underpinning of the relevant existing perimeter masonry walls from inside of the building will commence. There are three walls that will be underpinned and these are indicated in the graphic on page 7 and in the scheme plans starting from page 9. The proposed RC retaining walls underpinning the existing masonry (i.e. RW1 & RW2) have been designed to provide lateral stability for the retained soil, and hence no additional temporary works will be required for these.

2) Commence construction of the rest of the proposed 300-350mm thick reinforced concrete retaining walls at the same time as point 1 above. This will be done in typical underpinning sequence which is indicated in sketch 24078_SK01 & SK03. Final sequencing of underpinning is to be agreed with the Contractor and Structural Engineer prior to works commencing.

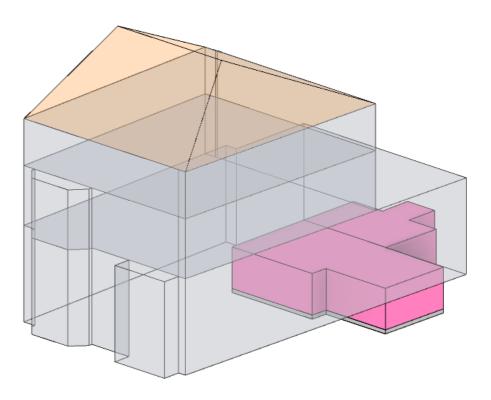
All the wall types forming the proposed basement extension (i.e. RW1, RW2, RW3, RW4) have been designed to provide lateral stability and therefore no additional temporary props will be required during the construction of said retaining walls.

3) After all the new retaining walls have been constructed in underpinning sequence, the soil remaining between the existing basement wall and the newly constructed retaining walls can be removed/excavated down to formation level. The existing basement walls of the existing utility room (which is circa 560mm higher in level than the rest of the basement) can be carefully demolished and the level lowered down to formation level.

5) Construct the new 200mm thick basement floor ground bearing RC slab and subsequently the new ground floor (either a 200mm thick RC slab or a timber joist floor) to the footprint of the new basement extension.

6) Proceed with minor internal alterations to achieve the Architect's requirements and introduce lintels / steel beams as required. At the same time construct retaining wall RW5 along the boundary with No. 255, to allow for raising the external level behind RW3 per the Architect's requirements - RW3 has been designed for the two stages, i.e. initially as unpropped to retain the lower/existing soil level, and subsequently as propped at the base to support the proposed/higher external level.

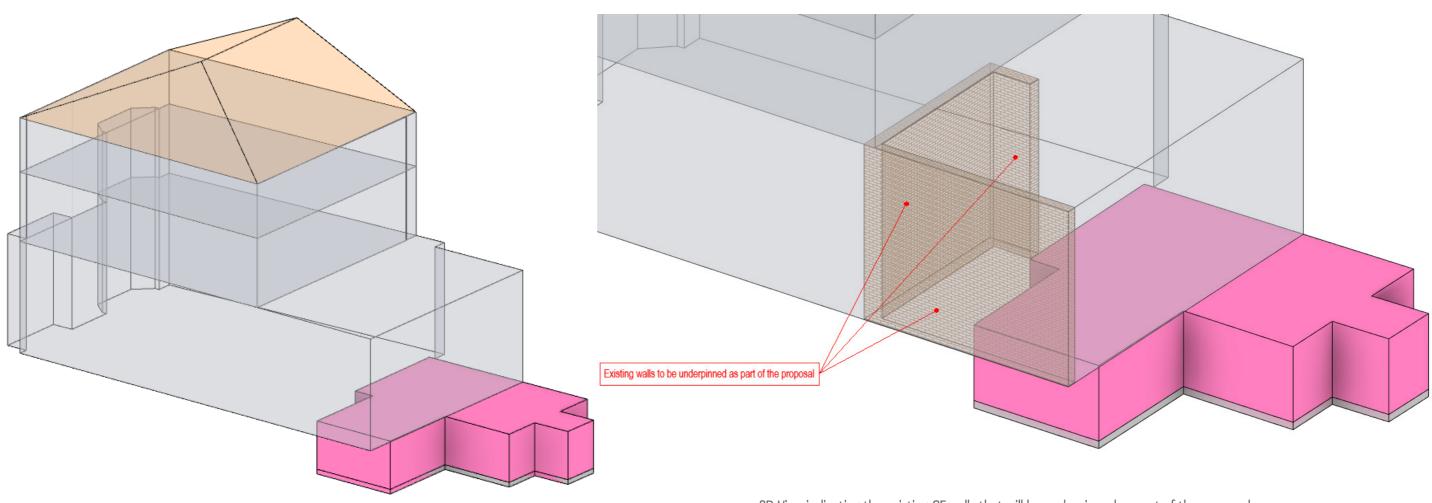
7) In the event that minor ingress of ground water occurs during the execution of the works this will be dealt with by the use of temporary sump pumps. In the permanent condition waterproofing to the new basement will be based on the Architects proposed details.



3D View of the building as Existing



3.0 CONSTRUCTION METHODOLOGY / METHOD STATEMENT

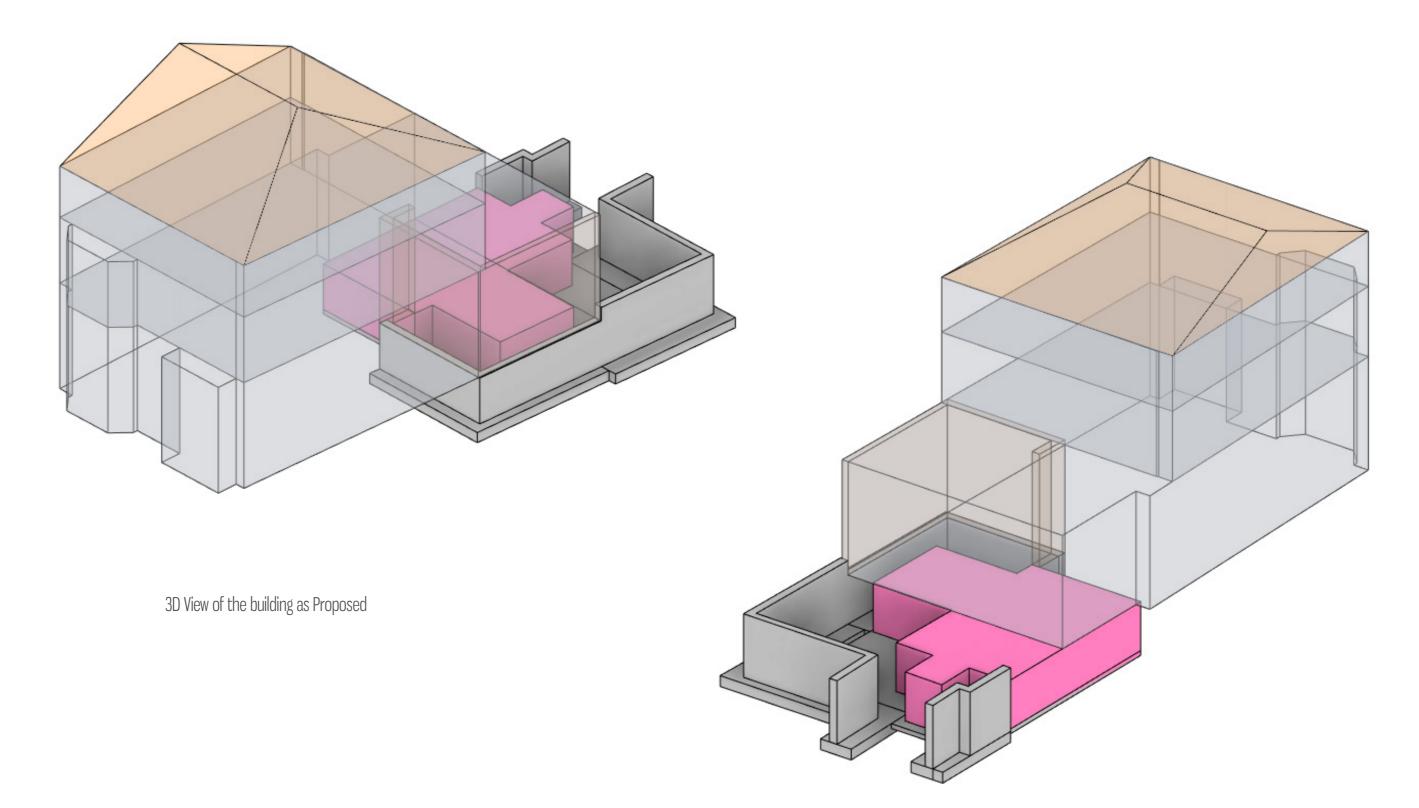


3D View of the building as Existing

3D View indicating the existing GF walls that will be underpinned as part of the proposal



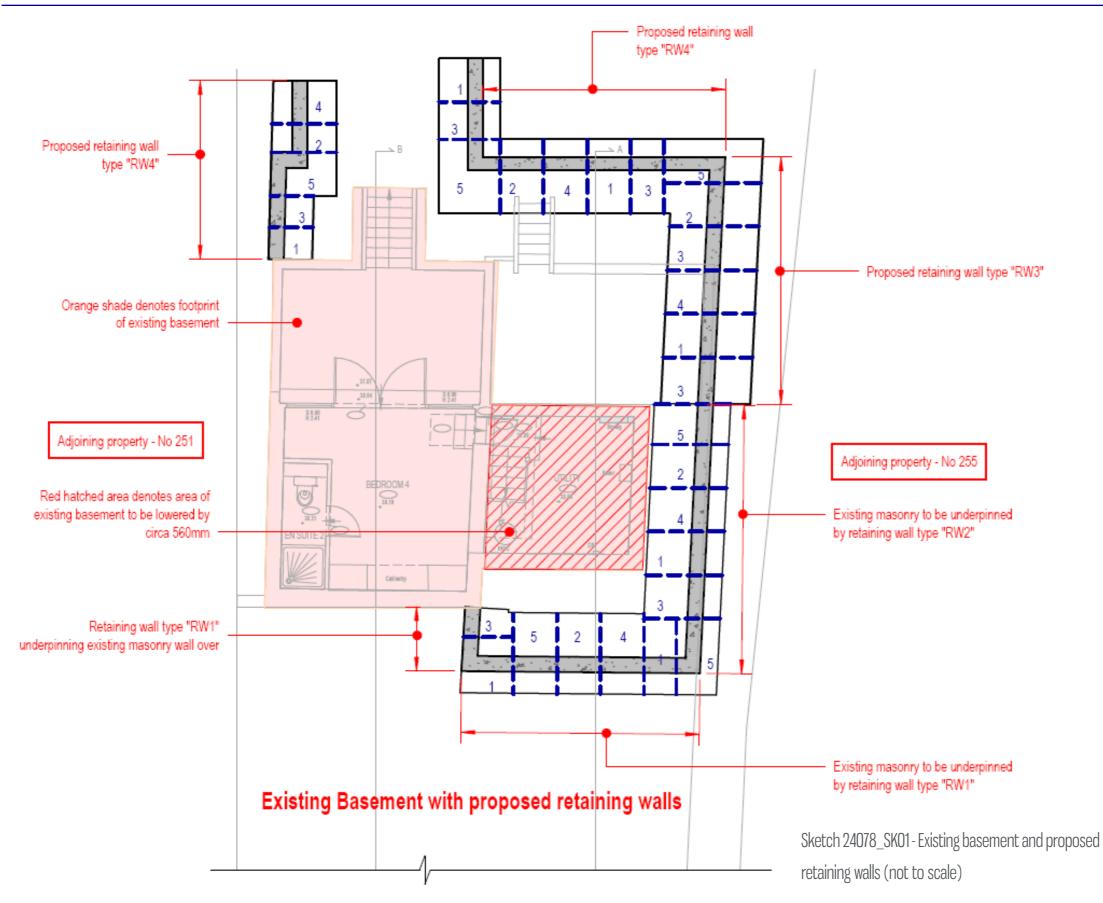
3.0 CONSTRUCTION METHODOLOGY / METHOD STATEMENT



3D View of the building as Proposed

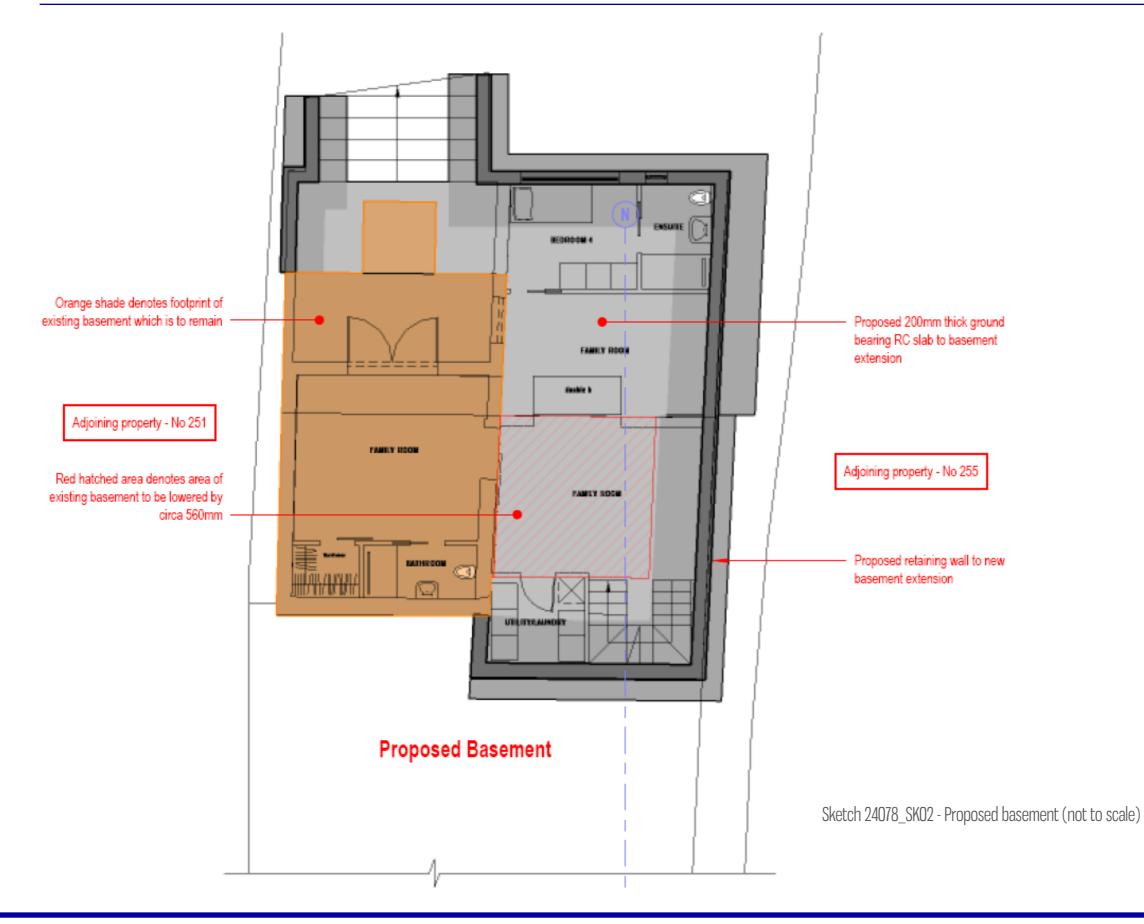








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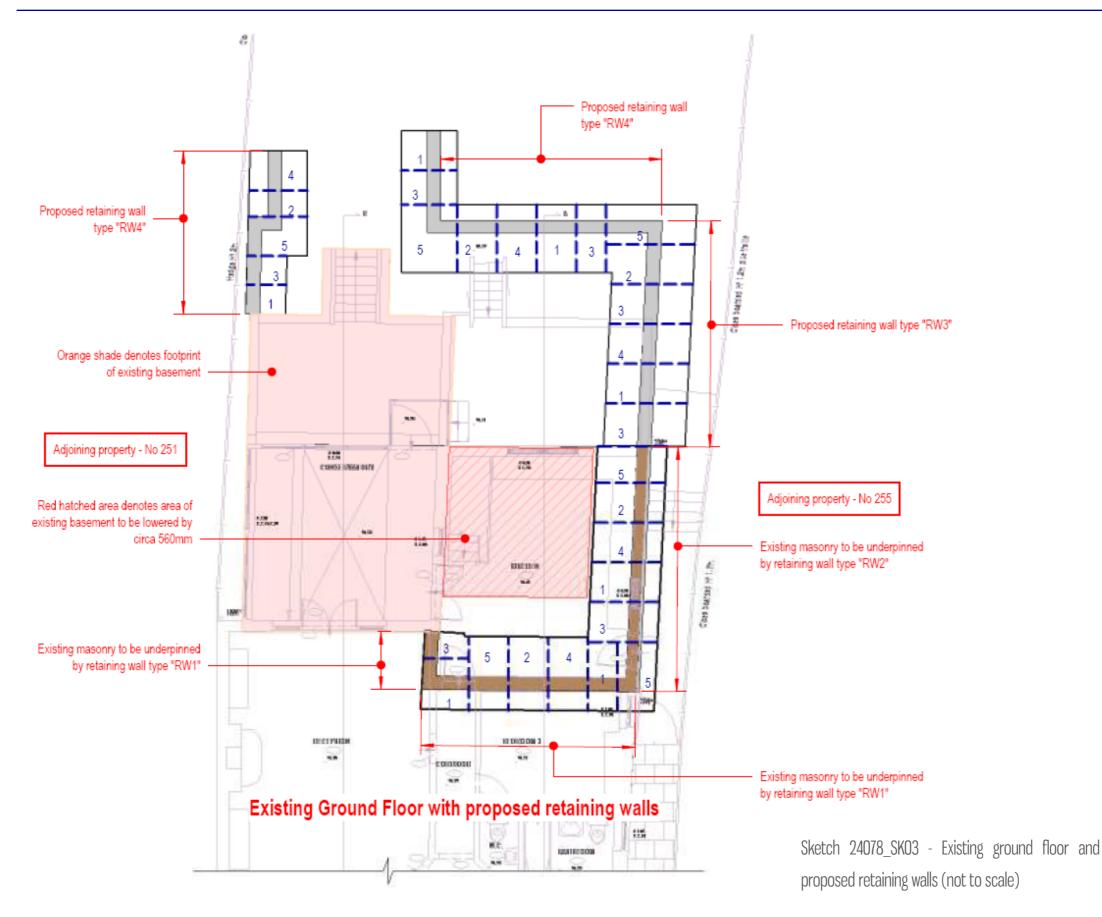


BASEMENT IMPACT ASSESSMENT



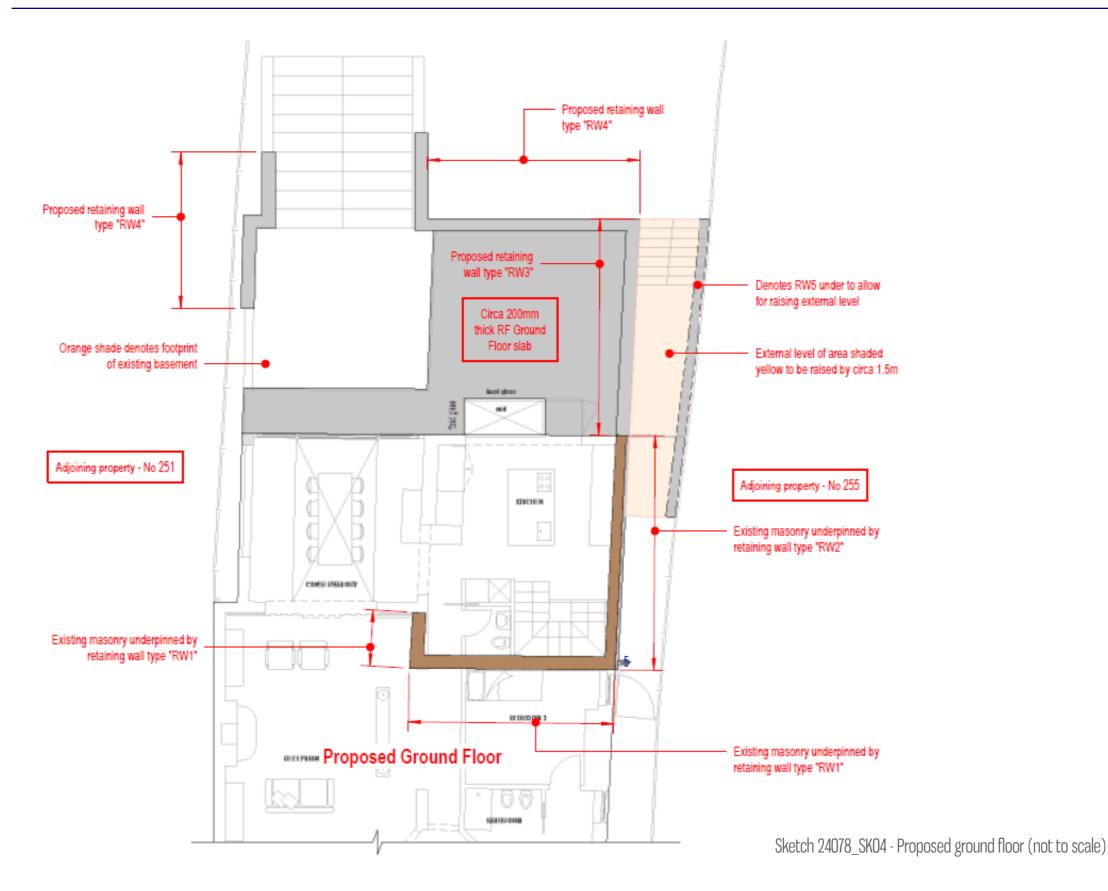
4.0 INITIAL SCHEME DRAWINGS

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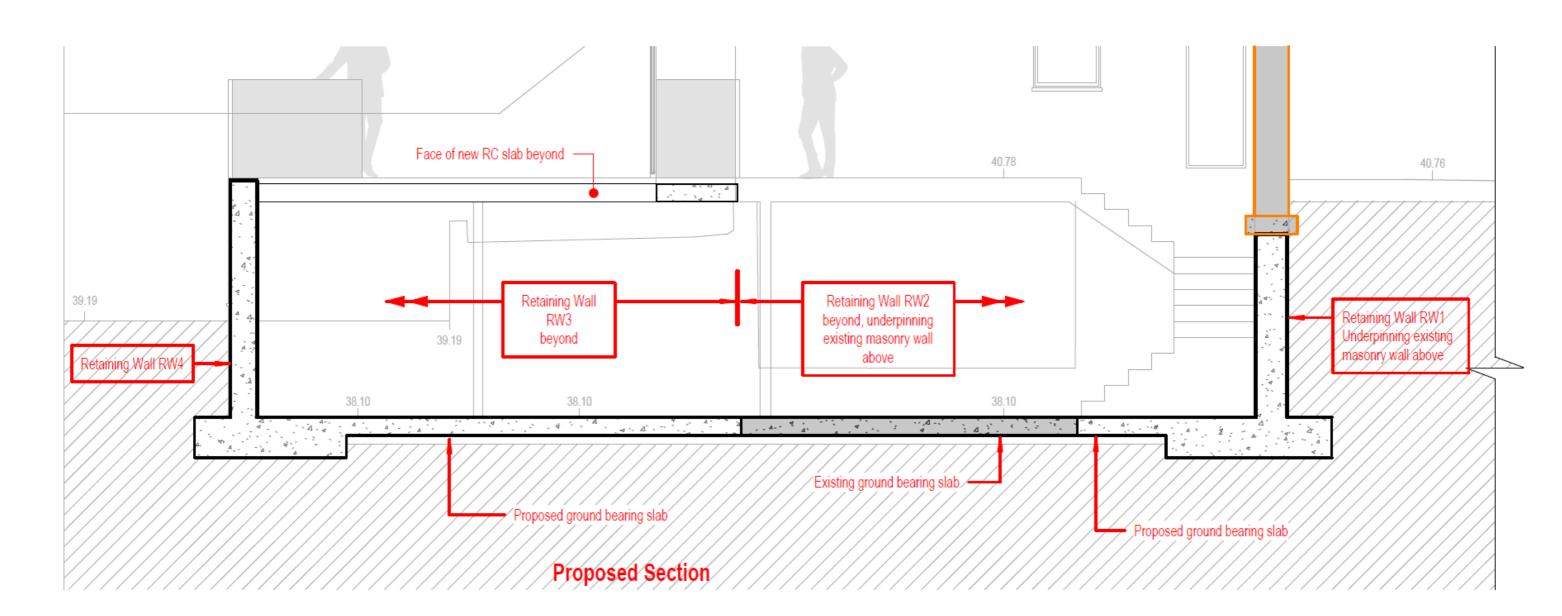


BASEMENT IMPACT ASSESSMENT

ads consultancy







Sketch 24078_SK05 - Proposed Section (not to scale)



BASEMENT IMPACT ASSESSMENT

5.1 INTRODUCTION

The adjoining properties to 253 Goldhurst Terrace, NW6 3EP, will be monitored during the underpinning, excavation and throughout the construction period of the proposed basement.

5.2 TARGET POINTS

Target points will be fixed on the elevations of the adjoining properties, as per the marked-up drawings included. These include the front and rear elevation walls of Nos.251 & 255 Goldhurst Terrace. These will need to be agreed and finalised as part of the Party Wall process, prior to commencing any works.

5.3 RESULTS

The results/reading shall be recorded in both tabular and graph forms, and an electronic copy must be circulated within twenty-four hours of the readings (refer to 3.2 below). The results should be clear, and indicate the trigger values as well, for reference and comparison to the readings.

The readings / results shall be circulated to the design team, the Building Owner's Party Wall Surveyor and the Adjoining Owner's Party Wall Surveyor and Advising Engineer.

5.4 READINGS

Readings shall be taken as follows:

| Activity | Frequency of readings |
|---|-----------------------|
| During underpinning works | Daily |
| During excavation | Twice Weekly |
| During construction of the basement and | Twice Weekly |
| ground floor RC slabs | |
| During the rest of the works | Weekly |

The above shall be reviewed in case the program of the works is altered due to unforeseen circumstances.

<u>5.5 TRIGGER VALUES</u>

Should a trigger value be reached, the contractor should immediately stop all work that might cause further movement, assesses the situation, and proposes alternative methods of proceeding. The trigger values/limits further to this point can be reviewed and agreed between all parties.

Proposed trigger values for both vertical and horizontal movement of masonry walls of adjoining buildings are to be agreed with

| the Adjoining | Owner's party | / wall surveyor | a suggestion follows: |
|---------------|---------------|-----------------|---|
| | | | |

| AMBER | +/- 5mm |
|-------|---------|
| | |
| RED | +/- 8mm |

Proposed trigger values for both vertical and horizontal movement of garden walls of adjoining buildings are to be agreed with

the Adjoining Owner's party wall surveyor - a suggestion follows:

| AMBER | +/- 7mm | All parties notified |
|-------|----------|-------------------------|
| RED | +/- 10mm | Works stop and reviewed |

5.6 ACTIONS

| Should | any | | movement | exceed | the | Amber | or | Red | tri | | |
|--------|-------|-------------------------------|---|-----------|---------|-----------|-------|---------|------|--|--|
| AMB | AMBER | | Project Engineer is notified immediately | | | | | | | | |
| | | • | Any worl | k that mi | ght c | ause fur | ther | move | eme | | |
| | | Readings' frequency increases | | | | | | | | | |
| | | • | Contract | or propo | ses al | ternativ | e me | ethods | s of | | |
| | | • | The proje | ect Engin | ieer, A | Adjoinin | g Ov | wner's | s Er | | |
| | | | works and decide if any further actions are r | | | | | | | | |
| | | • | If it is est | ablished | that a | any mov | eme | nt is c | lire | | |
| | | | tor stops | all work | s and | all parti | es re | eview | the | | |
| | | • | Trigger v | alues fro | m thi | s point o | on a | re revi | iew | | |
| RED | | • | All works | s stop | | | | | | | |
| | | • | Project E | ngineer | is not | ified im | med | iately | / A | | |



5.0 MONITORING

| All parties notified |
|-------------------------|
| Works stop and reviewed |

igger Values, the Contractor shall act as follows:

ent is stopped

- f proceeding
- ngineer and PW Surveyor meet on site to review the
- required
- ectly related to the underpinning works, the contrac-
- e works
- ved further and agreed between all parties

All parties review the works



5.0 MONITORING



BASEMENT IMPACT ASSESSMENT

ads consultancy

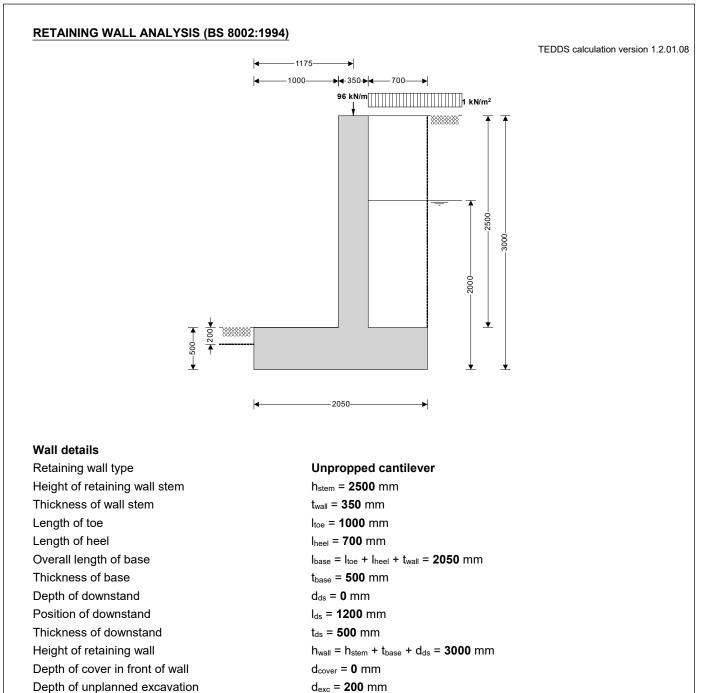
5.0 MONITORING

PRELIMINARY CALCULATIONS



6.0 PRELIMINARY CALCULATIONS

| Tekla Tedds | Project | Job no. 24078 | | | | |
|---|---|--------------------------|------------|--------------|------------------------------|---------------|
| ads consultancy 130 East Barnet Road | Calcs for Retaining Wall RW1 - Preliminary | | | | Start page no./Revision 1 | |
| EN4 8RE - New Barnet | Calcs by SN | Calcs date 05/12/2024 | Checked by | Checked date | Approved by | Approved date |



Retained material details Mobilisation factor Moist density of retained material

Effective height at virtual back of wall

Height of ground water behind wall

Height of saturated fill above base Density of wall construction

Density of base construction Angle of rear face of wall

Angle of soil surface behind wall

M = **1.5** γ_m = **18.0** kN/m³

h_{water} = 2000 mm

γ_{wall} = **23.6** kN/m³ γ_{base} = **23.6** kN/m³

α = **90.0** deg

 $\beta = 0.0 \text{ deg}$

 $h_{sat} = max(h_{water} - t_{base} - d_{ds}, 0 mm) = 1500 mm$

 $h_{eff} = h_{wall} + I_{heel} \times tan(\beta) = 3000 \text{ mm}$

| Tekla Tedds | Project | 253 Goldh | urst Terrace | | | Job no. | 4078 | |
|---|---|--|---------------------------|---------|------------|--------------------|------------------------------|--|
| ads consultancy 130 East Barnet Road | Calcs for Retaining Wall RW1 - Preliminary | | | | | Start page no./F | Start page no./Revision 2 | |
| EN4 8RE - New Barnet | Calcs by SN | Calcs date 05/12/2024 | Checked by | Check | ed date | Approved by | Approved date | |
| Saturated density of retained m Design shear strength Angle of wall friction | aterial | γ _s = 21.0 ki φ' = 29.3 de δ = 18.6 de | ∋g | | | | | |
| Base material details Firm clay Moist density Design shear strength Design base friction | | γ _{mb} = 18.0 l φ' _b = 24.2 d δ _b = 18.6 d | leg | | | | | |
| Allowable bearing pressure | | $O_b - 10.0$ C $P_{bearing} = 10$ | 0 | | | | | |
| Passive pressure coefficient for | + $\phi')^2$ / (sin(α) ² base material | $^{2} \times sin(\alpha - \delta) \times [1 +]$ | | | ., . | | | |
| At-rest pressure | - 4 | | (1) 0 544 | | | | | |
| At-rest pressure for retained ma | aterial | $K_0 = 1 - sir$ | n(φ') = 0.511 | | | | | |
| Loading details Surcharge load on plan Applied vertical dead load on w Applied vertical live load on wal Position of applied vertical load Applied horizontal dead load on Applied horizontal live load on w Height of applied horizontal load | ll on wall n wall wall | Surcharge $W_{dead} = 75.$ $W_{live} = 21.4$ $I_{load} = 1175$ $F_{dead} = 0.0$ $F_{live} = 0.0$ k $h_{load} = 0$ mr | kN/m mm kN/m N/m | | | | | |
| | 77.3 | | | 0.3 5.2 | | 9.6 | | |
| | | | | I | Loads sho | wn in kN/m, pressu | res shown in kN/m | |
| | | | | I | 20003 3110 | mini mani, piessu | | |

| Tekla Tedds | Project | | | | Job no. 24078 | |
|---|----------------|--------------------------|-----------------|--------------|-------------------|---------------|
| ads consultancy 130 East Barnet Road | Calcs for | Retaining Wall R | W1 - Preliminar | у | Start page no./Re | evision 3 |
| EN4 8RE - New Barnet | Calcs by SN | Calcs date 05/12/2024 | Checked by | Checked date | Approved by | Approved date |

| Vertical forces on wall | |
|-------------------------------------|--|
| Wall stem | $w_{\text{wall}} = h_{\text{stem}} \times t_{\text{wall}} \times \gamma_{\text{wall}} = \textbf{20.7 kN/m}$ |
| Wall base | $w_{base} = I_{base} \times t_{base} \times \gamma_{base} = 24.2 \text{ kN/m}$ |
| Surcharge | w _{sur} = Surcharge × I _{heel} = 0.7 kN/m |
| Moist backfill to top of wall | $w_{m_w} = I_{heel} \times (h_{stem} - h_{sat}) \times \gamma_m = 12.6 \text{ kN/m}$ |
| Saturated backfill | $w_s = I_{heel} \times h_{sat} \times \gamma_s = 22.1 \text{ kN/m}$ |
| Applied vertical load | $W_v = W_{dead} + W_{live} = 96.4 \text{ kN/m}$ |
| Total vertical load | $W_{total} = W_{wall} + W_{base} + W_{sur} + W_{m_w} + W_s + W_v = 176.6 \text{ kN/m}$ |
| Horizontal forces on wall | |
| Surcharge | $F_{sur} = K_a \times cos(90 - \alpha + \delta) \times Surcharge \times h_{eff} = 0.9 \text{ kN/m}$ |
| Moist backfill above water table | F_{m_a} = 0.5 × K _a × cos(90 - α + δ) × γ_m × (h _{eff} - h _{water}) ² = 2.6 kN/m |
| Moist backfill below water table | $F_{m_b} = K_a \times cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water} = 10.4 \text{ kN/m}$ |
| Saturated backfill | $F_s = 0.5 \times K_a \times cos(90 - \alpha + \delta) \times (\gamma_{s-} \gamma_{water}) \times h_{water}^2 = 6.5 \text{ kN/m}$ |
| Water | $F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water} = 19.6 \text{ kN/m}$ |
| Total horizontal load | $F_{total} = F_{sur} + F_{m_a} + F_{m_b} + F_s + F_{water} = 40 \text{ kN/m}$ |
| Calculate stability against sliding | |
| | |

Passive resistance of soil in front of wall Resistance to sliding

Overturning moments

Surcharge Moist backfill above water table Moist backfill below water table Saturated backfill Water Total overturning moment

Restoring moments

Wall stem Wall base Moist backfill Saturated backfill Design vertical dead load Total restoring moment

Check stability against overturning Total overturning moment Total restoring moment

Check bearing pressure

Surcharge Design vertical live load Total moment for bearing Total vertical reaction Distance to reaction Eccentricity of reaction
$$\begin{split} F_{p} &= 0.5 \times K_{p} \times cos(\delta_{b}) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^{2} \times \gamma_{mb} = \textbf{3.2 kN/m} \\ F_{res} &= F_{p} + (W_{total} - w_{sur} - W_{live}) \times tan(\delta_{b}) = \textbf{55.2 kN/m} \\ \textbf{PASS - Resistance force is greater than sliding force} \end{split}$$

$$\begin{split} M_{sur} &= F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2 = \textbf{1.3 kNm/m} \\ M_{m_a} &= F_{m_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3 = \textbf{6.1 kNm/m} \\ M_{m_b} &= F_{m_b} \times (h_{water} - 2 \times d_{ds}) / 2 = \textbf{10.4 kNm/m} \\ M_s &= F_s \times (h_{water} - 3 \times d_{ds}) / 3 = \textbf{4.3 kNm/m} \\ M_{water} &= F_{water} \times (h_{water} - 3 \times d_{ds}) / 3 = \textbf{13.1 kNm/m} \\ M_{ot} &= M_{sur} + M_{m_a} + M_{m_b} + M_s + M_{water} = \textbf{35.3 kNm/m} \end{split}$$

$$\begin{split} M_{wall} &= w_{wall} \times (I_{toe} + t_{wall} / 2) = \textbf{24.3 kNm/m} \\ M_{base} &= w_{base} \times I_{base} / 2 = \textbf{24.8 kNm/m} \\ M_{m_r} &= (w_{m_w} \times (I_{base} - I_{heel} / 2) + w_{m_s} \times (I_{base} - I_{heel} / 3)) = \textbf{21.4 kNm/m} \\ M_{s_r} &= w_s \times (I_{base} - I_{heel} / 2) = \textbf{37.5 kNm/m} \\ M_{dead} &= W_{dead} \times I_{load} = \textbf{88.1 kNm/m} \\ M_{rest} &= M_{wall} + M_{base} + M_{m_r} + M_{s_r} + M_{dead} = \textbf{196.1 kNm/m} \end{split}$$

M_{ot} = **35.3** kNm/m M_{rest} = **196.1** kNm/m PASS - Restoring moment is greater than overturning moment

$$\begin{split} &M_{sur_{-}r} = w_{sur} \times (I_{base} - I_{heel} / 2) = \textbf{1.2 kNm/m} \\ &M_{live} = W_{live} \times I_{load} = \textbf{25.1 kNm/m} \\ &M_{total} = M_{rest} - M_{ot} + M_{sur_{-}r} + M_{live} = \textbf{187.2 kNm/m} \\ &R = W_{total} = \textbf{176.6 kN/m} \\ &x_{bar} = M_{total} / R = \textbf{1060 mm} \\ &e = abs((I_{base} / 2) - x_{bar}) = \textbf{35 mm} \end{split}$$

| Tekla Tedds | Project 253 Goldhurst Terrace | | | | Job no. 24078 | |
|---|---|--------------------------|------------|------------------------------|------------------|---------------|
| ads consultancy 130 East Barnet Road EN4 8RE - New Barnet | Calcs for Retaining Wall RW1 - Preliminary | | | Start page no./Revision 4 | | |
| | Calcs by SN | Calcs date 05/12/2024 | Checked by | Checked date | Approved by | Approved date |

Bearing pressure at toe Bearing pressure at heel Reaction acts within middle third of base

 $p_{toe} = (R \mid I_{base}) - (6 \times R \times e \mid I_{base}^2) = 77.3 \text{ kN/m}^2$

 p_{heel} = (R / I_{base}) + (6 × R × e / I_{base}²) = **94.9** kN/m²

PASS - Maximum bearing pressure is less than allowable bearing pressure

| Tekla. Tedds | | 253 Goldh | urst Terrace | | 24 | 1078 | |
|--|--|--|--|--|------------------------------------|------------------|--|
| ads consultancy Ca | alcs for | Retaining Wall F | N/1 - Prelimin | any | Start page no./F | Revision 5 | |
| EN4 8RE - New Barnet | Retaining Wall RW1 - Preliminary Calcs by Calcs date Checked by Checked date | | | Approved by | Approved | | |
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| | | | | | | | |
| RETAINING WALL DESIGN (BS 8 | 8002:1994) | | | | TEDDS calculatio | n version 1.2. | |
| Ultimate limit state load factors | | | | | | | |
| Dead load factor | | γ _{f_d} = 1.4 | | | | | |
| Live load factor | | γ _{f_l} = 1.6 | | | | | |
| Earth and water pressure factor | | γ _{f_e} = 1.4 | | | | | |
| Factored vertical forces on wall | | | | | | | |
| Wall stem | | $W_{wall_f} = \gamma_{f_d}$ | $\times \; h_{\text{stem}} \times t_{\text{wall}} \times $ | γ _{wall} = 28.9 kN/n | n | | |
| Wall base | | $W_{base_f} = \gamma_{f_c}$ | $_{\rm b} 	imes {\sf I}_{\rm base} 	imes {\sf t}_{\rm base} 	imes$ | χ _{base} = 33.9 kN | /m | | |
| Surcharge | | $W_{sur_f} = \gamma_{f_l}$ | < Surcharge × | l _{heel} = 1.1 kN/m | | | |
| Moist backfill to top of wall | | $W_{m_w_f} = \gamma_{f_c}$ | $I \times I_{heel} \times (h_{stem})$ | - h _{sat}) × γ _m = 17. | 6 kN/m | | |
| Saturated backfill | | $W_{s_f} = \gamma_{f_d} \times$ | $I_{heel} \times h_{sat} \times \gamma_s$ | = 30.9 kN/m | | | |
| Applied vertical load | | $W_{v_f} = \gamma_{f_d}$ | $\langle W_{dead} + \gamma_{f_l} \times V_{dead}$ | W _{live} = 139.2 kN/ | /m | | |
| Total vertical load | | | | $W_{sur_f} + W_{m_w_f} + V$ | | 1.6 kN/m | |
| Factored horizontal at-rest force | s on wall | | | | | | |
| Surcharge | | F _{sur} f = γ _f ι × | K ₀ × Surchar | ge × h _{eff} = 2.5 kN | l/m | | |
| Moist backfill above water table | | $F_{m_a_f} = \gamma_{f_e} \times 0.5 \times K_0 \times \gamma_m \times (h_{eff} - h_{water})^2 = 6.4 \text{ kN/m}$ | | | | | |
| Moist backfill below water table | | $F_{m \ b \ f} = \gamma_{f \ e} \times K_0 \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water} = 25.7 \ kN/m$ | | | | | |
| Saturated backfill | | | | γ_{water} × h_{water}^2 = γ | | | |
| Water | | $F_{water f} = \gamma_{f e} \times 0.5 \times h_{water}^2 \times \gamma_{water} = 27.5 \text{ kN/m}$ | | | | | |
| voater Total horizontal load | | Ftotal f = Fsur f + Fm a f + Fm b f + Fs f + Fwater f = 78.1 kN/m | | | | | |
| Passive resistance of soil in front of | of wall | $F_{p_{f}} = \gamma_{f_{e}} \times 0.5 \times K_{p} \times \cos(\delta_{b}) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^{2} \times \gamma_{mb} = 4.5$ | | | | | |
| kN/m | | · • • | | (**) (********************************* | | 1 | |
| Factored overturning moments | | | | | | | |
| Surcharge | | M _{sur_f} = F _{sur} | $_{f} \times (h_{eff} - 2 \times c)$ | l _{ds}) / 2 = 3.7 kNn | n/m | | |
| Moist backfill above water table | | M _{m a f} = F _m | _{a f} × (h _{eff} + 2 × | h _{water} - 3 × d _{ds}) / | 3 = 15 kNm/m | | |
| Moist backfill below water table | | M _{m_b_f} = F _{m_b_f} × (h _{water} - 2 × d _{ds}) / 2 = 25.7 kNm/m | | | | | |
| Saturated backfill | | $M_{s_f} = F_{s_f} \times (h_{water} - 3 \times d_{ds}) / 3 = 10.7 \text{ kNm/m}$ | | | | | |
| Water | | $M_{water_f} = F_{water_f} \times (h_{water} - 3 \times d_{ds}) / 3 = 18.3 \text{ kNm/m}$ | | | | | |
| Total overturning moment | | M _{ot_f} = M _{sur_} | _f + M _{m_a_f} + M _n | n_b_f + Ms_f + M _{wat} | _{ter_f} = 73.4 kNm | /m | |
| Restoring moments | | | | | | | |
| Wall stem | | $M_{wall f} = W_{wall}$ | $_{\text{all}_{f}} \times (I_{\text{toe}} + t_{\text{wall}})$ | / 2) = 34 kNm/m | | | |
| Wall base | | _ | _{ase_f} × I _{base} / 2 = | | | | |
| Surcharge | | _ | - | / 2) = 1.9 kNm/ | m | | |
| Moist backfill | | | | | | = 30 kNm/ | |
| Saturated backfill | | $\begin{split} M_{m_r_f} &= (w_{m_w_f} \times (I_{base} - I_{heel} / 2) + w_{m_s_f} \times (I_{base} - I_{heel} / 3)) = \textbf{30} \text{ kNm} \\ M_{s_r_f} &= w_{s_f} \times (I_{base} - I_{heel} / 2) = \textbf{52.5} \text{ kNm/m} \end{split}$ | | | | | |
| Design vertical load | | $M_{v_f} = W_{v_f} \times I_{load} = 163.6 \text{ kNm/m}$ | | | | | |
| Total restoring moment | | $M_{\text{rest_f}} = M_{\text{wall_f}} + M_{\text{base_f}} + M_{\text{sur_r_f}} + M_{\text{m_r_f}} + M_{\text{s_r_f}} + M_{\text{v_f}} = 316.7 \text{ kNm/}$ | | | | | |
| Factored bearing pressure | | | | | | | |
| Total moment for bearing | | $M_{\text{total}} = M_{\text{total}}$ | est_f - M _{ot_f} = 24 3 | 3 3 kNm/m | | | |
| Total vertical reaction | | | = 251.6 kN/m | ••• ··· | | | |
| Distance to reaction | | | f / R _f = 967 m | m | | | |
| Eccentricity of reaction | | | ase / 2) - Xbar_f) = | | | | |
| - | | ((| ,/ | | within middle | third of h | |

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| ads consultancy 130 East Barnet Road | Calcs for | Retaining Wall F | Start page no./F | Revision 6 | | |
| EN4 8RE - New Barnet | Calcs by SN | Calcs date 05/12/2024 | Checked by | Checked date | Approved by | Approved da |
| Bearing pressure at toe | | $p_{toe_f} = (R_f / R_f)$ | I _{base}) + (6 × R _f | $\times e_f / I_{base}^2$) = 14 | 3.7 kN/m ² | |
| Bearing pressure at heel | | p _{heel_f} = (R _f | / I_{base}) - (6 × R | $_{\rm f} \times {\bf e}_{\rm f} / {\bf I}_{\rm base}^2$) = 10 | 1.8 kN/m ² | |
| Rate of change of base reaction | I | rate = (p _{toe} _ | _f - p _{heel_f}) / I _{base} | = 20.45 kN/m²/n | n | |
| Bearing pressure at stem / toe | | $p_{stem_toe_f} =$ | max(p _{toe_f} - (ra | te × I _{toe}), 0 kN/m ² | ²) = 123.3 kN/n | 1 ² |
| Bearing pressure at mid stem | | p _{stem_mid_f} = | max(p _{toe_f} - (ra | $te \times (I_{toe} + t_{wall} / 2)$ | 2)), 0 kN/m²) = | 119.7 kN/m ² |
| Bearing pressure at stem / heel | | $p_{stem_heel_f} =$ | max(p _{toe_f} - (ra | ate × (I_{toe} + t_{wall})), | 0 kN/m²) = 11 | 6.1 kN/m² |
| Design of reinforced concrete | retaining wall | toe (BS 8002:1 | 994 <u>)</u> | | | |
| Material properties | | | | | | |
| Characteristic strength of concre | | f _{cu} = 40 N/r | | | | |
| Characteristic strength of reinfo | rcement | f _y = 500 N/r | nm² | | | |
| Base details | | | | | | |
| Minimum area of reinforcement | | k = 0.13 % | | | | |
| Cover to reinforcement in toe | | c _{toe} = 50 m | m | | | |
| Calculate shear for toe design | Ì | | | | | |
| Shear from bearing pressure | | $V_{toe_bear} = (p_{toe_f} + p_{stem_toe_f}) \times I_{toe} / 2 = 133.5 \text{ kN/m}$ | | | | |
| Shear from weight of base | | $V_{toe_wt_base} = \gamma_{f_d} \times \gamma_{base} \times I_{toe} \times t_{base} = 16.5 \text{ kN/m}$ | | | | |
| Total shear for toe design | | V _{toe} = V _{toe_bear} - V _{toe_wt_base} = 117 kN/m | | | | |
| Calculate moment for toe des | ign | | | | | |
| Moment from bearing pressure | | | | m_mid_f) × (I_{toe} + t_{wa} | | |
| Moment from weight of base | | $M_{toe_wt_base} = (\gamma_{f_d} \times \gamma_{base} \times t_{base} \times (I_{toe} + t_{wall} / 2)^2 / 2) = 11.4 \text{ kNm/m}$ | | | | |
| Total moment for toe design | | $M_{toe} = M_{toe}$ | bear - M _{toe_wt_bas} | _e = 82.3 kNm/m | | |
| 500 | > | | | | | |
| | • • | • | • | • • | • | |
| | • • ← 150→ | • | • | ••• | • | |
| Check toe in bending | • • | • | • | ••• | • | |
| <u>↓</u> | • • | • b = 1000 m | • ım/m | • • | • | |

Lever arm

Constant

Area of tension reinforcement required Minimum area of tension reinforcement $d_{toe} = t_{base} - c_{toe} - (\phi_{toe} / 2) = 444.0 \text{ mm}$ $K_{toe} = M_{toe} / (b \times d_{toe}^2 \times f_{cu}) = 0.010$

Compression reinforcement is not required

$$\begin{split} z_{\text{toe}} &= \min(0.5 + \sqrt{(0.25 - (\min(K_{\text{toe}}, 0.225) / 0.9)), 0.95) \times d_{\text{toe}}} \\ z_{\text{toe}} &= \textbf{422} \text{ mm} \\ A_{\text{s_toe_des}} &= M_{\text{toe}} / (0.87 \times f_{\text{y}} \times z_{\text{toe}}) = \textbf{448} \text{ mm}^2/\text{m} \end{split}$$

 $A_{s_toe_min}$ = k × b × t_{base} = 650 mm²/m

| ads consultancy 130 East Barnet Road EN4 8RE - New Barnet Area of tension reinforcement re | Calcs for Calcs by SN | Retaining Wall F | RW1 - Prelimir | | Start page no./ | Revision | |
|---|-----------------------------|--|--|---|-----------------------|----------------------------|--|
| | | - | | Calcs for Retaining Wall RW1 - Preliminary | | | |
| Area of tension reinforcement re | | 05/12/2024 | Checked by | Checked date | Approved by | Approved d | |
| Area of tension reinforcement re | | | | | | | |
| | quired | | | A _{s_toe_min}) = 650 n | nm²/m | | |
| Reinforcement provided | | | a.bars @ 150 r | nm centres | | | |
| Area of reinforcement provided | | | 754 mm²/m | | | | |
| | | PASS - Rein | itorcement pr | ovided at the re | taining wall to | e is adequ | |
| Check shear resistance at toe | | | | | | | |
| Design shear stress | | $v_{toe} = V_{toe} /$ | $(b \times d_{toe}) = 0.2$ | 263 N/mm ² | | | |
| Allowable shear stress | | v _{adm} = min(| (0.8 × √(f _{cu} / 1 ľ | N/mm²), 5) × 1 N/ | /mm² = 5.000 M | V/mm² | |
| | | PASS - | Design shea | r stress is less t | than maximun | n shear str | |
| From BS8110:Part 1:1997 – Tal | ole 3.8 | | | | | | |
| Design concrete shear stress | | v _{c_toe} = 0.4 | | | | | |
| | | | Vto | be < Vc_toe - No sh | near reinforce | ment requi | |
| Design of reinforced concrete | retaining wa | all heel (BS 8002: | :1994 <u>)</u> | | | | |
| Material properties | | | | | | | |
| Characteristic strength of concrete | | f _{cu} = 40 N/mm ² | | | | | |
| Characteristic strength of reinfor | cement | f _y = 500 N/mm ² | | | | | |
| Base details | | | | | | | |
| Minimum area of reinforcement | | k = 0.13 % | | | | | |
| Cover to reinforcement in heel | | c _{heel} = 50 mm | | | | | |
| Calculate shear for heel design | ı | | | | | | |
| Shear from bearing pressure | | $V_{heel_bear} = (p_{heel_f} + p_{stem_heel_f}) \times I_{heel} / 2 = 76.3 \text{ kN/m}$ | | | | | |
| Shear from weight of base | | Vheel wt base | = γ _{f d} × γ _{base} × | I _{heel} × t _{base} = 11.6 | kN/m | | |
| Shear from weight of moist back | fill | V _{heel_wt_m} = w _{m_w_f} = 17.6 kN/m | | | | | |
| Shear from weight of saturated b | | V _{heel wt s} = W _{s f} = 30.9 kN/m | | | | | |
| Shear from surcharge | | V _{heel_sur} = w _{sur_f} = 1.1 kN/m | | | | | |
| Total shear for heel design | | Vheel = - Vheel_bear + Vheel_wt_base + Vheel_wt_m + Vheel_wt_s + Vheel_sur = -15 | | | | | |
| kN/m | | | | | | | |
| Calculate moment for heel des | ign | | | | | | |
| Moment from bearing pressure | | $M_{\text{heel_bear}} = (2 \times p_{\text{heel_f}} + p_{\text{stem_mid_f}}) \times (I_{\text{heel}} + t_{\text{wall}} / 2)^2 / 6 = 41.3 \text{ kNr}$ | | | 1.3 kNm/m | | |
| Moment from weight of base | | $M_{\text{heel}_wt_base} = (\gamma_{f_d} \times \gamma_{\text{base}} \times t_{\text{base}} \times (I_{\text{heel}} + t_{\text{wall}} / 2)^2 / 2) = 6.3 \text{ kNm/m}$ | | | | | |
| Moment from weight of moist bac | ckfill | $M_{\text{heel_wt_m}} = W_{\text{m_w_f}} \times (I_{\text{heel}} + t_{\text{wall}}) / 2 = 9.3 \text{ kNm/m}$ | | | | | |
| Moment from weight of saturated | | $M_{\text{heel}, \text{wt}, \text{s}} = W_{\text{s}, \text{f}} \times (I_{\text{heel}} + t_{\text{wall}}) / 2 = 16.2 \text{ kNm/m}$ | | | | | |
| Moment from surcharge | | | | _{vall}) / 2 = 0.6 kNm | | | |
| Total moment for heel design | | | | _wt_base + Mheel_wt_m | | M _{heel sur} = -8 | |
| kNm/m | | | | | - <u>_</u> <u>-</u> - | | |
| As the moment is | negative th | e design of the re | etaining wall h | neel is beyond ti | he scope of th | nis calculat | |

| Material properties | |
|--|---|
| Characteristic strength of concrete | f _{cu} = 40 N/mm ² |
| Characteristic strength of reinforcement | f _y = 500 N/mm ² |
| Wall details | |
| Minimum area of reinforcement | k = 0.13 % |
| Cover to reinforcement in stem | c _{stem} = 50 mm |
| Cover to reinforcement in wall | c _{wall} = 50 mm |

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| | Calcs for | Retaining Wall F | Start page no./Revision 8 | | | | |
| | Calcs by SN | Calcs date 05/12/2024 | Checked by | Checked date | Approved by | Approved date | |
| Factored horizontal at-rest for | Factored horizontal at-rest forces on stem | | | | | | |
| Surcharge | $F_{s_sur_f} = \gamma_{f_l} \times K_0 \times Surcharge \times (h_{eff} - t_{base} - d_{ds}) = 2 \text{ kN/m}$ | | | | | | |
| Moist backfill above water table | | $F_{s_m_a_f} = 0$ | $5 	imes \gamma_{f_e} 	imes K_0 	imes f$ | $\gamma_{m} \times (h_{eff} - t_{base} - d_{base})$ | _{ds} - h _{sat}) ² = 6.4 | kN/m | |

Moist backfill below water table Saturated backfill

Water

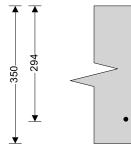
Calculate shear for stem design Shear at base of stem

Calculate moment for stem design Surcharge Moist backfill above water table Moist backfill below water table

Saturated backfill

Water

Total moment for stem design



| $V_{stem} = F_{s_sur_f} + F_{s_m_a_f} + F_{s_m_b_f} + F_{s_s_f} + F_{s_water_f} = 52.2 \text{ kN/m}$ |
|--|
| $M_{s_sur} = F_{s_sur_f} \times (h_{stem} + t_{base}) / 2 = 3.1 \text{ kNm/m}$ |
| $M_{s_m_a} = F_{s_m_a_f} \times (2 \times h_{sat} + h_{eff} - d_{ds} + t_{base} / 2) / 3 = 13.4 \text{ kNm/m}$ |
| $M_{s_m_b} = F_{s_m_b_f} \times h_{sat} / 2 = 14.5 \text{ kNm/m}$ |
| $M_{s_s} = F_{s_s} \times h_{sat} / 3 = 4.5 \text{ kNm/m}$ |
| $M_{s_water} = F_{s_water_f} \times h_{sat} / 3 = 7.7 \text{ kNm/m}$ |

 $F_{s_m_b_f} = \gamma_{f_e} \times K_0 \times \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{sat}) \times h_{sat} = 19.3 \text{ kN/m}$

 $F_{s_s_f} = 0.5 \times \gamma_{f_e} \times K_0 \times (\gamma_{s_} \gamma_{water}) \times h_{sat}^2 = 9 \text{ kN/m}$

 $F_{s_water_f} = 0.5 \times \gamma_{f_e} \times \gamma_{water} \times h_{sat}^2 = \textbf{15.5} \text{ kN/m}$

 $M_{stem} = M_{s_sur} + M_{s_m_a} + M_{s_m_b} + M_{s_s} + M_{s_water} = 43.2 \text{ kNm/m}$

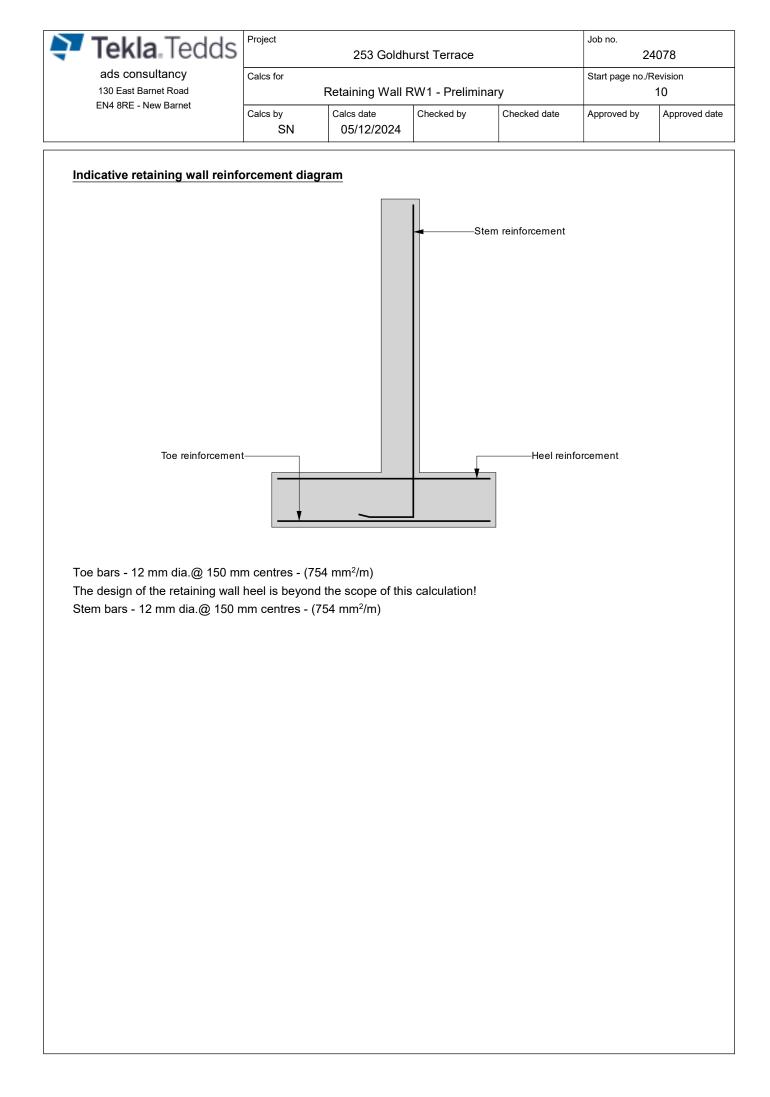
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| Check wall stem in bending | |
|--|---|
| Width of wall stem | b = 1000 mm/m |
| Depth of reinforcement | d _{stem} = t _{wall} – c _{stem} – (φ _{stem} / 2) = 294.0 mm |
| Constant | $K_{stem} = M_{stem} / (b \times d_{stem}^2 \times f_{cu}) = 0.012$ |
| | Compression reinforcement is not required |
| Lever arm | z_{stem} = min(0.5 + $\sqrt{(0.25 - (min(K_{stem}, 0.225) / 0.9)), 0.95) \times d_{stem}}$ |
| | z _{stem} = 279 mm |
| Area of tension reinforcement required | $A_{s_stem_des} = M_{stem} / (0.87 \times f_y \times z_{stem}) = 355 \text{ mm}^2/\text{m}$ |
| Minimum area of tension reinforcement | $A_{s_stem_min} = k \times b \times t_{wall} = 455 \text{ mm}^2/\text{m}$ |
| Area of tension reinforcement required | A _{s_stem_req} = Max(A _{s_stem_des} , A _{s_stem_min}) = 455 mm ² /m |
| Reinforcement provided | 12 mm dia.bars @ 150 mm centres |
| Area of reinforcement provided | A _{s_stem_prov} = 754 mm ² /m |
| | PASS - Reinforcement provided at the retaining wall stem is adequate |
| Check shear resistance at wall stem | |
| Design shear stress | v_{stem} = V_{stem} / (b × d _{stem}) = 0.178 N/mm ² |
| Allowable shear stress | v_{adm} = min(0.8 × $\sqrt{(f_{cu} / 1 N/mm^2)}$, 5) × 1 N/mm ² = 5.000 N/mm ² |
| | PASS - Design shear stress is less than maximum shear stress |
| From BS8110:Part 1:1997 – Table 3.8 | |
| Design concrete shear stress | v _{c_stem} = 0.507 N/mm ² |

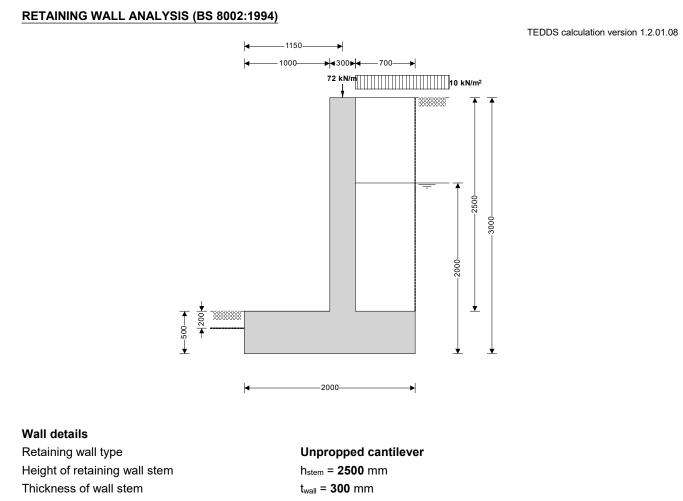
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| ads consultancy 130 East Barnet Road EN4 8RE - New Barnet | Calcs for Retaining Wall RW1 - Preliminary | | | Start page no./Revision 9 | | |
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| | | v _{stem} < v _{c_stem} - No shear reinforcement required |
|-----------------------------|---------------------------------|---|
| Check retaining wall defle | ection | |
| Basic span/effective depth | ratio | ratio _{bas} = 7 |
| Design service stress | | $f_{s} = 2 \times f_{y} \times A_{s_stem_req} / (3 \times A_{s_stem_prov}) = 201.2 \text{ N/mm}^{2}$ |
| Modification factor | factor _{tens} = min(0. | 55 + (477 N/mm ² - f_s)/(120 × (0.9 N/mm ² + (M _{stem} /(b × d _{stem} ²)))),2) = 2.00 |
| Maximum span/effective de | epth ratio | $ratio_{max} = ratio_{bas} \times factor_{tens} = 14.00$ |
| Actual span/effective depth | n ratio | ratio _{act} = h _{stem} / d _{stem} = 8.50 |
| | | PASS - Span to depth ratio is acceptable |



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|---|---|-----------------------------------|------------|--------------|------------------------------|---------------|
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| | Calcs by SN | Calcs date 05/12/2024 | Checked by | Checked date | Approved by | Approved date |



Length of toe Length of heel Overall length of base Thickness of base Depth of downstand Position of downstand Thickness of downstand Height of retaining wall Depth of cover in front of wall Depth of unplanned excavation Height of ground water behind wall Height of saturated fill above base Density of wall construction Density of base construction Angle of rear face of wall Angle of soil surface behind wall Effective height at virtual back of wall **Retained material details**

Retained material details Mobilisation factor

Moist density of retained material

I_{toe} = **1000** mm I_{heel} = **700** mm $I_{\text{base}} = I_{\text{toe}} + I_{\text{heel}} + t_{\text{wall}} = 2000 \text{ mm}$ t_{base} = **500** mm d_{ds} = **0** mm I_{ds} = 600 mm t_{ds} = **500** mm $h_{wall} = h_{stem} + t_{base} + d_{ds} = 3000 \text{ mm}$ d_{cover} = 0 mm d_{exc} = **200** mm h_{water} = 2000 mm h_{sat} = max(h_{water} - t_{base} - d_{ds}, 0 mm) = **1500** mm γ_{wall} = 23.6 kN/m³ γ_{base} = 23.6 kN/m³ α = **90.0** deg $\beta = 0.0 \deg$ $h_{eff} = h_{wall} + I_{heel} \times tan(\beta) = 3000 \text{ mm}$

M = **1.5** γ_m = **18.0** kN/m³

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| ads consultancy 130 East Barnet Road | Calcs for | Detaining Wall | DN/D Drolimi | Start page no./ | Start page no./Revision | |
| EN4 8RE - New Barnet | <u></u> | Retaining Wall F | | 2 | | |
| | Calcs by SN | Calcs date 05/12/2024 | Checked by | Checked date | Approved by | Approved da |
| Saturated density of retained ma | aterial | γ _s = 21.0 kl | N/m ³ | | | |
| Design shear strength | | φ' = 29.3 de | eg | | | |
| Angle of wall friction | | δ = 18.6 de | eg | | | |
| Base material details | | | | | | |
| Firm clay | | | | | | |
| Moist density | | γ _{mb} = 18.0 | kN/m³ | | | |
| Design shear strength | | φ' _b = 24.2 c | leg | | | |
| Design base friction | | δ _b = 18.6 d | eg | | | |
| Allowable bearing pressure | | P _{bearing} = 1 (|)0 kN/m² | | | |
| Using Coulomb theory | | | | | | |
| Active pressure coefficient for re | etained materi | al | | | | |
| $K_a = sin(\alpha - \alpha)$ | + φ')² / (sin(α) | $^2 \times \sin(\alpha - \delta) \times [1 + 1]$ | + √(sin(φ' + δ) : | $	imes$ sin(ϕ ' - eta) / (si | $n(\alpha - \delta) 	imes sin(lpha + \delta)$ | - β)))]²) = 0 . |
| Passive pressure coefficient for | base materia | I | | | | |
| | K _p = sir | n(90 - φ'♭)² / (sin(90 |) - δ _b) × [1 - √(| $sin(\phi_{P} + \delta_{P}) \times si$ | n(փ'♭) / (sin(90 + | $\delta_b)))]^2) = 4.$ |
| At-rest pressure | | | | | | |
| At-rest pressure for retained ma | terial | K ₀ = 1 – sir | n(¢') = 0.511 | | | |
| Loading details | | | | | | |
| Surcharge load on plan | | Surcharge | = 10.0 kN/m ² | | | |
| Applied vertical dead load on wa | all | W _{dead} = 60 | | | | |
| Applied vertical live load on wall | | W _{live} = 12.0 |) kN/m | | | |
| Position of applied vertical load | on wall | I _{load} = 1150 | mm | | | |
| Applied horizontal dead load on | wall | F _{dead} = 0.0 | kN/m | | | |
| Applied horizontal live load on w | all | F _{live} = 0.0 k | :N/m | | | |
| Height of applied horizontal load | l on wall | h _{load} = 0 mi | n | | | |
| | | 72 ↓ □□□□□□ | 111111111111111111111111111111111111111 | 0 | | |
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| 21.4 | 87.2 | | 67.8 | 2.9 5.2 6.5 | 19.6 | |
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| | | | | | , | |
| | | | | Loads sh | nown in kN/m, pressu | ires snown in k |

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| Vertical forces on wall | |
|---|---|
| Wall stem | $w_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall} = 17.7 \text{ kN/m}$ |
| Wall base | $w_{base} = I_{base} \times t_{base} \times \gamma_{base} = 23.6 \text{ kN/m}$ |
| Surcharge | w _{sur} = Surcharge × I _{heel} = 7 kN/m |
| Moist backfill to top of wall | $w_{m_w} = I_{heel} \times (h_{stem} - h_{sat}) \times \gamma_m = 12.6 \text{ kN/m}$ |
| Saturated backfill | $w_s = I_{heel} \times h_{sat} \times \gamma_s = 22.1 \text{ kN/m}$ |
| Applied vertical load | $W_v = W_{dead} + W_{live} = 72 \text{ kN/m}$ |
| Total vertical load | $W_{total} = W_{wall} + W_{base} + W_{sur} + W_{m_w} + W_s + W_v = 155 \text{ kN/m}$ |
| Horizontal forces on wall | |
| Surcharge | F_{sur} = K _a × cos(90 - α + δ) × Surcharge × h _{eff} = 8.7 kN/m |
| Moist backfill above water table | $F_{m_a} = 0.5 \times K_a \times cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2 = 2.6 \text{ kN/m}$ |
| Moist backfill below water table | $F_{m_b} = K_a \times cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water} = 10.4 \text{ kN/m}$ |
| Saturated backfill | $F_{s} = 0.5 \times K_{a} \times cos(90 - \alpha + \delta) \times (\gamma_{s}\text{-} \gamma_{water}) \times h_{water}^2 = \textbf{6.5} \ kN/m$ |
| Water | F_{water} = 0.5 × h_{water}^2 × γ_{water} = 19.6 kN/m |
| Total horizontal load | $F_{total} = F_{sur} + F_{m_a} + F_{m_b} + F_s + F_{water} = 47.9 \text{ kN/m}$ |
| Calculate stability against sliding | |
| Passive resistance of soil in front of wall | $F_{p} = 0.5 \times K_{p} \times cos(\delta_{b}) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^{2} \times \gamma_{mb} = 3.2 \text{ kN/m}$ |
| | |

PASS - Resistance force is greater than sliding force

 $M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2 = 13.1 \text{ kNm/m}$ $M_{m a} = F_{m a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3 = 6.1 \text{ kNm/m}$ $M_{m_b} = F_{m_b} \times (h_{water} - 2 \times d_{ds}) / 2 = 10.4 \text{ kNm/m}$ $M_s = F_s \times (h_{water} - 3 \times d_{ds}) / 3 = 4.3 \text{ kNm/m}$ $M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3 = 13.1 \text{ kNm/m}$ $M_{ot} = M_{sur} + M_{m_a} + M_{m_b} + M_s + M_{water} = 47 \text{ kNm/m}$

 $F_{res} = F_p + (W_{total} - W_{sur} - W_{live}) \times tan(\delta_b) = 49.0 \text{ kN/m}$

 $M_{wall} = w_{wall} \times (I_{toe} + t_{wall} / 2) = 20.4 \text{ kNm/m}$ $M_{\text{base}} = w_{\text{base}} \times I_{\text{base}} / 2 = 23.6 \text{ kNm/m}$ $M_{m_r} = (w_{m_w} \times (I_{base} - I_{heel} / 2) + w_{m_s} \times (I_{base} - I_{heel} / 3)) = 20.8 \text{ kNm/m}$ $M_{s_r} = w_s \times (I_{base} - I_{heel} / 2) = 36.4 \text{ kNm/m}$ $M_{dead} = W_{dead} \times I_{load} = 69 \text{ kNm/m}$ Mrest = Mwall + Mbase + Mm r + Ms r + Mdead = 170.1 kNm/m

Mot = 47.0 kNm/m Mrest = 170.1 kNm/m PASS - Restoring moment is greater than overturning moment

 $M_{sur_r} = W_{sur} \times (I_{base} - I_{heel} / 2) = 11.6 \text{ kNm/m}$ Mlive = Wlive × Iload = 13.8 kNm/m M_{total} = M_{rest} - M_{ot} + M_{sur} + M_{live} = **148.5** kNm/m R = W_{total} = **155.0** kN/m $x_{bar} = M_{total} / R = 958 mm$ e = abs((I_{base} / 2) - x_{bar}) = 42 mm

Resistance to sliding

Overturning moments

Surcharge Moist backfill above water table Moist backfill below water table Saturated backfill Water Total overturning moment

Restoring moments

Wall stem Wall base Moist backfill Saturated backfill Design vertical dead load Total restoring moment

Check stability against overturning Total overturning moment Total restoring moment

Check bearing pressure

Surcharge Design vertical live load Total moment for bearing Total vertical reaction Distance to reaction Eccentricity of reaction

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Reaction acts within middle third of base

Bearing pressure at toe Bearing pressure at heel
$$\begin{split} p_{\text{toe}} &= (\mathsf{R} \ / \ \mathsf{I}_{\text{base}}) + (6 \times \mathsf{R} \times e \ / \ \mathsf{I}_{\text{base}}^2) = \textbf{87.2} \ \mathsf{kN}/m^2 \\ p_{\text{heel}} &= (\mathsf{R} \ / \ \mathsf{I}_{\text{base}}) - (6 \times \mathsf{R} \times e \ / \ \mathsf{I}_{\text{base}}^2) = \textbf{67.8} \ \mathsf{kN}/m^2 \end{split}$$

PASS - Maximum bearing pressure is less than allowable bearing pressure

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| EN4 8RE - New Barnet | | Retaining Wall F | 5 | | | |
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| RETAINING WALL DESIGN (BS | 8002:1994) | | | | | |
| Ultimate limit state load factors | | | | | TEDDS calculation | n version 1.2.0 |
| Dead load factor | | γ _{f_d} = 1.4 | | | | |
| Live load factor | | γ _{f_l} = 1.6 | | | | |
| Earth and water pressure factor | | γ _{f_e} = 1.4 | | | | |
| Factored vertical forces on wall | | | | | | |
| Wall stem | | $\mathbf{W}_{wall_f} = \gamma_{f_d}$ | imes h _{stem} $	imes$ t _{wall} $	imes$ | _{γwall} = 24.8 kN/n | n | |
| Wall base | | $W_{\text{base f}} = \gamma_{\text{f}}$ | $_{ m l} 	imes {\sf I}_{ m base} 	imes {\sf t}_{ m base} 	imes$ | γ _{base} = 33 kN/m | ı | |
| Surcharge | | | | I _{heel} = 11.2 kN/m | | |
| Moist backfill to top of wall | | | - | - h _{sat}) × γ _m = 17. | | |
| Saturated backfill | | | $I_{heel} \times h_{sat} \times \gamma_s$ | , . | | |
| Applied vertical load | | | - | W _{live} = 103.2 kN/ | /m | |
| Total vertical load | | | . – | N _{sur_f} + W _{m_w_f} + V | | 0.7 kN/m |
| Factored horizontal at-rest force | s on wall | _ | | | | |
| Surcharge | | $F_{sur} f = \gamma f + \lambda$ | Ko x Surchard | ge × h _{eff} = 24.5 k | N/m | |
| Moist backfill above water table | | | - | $h \times (h_{eff} - h_{water})^2 =$ | | |
| Moist backfill below water table | | | | $f_{\rm ff} - h_{\rm water}) \times h_{\rm water}$ | | |
| Saturated backfill | | | | γ_{water} × h_{water}^2 = γ | | |
| Water | | | | × γ_{water} = 27.5 k | | |
| Total horizontal load | | _ • = | | $\sim \gamma$ water = 27.9 K _b_f + Fs_f + Fwater | | n |
| Passive resistance of soil in front | of wall | | | $(\delta_b) \times (d_{cover} + t_{ba})$ | | |
| kN/m | | 1 p_1 /1_6 A | | | | |
| Factored overturning moments | | | | | | |
| Surcharge | | M _{sur_f} = F _{sur} | $_{f} \times (h_{eff} - 2 \times c)$ | l _{ds}) / 2 = 36.8 kN | im/m | |
| Moist backfill above water table | | $M_{m_a_f} = F_{m_a}$ | _a_f × (h _{eff} + 2 × | h _{water} - 3 × d _{ds}) / | 3 = 15 kNm/m | |
| Moist backfill below water table | | $M_{m_b_f} = F_{m_b}$ | _b_f × (h _{water} - 2 | × d _{ds}) / 2 = 25.7 | kNm/m | |
| Saturated backfill | | $M_{s_f} = F_{s_f} >$ | \times (h _{water} - 3 \times d _d | _s) / 3 = 10.7 kNn | n/m | |
| Water | | $M_{water_f} = F_v$ | vater_f × (h _{water} - 3 | 3 × d _{ds}) / 3 = 18. | 3 kNm/m | |
| Total overturning moment | | M _{ot_f} = M _{sur_} | _f + M _{m_a_f} + M _m | $h_b_f + M_{s_f} + M_{wat}$ | _{ter_f} = 106.5 kNr | m/m |
| Restoring moments | | | | | | |
| Wall stem | | $M_{wall_f} = W_{wall_f}$ | $_{\text{all}_{f}} \times (I_{\text{toe}} + t_{\text{wall}})$ | / 2) = 28.5 kNm/ | m | |
| Wall base | | | _{ase_f} × I _{base} / 2 = | | | |
| Surcharge | | _ | - | ı / 2) = 18.5 kNm | ı/m | |
| Moist backfill | | | | , el / 2) + W _{m_s_f} × (| | = 29.1 kNm |
| Saturated backfill | | • | • | 2) = 50.9 kNm/m | | |
| Design vertical load | | | × I _{load} = 118.7 | | | |
| Total restoring moment | | | | /I _{sur_r_f} + M _{m_r_f} + | $M_{s_r_f} + M_{v_f} = 2$ | 278.7 kNm/ |
| Factored bearing pressure | | | | | | |
| Total moment for bearing | | M _{total} f = M _{re} | est_f - Mot_f = 17 2 | 2.2 kNm/m | | |
| Total vertical reaction | | | = 220.7 kN/m | | | |
| Distance to reaction | | | _{l_f} / R _f = 780 m | m | | |
| Eccentricity of reaction | | e _f = abs((l _{ba} | _{ase} / 2) - x _{bar_f}) = | = 220 mm | | |
| | | | | Reaction acts | within middle | third of ba |

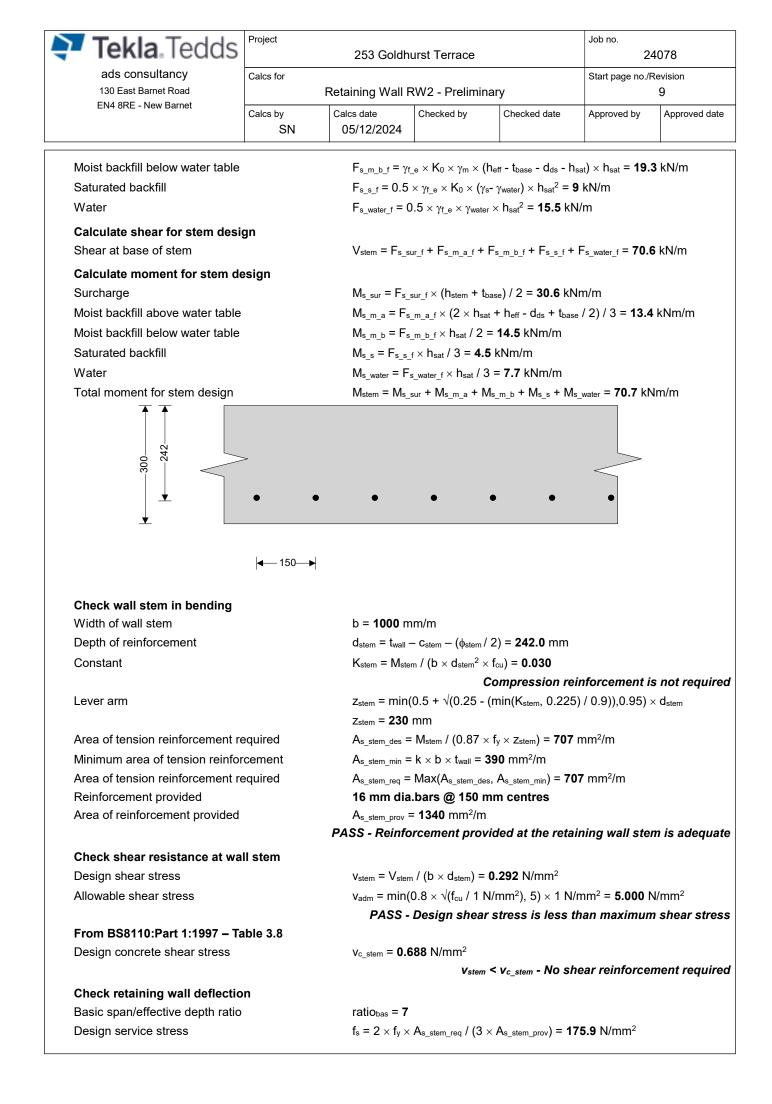
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| EIN4 ORE - New Damet | Calcs by SN | Calcs date 05/12/2024 | Checked by | Checked date | Approved by | Approved da | |
| Bearing pressure at toe | | $p_{toe_f} = (R_f)$ | $(I_{base}) + (6 \times R)$ | $R_{f} \times e_{f} / I_{base}^{2}$ = 18 | 3.1 kN/m² | | |
| Bearing pressure at heel | | $p_{heel_f} = (R_f)$ | / I_{base}) - (6 × F | $R_f \times e_f / I_{base^2} = 37$ | .6 kN/m² | | |
| Rate of change of base reaction | n | rate = (p _{toe} | _f - p _{heel_f}) / I _{bas} | _e = 72.72 kN/m²/n | า | | |
| Bearing pressure at stem / toe | | $p_{\text{stem_toe_f}} =$ | max(p _{toe_f} - (ra | ate × I _{toe}), 0 kN/m ² | ²) = 110.4 kN/r | n² | |
| Bearing pressure at mid stem | | p _{stem_mid_f} = | max(p _{toe_f} - (r | ate \times (I _{toe} + t _{wall} / 2 |)), 0 kN/m²) = | 99.5 kN/m ² | |
| Bearing pressure at stem / heel | | Pstem_heel_f = | max(p _{toe_f} - (r | rate × (I_{toe} + t_{wall})), | 0 kN/m²) = 88 | .5 kN/m² | |
| Design of reinforced concrete | retaining wa | III toe (BS 8002:1 | <u>994)</u> | | | | |
| Material properties | | | | | | | |
| Characteristic strength of concre | | f _{cu} = 40 N/r | | | | | |
| Characteristic strength of reinfor | rcement | f _y = 500 N/ | mm² | | | | |
| Base details | | | | | | | |
| Minimum area of reinforcement | | k = 0.13 % | | | | | |
| Cover to reinforcement in toe | | c _{toe} = 50 m | m | | | | |
| Calculate shear for toe design | ı | | | | | | |
| Shear from bearing pressure | | $V_{toe_bear} = ($ | p _{toe_f} + p _{stem_toe} | e_f) × I _{toe} / 2 = 146. | 7 kN/m | | |
| Shear from weight of base | | $V_{toe_wt_base}$ = $\gamma_{f_d} \times \gamma_{base} \times I_{toe} \times t_{base}$ = 16.5 kN/m | | | | | |
| Total shear for toe design | | $V_{toe} = V_{toe_t}$ | oear - V _{toe_wt_base} | _e = 130.2 kN/m | | | |
| Calculate moment for toe des | ign | | | | | | |
| Moment from bearing pressure | • | M _{toe bear} = (| 2 × p _{toe f} + p _{ste} | $_{em_{mid_f}} \times (I_{toe} + t_{wa})$ | "/2)²/6 = 10 2 | 2.6 kNm/m | |
| Moment from weight of base | | | | $ t_{base} \times (I_{toe} + t_{wall}) $ | | | |
| Total moment for toe design | | | | _{se} = 91.7 kNm/m | , , | | |
| 5 00 | • • | • | · | • • | • | | |
| . | ← 150 | | | | | | |
| Check toe in bending | | h - 4000 | m/m | | | | |
| Width of toe Depth of reinforcement | | b = 1000 m | | ?) = 444.0 mm | | | |
| Constant | | | $- c_{\text{toe}} - (\phi_{\text{toe}} / 2)$ / (b × d _{toe} ² × f _{cl} | | | | |
| Constant | | rx _{toe} - IVI _{toe} | • | Compression re | inforcement | s not requir | |
| Lever arm | | $z_{\rm min} = \min\{0\}$ | | (min(K _{toe} , 0.225) / | | - | |
| | | z _{toe} = 422 r | | (IIIII (INtoe, U.223) / | 0.9)),0.90) × (| JIOE | |
| Area of tension reinforcement re | equired | $A_{s_toe_des} =$ | M_{toe} / (0.87 $	imes$ f | $f_y \times z_{toe}$) = 500 mm | n²/m | | |
| | | | | _ | | | |

 $A_{s_toe_min} = k \times b \times t_{base} = \textbf{650} \text{ mm}^2\text{/m}$

Minimum area of tension reinforcement

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| EIN4 ORE - New Damet | Calcs by SN | Calcs date 05/12/2024 | Checked by | Checked date | Approved by | Approved of | | | |
| Area of tension reinforcement re | equired | A _{s_toe_req} = | Max(A _{s_toe_des} , | A _{s_toe_min}) = 650 r | mm²/m | | | | |
| Reinforcement provided | | 12 mm dia.bars @ 150 mm centres | | | | | | | |
| Area of reinforcement provided | | | 754 mm²/m | | | | | | |
| | | PASS - Rein | forcement pr | ovided at the re | taining wall to | be is adequ | | | |
| Check shear resistance at toe |) | | | | | | | | |
| Design shear stress | | $v_{toe} = V_{toe}$ / | $(b \times d_{toe}) = 0.2$ | 293 N/mm² | | | | | |
| Allowable shear stress | | v _{adm} = min(| 0.8 × √(f _{cu} / 1 I | N/mm²), 5) × 1 N | /mm ² = 5.000 | N/mm ² | | | |
| | | PASS - | Design shea | r stress is less i | than maximur | n shear str | | | |
| From BS8110:Part 1:1997 – Ta | able 3.8 | | | | | | | | |
| Design concrete shear stress | | v _{c_toe} = 0.4 0 | | | | | | | |
| | | | Vte | _{oe} < v _{c_toe} - No sl | hear reinforce | ment requ | | | |
| Design of reinforced concrete | e retaining w | all heel (BS 8002: | <u>1994)</u> | | | | | | |
| Material properties | | | | | | | | | |
| Characteristic strength of concr | f _{cu} = 40 N/r | nm² | | | | | | | |
| Characteristic strength of reinfo | rcement | f _y = 500 N/mm ² | | | | | | | |
| Base details | | | | | | | | | |
| Minimum area of reinforcement | | k = 0.13 % | | | | | | | |
| Cover to reinforcement in heel | | c _{heel} = 50 m | ım | | | | | | |
| Calculate shear for heel desig | ın | | | | | | | | |
| Shear from bearing pressure | | V _{heel_bear} = | (p _{heel_f} + p _{stem_h} | neel_f) × I _{heel} / 2 = 4 | 4.2 kN/m | | | | |
| Shear from weight of base | | | | I _{heel} × t _{base} = 11.6 | | | | | |
| Shear from weight of moist back | kfill | V _{heel_wt_m} = | Wm_w_f = 17.6 | kN/m | | | | | |
| Shear from weight of saturated | backfill | $V_{heel_wt_s} = v_{heel_wt_s}$ | w _{s_f} = 30.9 kN/ | /m | | | | | |
| Shear from surcharge | | $V_{heel_sur} = w$ | /sur_f = 11.2 kN | /m | | | | | |
| Total shear for heel design kN/m | | $V_{heel} = -V_{heel}$ | neel_bear + Vheel_v | $w_{t_{base}} + V_{heel_wt_m}$ | + V _{heel_wt_s} + V _h | neel_sur = 27. | | | |
| Calculate moment for heel de | sign | | | | | | | | |
| Moment from bearing pressure | | M _{heel_bear} = | $(2 \times p_{\text{heel}_f} + p_s)$ | $stem_mid_f) \times (I_{heel} +$ | $t_{wall} / 2)^2 / 6 = 2$ | 2 1 kNm/m | | | |
| Moment from weight of base | | | | $\times t_{base} \times (I_{heel} + t_{wast})$ | | | | | |
| Moment from weight of moist ba | ackfill | | | + t _{wall}) / 2 = 8.8 kN | | | | | |
| · · · · · · · · · · · · · · · · · · · | d backfill | | | /all) / 2 = 15.4 kNr | | | | | |
| Moment from weight of saturate | | | | | | | | | |
| Moment from weight of saturate Moment from surcharge | | $M_{heel sur} = v$ | $V_{sur_f} \times (I_{heel} + t_w)$ | _{wall}) / 2 = 5.6 kNm | ı/m | | | | |

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| 4 | 150 _ | | | | | | | |
| 500 444 | • | • | • | • • | • | | | |
| Check heel in bending Width of heel | | b = 1000 m | | | | | | |
| Depth of reinforcement Constant | | | | $c_{heel} - (\phi_{heel} / 2) = 444.0 \text{ mm}$ / (b × d_{heel} ² × f_{ev}) = 0.002 | | | | |
| Ounstant | K _{heel} = M _{heel} / (b × d _{heel} ² × f _{cu}) = 0.002 Compression reinforcement is not requ | | | | | | | |
| Lever arm | | z _{heel} = min(z _{heel} = 422 | | (min(K _{heel} , 0.225) |) / 0.9)),0.95) × | d _{heel} | | |
| Area of tension reinforcement requi | red | | | f _y × z _{heel}) = 81 m | m²/m | | | |
| Minimum area of tension reinforcem | ent | | $\mathbf{k} \times \mathbf{b} \times \mathbf{t}_{base} =$ | | | | | |
| Area of tension reinforcement requi | red | A _{s_heel_req} = Max(A _{s_heel_des} , A _{s_heel_min}) = 650 mm ² /m | | | | | | |
| Reinforcement provided | | 12 mm dia.bars @ 150 mm centres | | | | | | |
| Area of reinforcement provided | | As_heel_prov = 754 mm ² /m PASS - Reinforcement provided at the retaining wall heel is adequa | | | | | | |
| | | PASS - Reilli | orcement pro | viueu al lile lela | anning wan ne | ei is auequa | | |
| Check shear resistance at heel Design shear stress | | Vhan - 1/1 | / (b × d _{bab}) – r | 061 N/mm ² | | | | |
| Allowable shear stress | | v _{heel} = V _{heel} / (b × d _{heel}) = 0.061 N/mm ² v _{adm} = min(0.8 × √(f _{cu} / 1 N/mm ²), 5) × 1 N/mm ² = 5.000 N/mm ² | | | | | | |
| , montable official official | | | | stress is less t | | | | |
| From BS8110:Part 1:1997 – Table | 3.8 | | - | | | | | |
| Design concrete shear stress | | Vc_heel = 0.4 | 09 N/mm ² | | | | | |
| | | | Vhee | ı < v _{c_heel} - No sł | near reinforce | ment require | | |
| Design of reinforced concrete ret | aining wal | I stem (BS 8002 | :1994 <u>)</u> | | | | | |
| Material properties | | | — | | | | | |
| Characteristic strength of concrete | | f _{cu} = 40 N/r | nm² | | | | | |
| Characteristic strength of reinforcer | nent | f _y = 500 N/r | mm² | | | | | |
| Wall details | | | | | | | | |
| Minimum area of reinforcement | | k = 0.13 % | | | | | | |
| Cover to reinforcement in stem | | c _{stem} = 50 n | | | | | | |
| Cover to reinforcement in wall | | c _{wall} = 50 m | IM | | | | | |
| Factored horizontal at-rest forces | on stem | | | | | | | |
| Surcharge | | $F_{s_sur_f} = \gamma_{f_l} \times K_0 \times Surcharge \times (h_{eff} - t_{base} - d_{ds}) = 20.4 \text{ kN/m}$ | | | | | | |
| Moist backfill above water table | | $F_{s_m_a_f} = 0.5 \times \gamma_{f_e} \times K_0 \times \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{sat})^2 = 6.4 \text{ kN/m}$ | | | | | | |



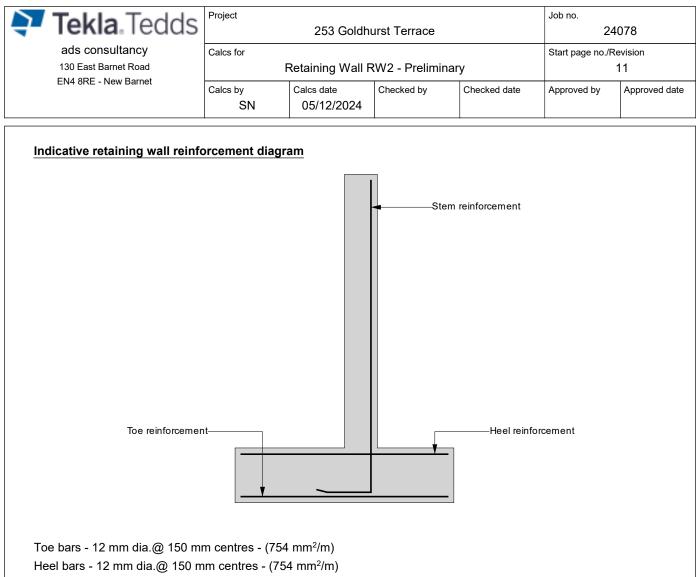
| Tekla. Tedds | Project | Job no. 24078 | | | | |
|---|----------------|--------------------------|-----------------|--------------|-------------------|---------------|
| ads consultancy 130 East Barnet Road EN4 8RE - New Barnet | Calcs for | Retaining Wall F | RW2 - Prelimina | ry | Start page no./Re | evision 10 |
| EN4 OKE - New Damet | Calcs by SN | Calcs date 05/12/2024 | Checked by | Checked date | Approved by | Approved date |

Modification factorfactor_tens = min(0.55 + (477 N/mm² - f_s)/(120 × (0.9 N/mm² + (M_{stem}/(b × d_{stem²})))),2) = **1.74**Maximum span/effective depth ratioratio_max = ratio_bas × factor_tens = **12.18**

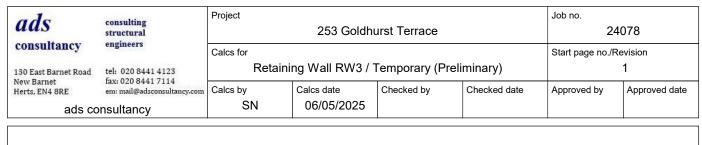
Actual span/effective depth ratio

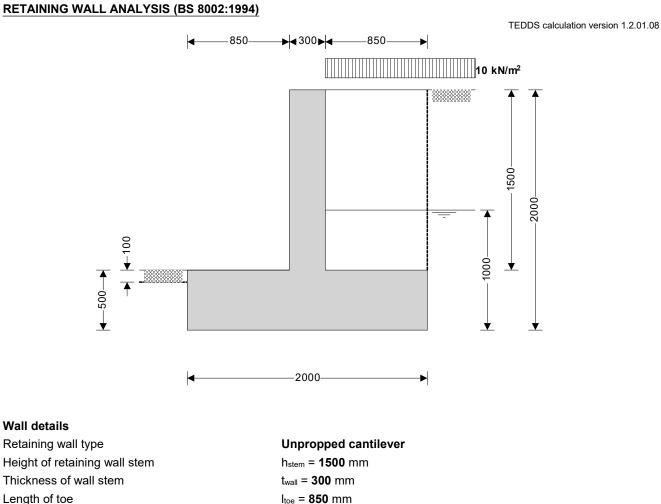
ratio_{act} = h_{stem} / d_{stem} = **10.33**

PASS - Span to depth ratio is acceptable



Stem bars - 16 mm dia.@ 150 mm centres - (1340 mm²/m)





I_{heel} = **850** mm

t_{base} = **500** mm

 $d_{ds} = 0 \text{ mm}$

I_{ds} = 600 mm

t_{ds} = **500** mm

d_{cover} = 0 mm d_{exc} = **100** mm

h_{water} = 1000 mm

γ_{wall} = 23.6 kN/m³

γ_{base} = 23.6 kN/m³

α = **90.0** deg

 $\beta = 0.0 \text{ deg}$

M = 1.5

γ_m = 18.0 kN/m³

 $I_{\text{base}} = I_{\text{toe}} + I_{\text{heel}} + t_{\text{wall}} = 2000 \text{ mm}$

 $h_{wall} = h_{stem} + t_{base} + d_{ds} = 2000 \text{ mm}$

 $h_{eff} = h_{wall} + I_{heel} \times tan(\beta) = 2000 \text{ mm}$

 $h_{sat} = max(h_{water} - t_{base} - d_{ds}, 0 mm) = 500 mm$

Height of retaining wall stem Thickness of wall stem Length of toe Length of heel Overall length of base Thickness of base Depth of downstand Position of downstand Thickness of downstand Height of retaining wall Depth of cover in front of wall Depth of unplanned excavation Height of ground water behind wall Height of saturated fill above base Density of wall construction Density of base construction Angle of rear face of wall Angle of soil surface behind wall Effective height at virtual back of wall **Retained material details**

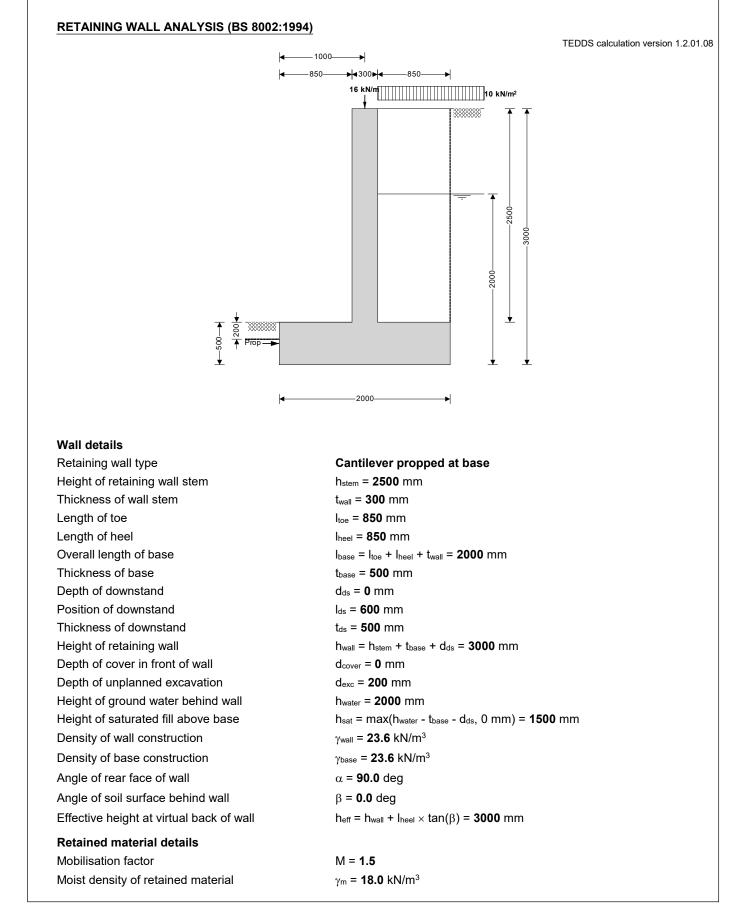
Mobilisation factor

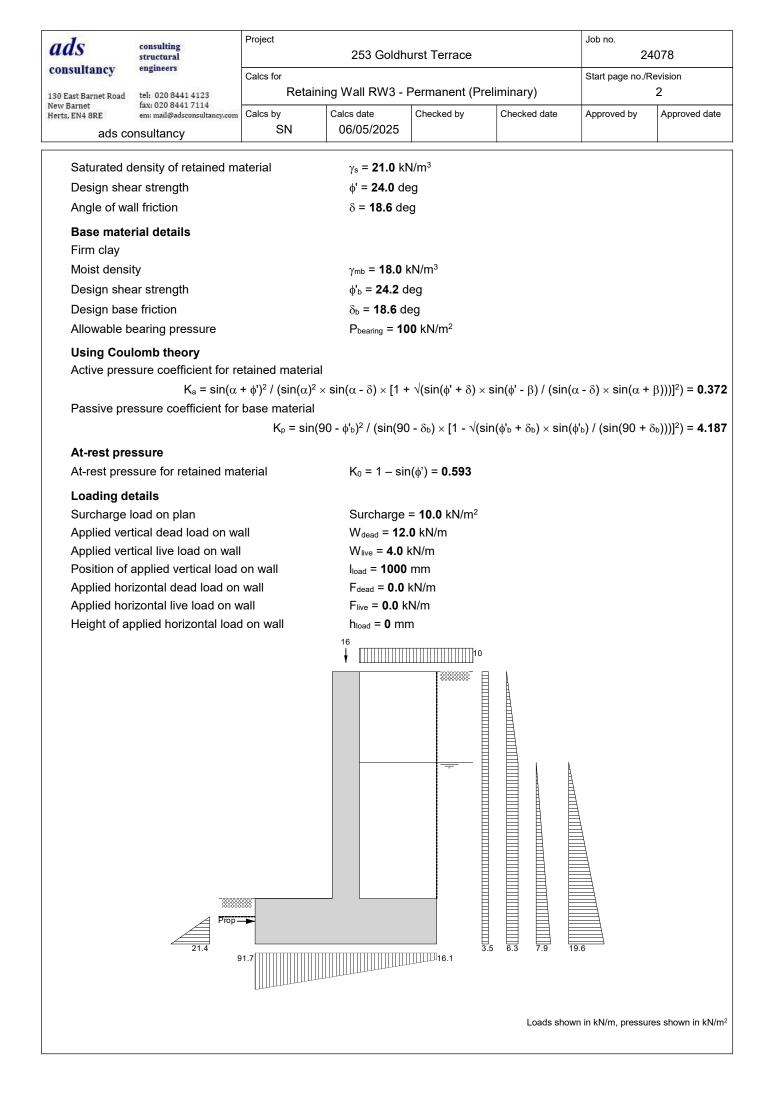
| Moist | density | of | retained | material |
|---------|---------|----|----------|----------|
| IVIOISL | uensity | υı | retaineu | material |

| ads | consulting structural engineers | Project | 253 Goldh | urst Terrace | | | Job no | | 1078 |
|----------------------------------|--|---------------------------------|--|--|--------------------------------|----------|---------------|-----------------|-------------------------|
| consultancy | tel: 020 8441 4123 | Calcs for Retair | ning Wall RW3 / | Temporary (Pr | eliminary) | | Start p | bage no./R | evision 2 |
| New Barnet Herts, EN4 8RE | fax: 020 8441 7114 em: mail@adsconsultancy.com nsultancy | Calcs by SN | Calcs date 06/05/2025 | Checked by | Checked o | late | Approv | ved by | Approved date |
| | | | | - | | | | | |
| | ensity of retained ma | aterial | γ _s = 21.0 kl | | | | | | |
| Design shea | • | | φ' = 24.0 de | • | | | | | |
| Angle of wa | Il friction | | δ = 18.6 de | g | | | | | |
| Base mater | ial details | | | | | | | | |
| Firm clay | | | | | | | | | |
| Moist densit | • | | γ _{mb} = 18.0 | | | | | | |
| Design shea | • | | φ' _b = 24.2 c | 0 | | | | | |
| Design base | | | δ _b = 18.6 d | • | | | | | |
| Allowable b | earing pressure | | P _{bearing} = 10 | 00 kN/m² | | | | | |
| Using Coul | omb theory | | | | | | | | |
| Active press | sure coefficient for re | etained materia | l | | | | | | |
| | $K_a = sin(\alpha$ | + $\phi')^2 / (\sin(\alpha)^2)$ | × sin(α - δ) × [1 + | - √(sin(φ' + δ) × | sin(φ' - β) | ′(sin(a | α-δ)× | $\sin(\alpha +$ | $(\beta)))]^2) = 0.372$ |
| Passive pre | ssure coefficient for | base material | | | | | | | |
| | | K _p = sin(| 90 - φ'₅)² / (sin(90 |) - δ _b) × [1 - √(s | $\sin(\phi'_{b} + \delta_{b})$ | × sin(o | þ'₅) / (si | n(90 + a | бь)))]²) = 4.187 |
| At-rest pres | ssure | | | | | | | | |
| At-rest pres | sure for retained ma | terial | K ₀ = 1 – sir | n(φ') = 0.593 | | | | | |
| Loading de | taile | | | | | | | | |
| Surcharge l | | | Surcharge | = 10.0 kN/m ² | | | | | |
| - | ical dead load on wa | all | W _{dead} = 0.0 | | | | | | |
| | ical live load on wall | | W _{live} = 0.0 | | | | | | |
| •• | applied vertical load | | $I_{load} = 0 \text{ mm}$ | | | | | | |
| | zontal dead load on | | F _{dead} = 0.0 | | | | | | |
| | zontal live load on w | | F _{live} = 0.0 k | | | | | | |
| | plied horizontal load | | h _{load} = 0 mi | | | | | | |
| 0 1 | | | 011111111 | | | | | | |
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| | | | | | | | 3.9 | 目 | |
| | | | | | | | | | |
| | 28.6 | 0.4 | | 36. | | 6.3 | 3.9 | 9.8 | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | do obou | n in kN/n | n proceur | |
| | | | | | Loa | | 11 III KIN/II | n, pressur | es snown in kin/m |
| Vertical for | ces on wall | | | | Loa | | 11 III KIN/II | n, pressur | es shown in kN/m² |
| Vertical for Wall stem | ces on wall | | W _{wall} = h _{stern} | \times t _{wall} \times γ _{wall} = | | us snow | 11 III KIN/II | n, pressur | es snown in kiv/m |

| ads | consulting structural | Project | 253 Goldh | urst Terrace | | Job no. 2 | 4078 |
|------------------------------|---|-----------|--------------------------------------|--|---|----------------------------------|------------------|
| consultancy | engineers | Calcs for | | | | Start page no./I | Revision |
| 30 East Barnet Road | tel: 020 8441 4123 | Reta | ining Wall RW3 / | Temporary (Pr | eliminary) | | 3 |
| lew Barnet lerts, EN4 8RE | fax: 020 8441 7114 em: mail@adsconsultancy.com | Calcs by | Calcs date | Checked by | Checked date | Approved by | Approved da |
| ads co | nsultancy | SN | 06/05/2025 | | | | |
| Surcharge | | | w _{sur} = Surc | harge × I _{heel} = | 8.5 kN/m | | |
| 0 | ill to top of wall | | | - | < γ _m = 15.3 kN/m | ı | |
| Saturated b | · | | — | $h_{sat} \times \gamma_s = 8.9$ | • | | |
| Total vertica | | | | - | + w _{m_w} + w _s = 66 | 5.9 kN/m | |
| Horizontal | forces on wall | | | | | | |
| Surcharge | | | F _{sur} = K _a × | cos(90 - α + δ) |) × Surcharge × ł | n _{eff} = 7 kN/m | |
| 0 | ill above water table | | | | $-\alpha + \delta$) × γ_m × (h _e | | 2 kN/m |
| Moist backf | ill below water table | | _ | | δ) × $\gamma_{\rm m}$ × (h _{eff} - h _{wa} | - | |
| Saturated b | ackfill | | _ | | $(\gamma_{s} + \delta) \times (\gamma_{s} - \gamma_{water})$ | , | |
| Water | | | | $\times h_{water}^2 \times \gamma_{wate}$ | ,, | indioi | |
| Total horizo | ntal load | | | | - Fs + F _{water} = 23. | 4 kN/m | |
| Calculate s | tability against slid | lina | | | | | |
| | istance of soil in fror | • | $F_{\rm p} = 0.5 \times F_{\rm p}$ | $(h_{\rm p} \times \cos(\delta_{\rm h}) \times 0)$ | $(d_{cover} + t_{base} + d_{ds})$ | $= d_{exc}^2 \times v_{mb} =$ | 5.7 kN/m |
| Resistance | | | | | tan(δ _b) = 25.4 kN | , . | |
| rtoolotanoo | to onding | | Ties Tp | . , | esistance force | | n slidina fo |
| Overturnin | g moments | | | | | 0 | 0 |
| Surcharge | gmomenta | | Meur = Feur 3 | x (heff - 2 x dds |) / 2 = 7 kNm/m | | |
| - | ill above water table | | | • | water - 3 × d _{ds}) / 3 | = 4.2 kNm/m | |
| | ill below water table | | | | d_{ds}) / 2 = 3.2 kNr | | |
| Saturated b | | | | | / 3 = 0.7 kNm/m | | |
| Water | | | | | × d _{ds}) / 3 = 1.6 kN | Jm/m | |
| | Irning moment | | | | + M _s + M _{water} = 16 | | |
| Restoring I | moments | | | | | | |
| Wall stem | nomenta | | Mwall = Wwall | \times (Itoo + two / 2 | ?) = 10.6 kNm/m | | |
| Wall base | | | | $_{se} \times I_{base} / 2 = 2$ | | | |
| Moist backf | ill | | | | $/2) + W_{m_s} \times (I_{base})$ | - lbool (3)) = 2 | 4 1 kNm/m |
| Saturated b | | | | | = 14.1 kNm/m | | |
| | ing moment | | | . , | _r + M _{s_r} = 72.4 kN | Nm/m | |
| | oility against overtu | rning | | | , | | |
| | Irning moment | ming | M _{ot} = 16.7 | kNm/m | | | |
| | ing moment | | M _{rest} = 72.4 | | | | |
| | 0 | | PASS | - Restoring m | oment is greate | er than overtu | rning mom |
| Check bea | ring pressure | | | | | | |
| Surcharge | . | | M _{sur} r = w _{su} | r × (I _{base} - I _{heel} / | 2) = 13.4 kNm/m | ı | |
| • | ent for bearing | | | t - Mot + Msur_r : | | | |
| Total vertica | - | | | • 66.9 kN/m | | | |
| Distance to | reaction | | $x_{bar} = M_{total}$ | / R = 1031 mn | า | | |
| Eccentricity | of reaction | | e = abs((I _{ba} | _{ase} / 2) - x _{bar}) = | | | |
| _ | | | | | Reaction acts | | e third of b |
| | ssure at toe | | | | e / I _{base} ²) = 30.4 | | |
| Rearing pre | ssure at heel | | $p_{heel} = (R /$ | I _{base}) + (6 × R > | < e / I _{base} ²) = 36.6 | 6 kN/m² | |







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|--|--|--|--|--|---|---|------------------|--|--|
| and the second | structural engineers | | 253 Goldh | urst Terrace | | 2 | 4078 | | |
| consultancy | engineers | Calcs for | | | | Start page no./ł | | | |
| 30 East Barnet Road Jew Barnet | tel: 020 8441 4123 fax: 020 8441 7114 | Reta | ining Wall RW3 - | Permanent (P | reliminary) | | 3 | | |
| ierts, EN4 8RE | em: mail@adsconsultancy.com | - | Calcs date | Checked by | Checked date | Approved by | Approved dat | | |
| ads co | onsultancy | SN | 06/05/2025 | | | | | | |
| Vertical for | rces on wall | | | | | | | | |
| Wall stem | | | w _{wall} = h _{sten} | $_{n} \times t_{wall} \times \gamma_{wall} =$ | 17.7 kN/m | | | | |
| Wall base | | | $w_{base} = I_{base}$ | $_{e} 	imes \mathbf{t}_{base} 	imes \gamma_{base}$ | = 23.6 kN/m | | | | |
| Surcharge | | | w _{sur} = Surc | harge × I _{heel} = | 8.5 kN/m | | | | |
| Moist back | fill to top of wall | | $w_{m_w} = I_{heel}$ | \times (h _{stem} - h _{sat}) | × γ _m = 15.3 kN/n | า | | | |
| Saturated b | backfill | | $w_s = I_{heel} \times$ | $h_{sat} \times \gamma_s = 26.8$ | B kN/m | | | | |
| Applied ver | tical load | | $W_v = W_{dead}$ | d + W _{live} = 16 k | :N/m | | | | |
| Total vertic | al load | | W _{total} = w _{wa} | all + Wbase + Wsu | r + w _{m_w} + w _s + W | / _v = 107.9 kN/n | า | | |
| Horizontal | forces on wall | | | | | | | | |
| Surcharge | | | F_{sur} = $K_a \times$ | cos(90 - α + δ |) $	imes$ Surcharge $	imes$ ł | n _{eff} = 10.6 kN/m | ı | | |
| Moist backfill above water table | | | $F_{m_a} = 0.5 \times K_a \times cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2 = 3.2 \text{ kN/m}$ | | | | | | |
| Moist backfill below water table | | | F _{m_b} = K _a × | cos(90 - α + a | δ) × γ_m × (h _{eff} - h _w | _{ater}) × h _{water} = 1 2 | 2.7 kN/m | | |
| Saturated b | backfill | | $F_s = 0.5 \times$ | $K_a 	imes cos(90 - cos)$ | α + δ) × (γs- γ _{water}) | × h _{water} ² = 7.9 | κN/m | | |
| Water | | $F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water} = 19.6 \text{ kN/m}$ | | | | | | | |
| Total horizo | ontal load | | $F_{total} = F_{sur}$ | + F _{m_a} + F _{m_b} · | + F _s + F _{water} = 53. | 9 kN/m | | | |
| Calculate | propping force | | | | | | | | |
| Passive res | sistance of soil in from | nt of wall | $F_p = 0.5 \times$ | $K_p \times cos(\delta_b) \times$ | (d _{cover} + t _{base} + d _d | s - d _{exc})² × γ _{mb} = | 3.2 kN/m | | |
| Propping for | orce | | F _{prop} = max | k(F _{total} - F _P - (W | / _{total} - W _{sur} - W _{live}) | × tan(δ₅), 0 kN/ | m) | | |
| | | | F _{prop} = 18.6 | 6 kN/m | | | | | |
| Overturnin | ig moments | | | | | | | | |
| Surcharge | | | $M_{sur} = F_{sur}$ | × (h _{eff} - 2 × d _{ds} | s) / 2 = 15.9 kNm | /m | | | |
| Moist back | fill above water table | | $M_{m_a} = F_{m_a}$ | $_{a} \times (h_{eff} + 2 \times h)$ | n_{water} - 3 \times d _{ds}) / 3 | = 7.4 kNm/m | | | |
| Moist back | fill below water table | | $M_{m_b} = F_{m_b}$ | $_{b} \times (h_{water} - 2 \times$ | d _{ds}) / 2 = 12.7 kM | Nm/m | | | |
| Saturated b | backfill | | $M_s = F_s \times ($ | h_{water} - $3 	imes d_{ds}$) | / 3 = 5.3 kNm/m | | | | |
| Water | | | $M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3 = 13.1 \text{ kNm/m}$ | | | | | | |
| Total overtu | urning moment | | $M_{ot} = M_{sur}$ - | + M _{m_a} + M _{m_b} | + M _s + M _{water} = 54 | 4.3 kNm/m | | | |
| Restoring | moments | | | | | | | | |
| Wall stem | | | $M_{wall} = W_{wal}$ | $_{\rm I} 	imes$ (I _{toe} + t _{wall} / 2 | 2) = 17.7 kNm/m | | | | |
| Wall base | | | M _{base} = w _{ba} | $_{\rm ase} \times I_{\rm base} / 2 = 2$ | 23.6 kNm/m | | | | |
| Moist back | fill | | M _{m_r} = (w _m | $_w \times (I_{base} - I_{heel})$ | /2) + $w_{m_s} \times (I_{bas}$ | _e - I _{heel} / 3)) = 2 | 4.1 kNm/m | | |
| Saturated b | backfill | | $M_{s_r} = w_s \times$ | (I _{base} - I _{heel} / 2) | = 42.2 kNm/m | | | | |
| Design vertical dead load | | | $M_{dead} = W_{d}$ | $_{\text{lead}} \times I_{\text{load}} = 12$ | kNm/m | | | | |
| Total restor | ring moment | | M _{rest} = M _{wa} | II + M _{base} + M _m | _r + Ms_r + M _{dead} = | 119.6 kNm/m | | | |
| Check bea | ring pressure | | | | | | | | |
| Surcharge | | | M _{sur_r} = w _{su} | $_{ m ir} 	imes$ (I _{base} - I _{heel} / | 2) = 13.4 kNm/n | n | | | |
| Design vert | tical live load | | M _{live} = W _{live} | e × I _{load} = 4 kNr | n/m | | | | |
| | | | | | | | | | |

Total moment for bearing Total vertical reaction Distance to reaction Eccentricity of reaction

Bearing pressure at toe Bearing pressure at heel

PASS - Maximum bearing pressure is less than allowable bearing pressure

Reaction acts within middle third of base

 $M_{total} = M_{rest} - M_{ot} + M_{sur_r} + M_{live} = 82.7 \text{ kNm/m}$

 $p_{toe} = (R / I_{base}) + (6 \times R \times e / I_{base}^2) = 91.7 \text{ kN/m}^2$

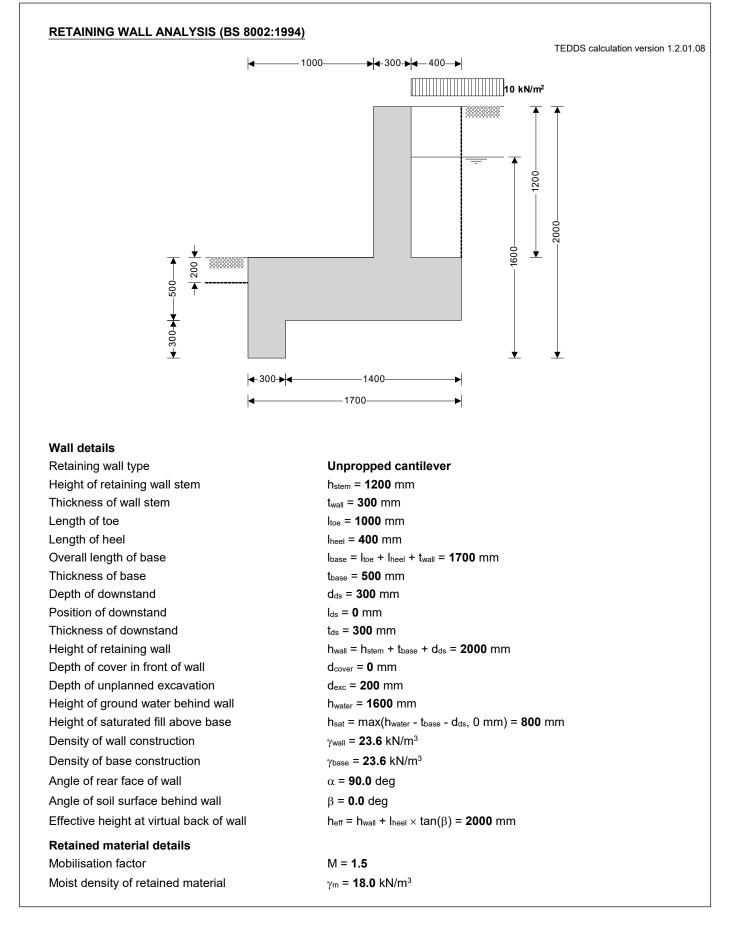
 $p_{\text{heel}} = (R \ / \ I_{\text{base}}) - (6 \times R \times e \ / \ I_{\text{base}}^2) = \textbf{16.1} \ kN/m^2$

R = W_{total} = **107.9** kN/m

 $x_{\text{bar}} = M_{\text{total}} / R = 766 \text{ mm}$

e = abs((I_{base} / 2) - x_{bar}) = **234** mm

| Tekla. Tedds | Project | Job no. 24078 | | | | |
|---|----------------|--------------------------|----------------|--------------|-------------------|---------------|
| ads consultancy 130 East Barnet Road | Calcs for F | Retaining Wall R | W4 - Prelimina | ry | Start page no./Re | evision 1 |
| EN4 8RE - New Barnet | Calcs by SN | Calcs date 13/12/2024 | Checked by | Checked date | Approved by | Approved date |



| ecta ledas | Project 253 Goldhurst Terrace | | | | | Job no. 24078 | | | |
|--------------------------------------|-------------------------------|--|--|--|--|---|--|--|--|
| 130 East Barnet Road | alcs for | Retaining Wall I | RW4 - Prelimiı | nary | Start page no./I | Start page no./Revision 2 | | | |
| EN4 8RE - New Barnet Ci | alcs by SN | Calcs date 13/12/2024 | Checked by | Checked date | Approved by | Approved date | | | |
| Saturated density of retained mate | erial | γ _s = 21.0 k | N/m ³ | | | | | | |
| Design shear strength | | φ' = 29.3 d | eg | | | | | | |
| Angle of wall friction | | δ = 18.6 de | ∋g | | | | | | |
| Base material details | | | | | | | | | |
| Firm clay | | | | | | | | | |
| Moist density | | γ _{mb} = 18.0 | | | | | | | |
| Design shear strength | | φ' _b = 24.2 c | leg | | | | | | |
| Design base friction | | δ _b = 18.6 deg | | | | | | | |
| Allowable bearing pressure | | P _{bearing} = 10 |)0 kN/m² | | | | | | |
| Using Coulomb theory | | | | | | | | | |
| Active pressure coefficient for reta | | | | | | | | | |
| | | $^{2} \times sin(\alpha - \delta) \times [1 - \delta]$ | + √(sin(φ' + δ) : | $\times \sin(\phi' - \beta) / (\sin \phi)$ | $(\alpha - \delta) \times \sin(\alpha +$ | $(\beta)))]^{2}) = 0.3$ | | | |
| Passive pressure coefficient for ba | | | | | /. . \ / / | a)))501 | | | |
| | K _p = sin | l(90 - φ'ь)² / (sin(90 |)- δ _Ϸ) × [1 - √(| $\sin(\phi_b + \delta_b) \times \sin(\phi_b + \delta_b)$ | (ф'ь) / (sin(90 + | δ _b)))] ²) = 4.1 | | | |
| At-rest pressure | | | | | | | | | |
| At-rest pressure for retained mater | rial | $K_0 = 1 - si$ | n(ø') = 0.511 | | | | | | |
| Loading details | | | | | | | | | |
| Surcharge load on plan | | Surcharge | = 10.0 kN/m ² | | | | | | |
| Applied vertical dead load on wall | | W _{dead} = 0.0 |) kN/m | | | | | | |
| Applied vertical live load on wall | | W _{live} = 0.0 | | | | | | | |
| Position of applied vertical load on | | I _{load} = 0 mn | | | | | | | |
| Applied horizontal dead load on wa | | F _{dead} = 0.0 | | | | | | | |
| Applied horizontal live load on wal | | F _{live} = 0.0 k | | | | | | | |
| Height of applied horizontal load o | n wali | h _{load} = 0 m | m | | | | | | |
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| | | | | 2.9 2.1 | | | | | |
| 42.9 | 29.4 | | 2 | 2.9 2.1 2.7 | 5.2 15.7 | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | Loads sho | wn in kN/m, pressu | res shown in kN | | | |
| Vertical forces on wall | | | | | · | | | | |
| Wall stem | | w _{wall} = h _{ster} | $1 \times t_{wall} \times \gamma_{wall} =$ | • 8.5 kN/m | | | | | |
| | | | | | | | | | |

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| Wall base | | W _{base} = I _{base} | $h_{a} \times \mathbf{t}_{base} \times \gamma_{base}$ | = 20.1 kN/m | | | | |
| Wall downstand | | | $t_{ds} \times \gamma_{base} = 2.$ | | | | | |
| Surcharge | | | harge × I _{heel} = | | | | | |
| Moist backfill to top of wall | | | - | × γ _m = 2.9 kN/m | | | | |
| Saturated backfill | | | $h_{sat} \times \gamma_s = 6.7$ | | | | | |
| Total vertical load | | | - | + W_{sur} + W_{m_w} + v | v _s = 44.3 kN/m | | | |
| Horizontal forces on wall | | | | | | | | |
| Surcharge | | Fsur = Ka × | cos(90 - α + δ |) × Surcharge × ł | n _{eff} = 5.8 kN/m | | | |
| Moist backfill above water table | | | $-\alpha + \delta$) × γ_m × (h _e | | i kN/m | | | |
| Moist backfill below water table | | — | • | δ) × γ_m × (h _{eff} - h _w | , | | | |
| Saturated backfill | | | | $(\iota + \delta) \times (\gamma_{s} - \gamma_{water})$ | | | | |
| Water | | | • | er = 12.6 kN/m | | | | |
| Total horizontal load | | | | + F _s + F _{water} = 26 . | 3 kN/m | | | |
| Calculate stability against slid | lina | | | | | | | |
| Passive resistance of soil in fro | | $F_{\rm p} = 0.5 \times 10^{-10}$ | $K_n \times \cos(\delta_n) \times \delta_n$ | (d _{cover} + t _{base} + d _d | s - dexc) ² × vmr = | = 12,9 kN/n | | |
| Resistance to sliding | $\begin{split} F_{p} &= 0.5 \times K_{p} \times \cos(\delta_{b}) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^{2} \times \gamma_{mb} = \textbf{12.9 kN/m} \\ F_{res} &= F_{p} + (W_{total} - w_{sur}) \times tan(\delta_{b}) = \textbf{26.4 kN/m} \end{split}$ | | | | | | | |
| i constantos to situlity | | ries – r p r | | esistance force | | n sliding f | | |
| Overturning moments | | | | | | | | |
| Surcharge | | M _{sur} = F _{sur} | \times (h _{eff} - 2 \times d _{ds} | s) / 2 = 4.1 kNm/r | n | | | |
| Moist backfill above water table | | $M_{m_a} = F_{m_a}$ | $_{a} \times (h_{eff} + 2 \times h)$ | lwater - $3 \times d_{ds}$) / 3 | = 0.6 kNm/m | | | |
| Moist backfill below water table | | $M_{m_b} = F_{m_b}$ | $_{\text{b}} 	imes$ (h _{water} - 2 $	imes$ | d _{ds}) / 2 = 1.7 kNi | m/m | | | |
| Saturated backfill | | $M_s = F_s \times (h_{water} - 3 \times d_{ds}) / 3 = 1 \text{ kNm/m}$ | | | | | | |
| Water | | M_{water} = $F_{water} \times (h_{water} - 3 \times d_{ds}) / 3 = 2.9 \text{ kNm/m}$ | | | | | | |
| Soil in front of wall | | $M_{p_o} = F_p \times [2 \times d_{ds} - t_{base} - d_{cover} + d_{exc}] \ / \ 3 = \textbf{1.3} \ kNm/m$ | | | | | | |
| Total overturning moment | | $M_{ot} = M_{sur} + $ | ⊦ M _{m_a} + M _{m_b} · | + M _s + M _{water} + M | _{p_o} = 11.5 kNm | /m | | |
| Restoring moments | | | | | | | | |
| Wall stem | | | | 2) = 9.8 kNm/m | | | | |
| Wall base | | | $_{\rm se} 	imes I_{\rm base} / 2 = 1$ | | | | | |
| Wall downstand | | | $(I_{ds} + t_{ds} / 2) =$ | | | | | |
| Moist backfill | | | | $/2) + W_{m_s} \times (I_{bas})$ | _e - I _{heel} / 3)) = 4 | .3 kNm/m | | |
| Saturated backfill | | | . , | = 10.1 kNm/m | | | | |
| Total restoring moment | | $M_{rest} = M_{wal}$ | I + M _{base} + M _{ds} | $+ M_{m_r} + M_{s_r} = 4$ | 1.5 kNm/m | | | |
| Check stability against overtu | Irning | | | | | | | |
| Total overturning moment | | M _{ot} = 11.5 | | | | | | |
| Total restoring moment | | M _{rest} = 41.5 | | | _ | _ | | |
| | | PASS | - Restoring m | noment is greate | er than overtu | rning mon | | |
| Check bearing pressure | | | | | | | | |
| Surcharge | | | | 2) = 6 kNm/m | | | | |
| Total moment for bearing | | | st - Mot + Msur_r | = 36 kNm/m | | | | |
| Total vertical reaction | | | 44.3 kN/m | | | | | |
| Distance to reaction | | | / R = 814 mm | 26 mm | | | | |
| Eccentricity of reaction | | e = abs((l _{ba} | _{ase} / 2) - x _{bar}) = | 36 mm Reaction acts | within middle | a third of l | | |
| | | | | Reaction acts | kN/m² | | | |

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Bearing pressure at heel

 p_{heel} = (R / I_{base}) - (6 × R × e / I_{base}^2) = 22.7 kN/m²

PASS - Maximum bearing pressure is less than allowable bearing pressure

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TEDDS calculation version 1.2.01.08

RETAINING WALL ANALYSIS (BS 8002:1994)

Wall details

Retaining wall type Height of retaining wall stem Thickness of wall stem Length of toe Length of heel Overall length of base Thickness of base Depth of downstand Position of downstand Thickness of downstand Height of retaining wall Depth of cover in front of wall Depth of unplanned excavation Height of ground water behind wall Height of saturated fill above base Density of wall construction Density of base construction Angle of rear face of wall Angle of soil surface behind wall Effective height at virtual back of wall

Retained material details Mobilisation factor

Moist density of retained material

Cantilever propped at top h_{stem} = **1725** mm t_{wall} = **250** mm $I_{toe} = 0 \text{ mm}$ I_{heel} = **500** mm $I_{\text{base}} = I_{\text{toe}} + I_{\text{heel}} + t_{\text{wall}} = 750 \text{ mm}$ t_{base} = **300** mm $d_{ds} = 0 \text{ mm}$ I_{ds} = **200** mm t_{ds} = **300** mm $h_{wall} = h_{stem} + t_{base} + d_{ds} = 2025 \text{ mm}$ d_{cover} = **150** mm d_{exc} = **0** mm h_{water} = **1500** mm h_{sat} = max(h_{water} - t_{base} - d_{ds}, 0 mm) = **1200** mm γ_{wall} = 23.6 kN/m³ γ_{base} = 23.6 kN/m³ α = **90.0** deg β = **0.0** deg $h_{eff} = h_{wall} + I_{heel} \times tan(\beta) = 2025 \text{ mm}$

M = **1.5** γ_m = **18.0** kN/m³

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| Saturated density of retained m | aterial | γ _s = 21.0 k | | | | |
| Design shear strength | | φ' = 29.3 d | eg | | | |
| Angle of wall friction | | δ = 22.8 de | eg | | | |
| Base material details | | | | | | |
| Firm clay | | | | | | |
| Moist density | | γ _{mb} = 18.0 | kN/m³ | | | |
| Design shear strength | | φ' _b = 24.2 c | deg | | | |
| Design base friction | | δ _b = 18.6 d | leg | | | |
| Allowable bearing pressure | | P _{bearing} = 1 | 00 kN/m² | | | |
| Using Coulomb theory | | | | | | |
| Active pressure coefficient for re | etained materia | l | | | | |
| $K_a = sin(\alpha)$ | + $\phi')^2 / (\sin(\alpha)^2)$ | $\times \sin(\alpha - \delta) \times [1 - \delta]$ | + √(sin(φ' + δ) > | sin(φ' - β) / (sin(| α - δ) × sin(α + | · β)))]²) = 0.304 |
| Passive pressure coefficient for | base material | | | | | |
| | K _p = sin(| 90 - φ' _b)² / (sin(90 | 0 - δ⊳) × [1 - √(s | $\sin(\phi_{\rm b} + \delta_{\rm b}) \times \sin(\phi_{\rm b})$ | φ' _b) / (sin(90 + | δ _b)))] ²) = 4.187 |
| At-rest pressure | | | | | | |
| At-rest pressure for retained ma | aterial | K ₀ = 1 – si | n(ǫ') = 0.511 | | | |
| Loading details | | | | | | |
| Surcharge load on plan | | Surcharge | = 10.0 kN/m ² | | | |
| Applied vertical dead load on w | all | W _{dead} = 0.0 | | | | |
| Applied vertical live load on wa | | W _{live} = 0.0 | | | | |
| Position of applied vertical load | | $I_{load} = 0 mn$ | | | | |
| Applied horizontal dead load on | | F _{dead} = 0.0 | | | | |
| Applied horizontal live load on v | | F _{live} = 0.0 k | ۸۷/m | | | |
| Height of applied horizontal load | d on wall | h _{load} = 0 mi | | | | |
| | | | 10 | | | |
| | Prop — | 1 | | l. | | |
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| | 32.1 87.1 | 7 | 2.8 | 2.6 4.7 14.7 | _ | |
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| | | | | | | |
| | | | | Loads show | wn in kiw/m, pressu | res shown in kN/m ² |

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| Vertical forces on wall | | | | | | | | |
| Wall stem | | w | $\times t_{wall} \times \gamma_{wall} =$ | 10 2 kN/m | | | | |
| Wall base | | | \times t _{base} \times γ _{base} | | | | | |
| Surcharge | | | harge \times I _{heel} = | | | | | |
| Moist backfill to top of wall | | $w_{m_w} = I_{heel}$ | × (h _{stem} - h _{sat}) : | × γ _m = 4.7 kN/m | ‹N/m | | | |
| Saturated backfill | | $w_s = I_{heel} \times I_{heel}$ | $w_s = l_{heel} \times h_{sat} \times \gamma_s = 12.6 \text{ kN/m}$ | | | | | |
| Total vertical load | | W _{total} = w _{wa} | II + Wbase + Wsur | v _{sur} + w _{m_w} + w _s = 37.8 kN/m | | | | |
| Horizontal forces on wall | | | | | | | | |
| Surcharge | | $F_{sur} = K_a \times K_a$ | F_{sur} = K _a × cos(90 - α + δ) × Surcharge × h _{eff} = 5.7 kN/m | | | | | |
| Moist backfill above water table | | | | | L \2 | | | |

Moist backfill above water table Moist backfill below water table Saturated backfill Water Total horizontal load

Calculate propping force

Passive resistance of soil in front of wall Propping force

Overturning moments

Surcharge Moist backfill above water table Moist backfill below water table Saturated backfill Water Total overturning moment

Restoring moments

Wall stem Wall base Moist backfill Saturated backfill Total restoring moment

Check bearing pressure

Propping force Surcharge Total moment for bearing Total vertical reaction Distance to reaction Eccentricity of reaction

Bearing pressure at toe Bearing pressure at heel
$$\begin{split} F_{p} &= 0.5 \times K_{p} \times cos(\delta_{b}) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^{2} \times \gamma_{mb} = \textbf{7.2 kN/m} \\ F_{prop} &= max(F_{total} - F_{p} - (W_{total} - w_{sur}) \times tan(\delta_{b}), \ 0 \ kN/m) \\ F_{prop} &= \textbf{6.6 kN/m} \end{split}$$

 $F_{m b} = K_a \times cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water} = 4 \text{ kN/m}$

 $F_s = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times (\gamma_s - \gamma_{water}) \times h_{water}^2 = 3.5 \text{ kN/m}$

 $F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water} = \textbf{11} \text{ kN/m}$

 $F_{total} = F_{sur} + F_{m a} + F_{m b} + F_{s} + F_{water} = 24.9 \text{ kN/m}$

$$\begin{split} M_{sur} &= F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2 = \textbf{5.7 kNm/m} \\ M_{m_a} &= F_{m_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3 = \textbf{1.2 kNm/m} \\ M_{m_b} &= F_{m_b} \times (h_{water} - 2 \times d_{ds}) / 2 = \textbf{3 kNm/m} \\ M_{s} &= F_{s} \times (h_{water} - 3 \times d_{ds}) / 3 = \textbf{1.8 kNm/m} \\ M_{water} &= F_{water} \times (h_{water} - 3 \times d_{ds}) / 3 = \textbf{5.5 kNm/m} \\ M_{ot} &= M_{sur} + M_{m_a} + M_{m_b} + M_{s} + M_{water} = \textbf{17.2 kNm/m} \end{split}$$

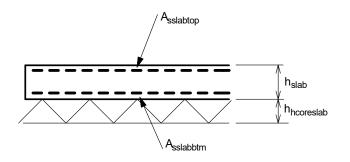
$$\begin{split} M_{wall} &= w_{wall} \times (I_{toe} + t_{wall} / 2) = \textbf{1.3 kNm/m} \\ M_{base} &= w_{base} \times I_{base} / 2 = \textbf{2 kNm/m} \\ M_{m_r} &= (w_{m_w} \times (I_{base} - I_{heel} / 2) + w_{m_s} \times (I_{base} - I_{heel} / 3)) = \textbf{2.4 kNm/m} \\ M_{s_r} &= w_s \times (I_{base} - I_{heel} / 2) = \textbf{6.3 kNm/m} \\ M_{rest} &= M_{wall} + M_{base} + M_{m_r} + M_{s_r} = \textbf{11.9 kNm/m} \end{split}$$

$$\begin{split} \mathsf{M}_{\text{prop}} &= \mathsf{F}_{\text{prop}} \times (\mathsf{h}_{\text{wall}} - \mathsf{d}_{\text{ds}}) = \textbf{13.4 kNm/m} \\ \mathsf{M}_{\text{sur}_r} &= \mathsf{w}_{\text{sur}} \times (\mathsf{I}_{\text{base}} - \mathsf{I}_{\text{heel}} / 2) = \textbf{2.5 kNm/m} \\ \mathsf{M}_{\text{total}} &= \mathsf{M}_{\text{rest}} - \mathsf{M}_{\text{ot}} + \mathsf{M}_{\text{prop}} + \mathsf{M}_{\text{sur}_r} = \textbf{10.7 kNm/m} \\ \mathsf{R} &= \mathsf{W}_{\text{total}} = \textbf{37.8 kN/m} \\ \mathsf{x}_{\text{bar}} &= \mathsf{M}_{\text{total}} / \mathsf{R} = \textbf{283 mm} \\ \mathsf{e} &= \mathsf{abs}((\mathsf{I}_{\text{base}} / 2) - \mathsf{x}_{\text{bar}}) = \textbf{92 mm} \\ \hline \textit{Reaction acts within middle third of base} \\ \mathsf{p}_{\text{toe}} &= (\mathsf{R} / \mathsf{I}_{\text{base}}) + (\mathsf{6} \times \mathsf{R} \times \mathsf{e} / \mathsf{I}_{\text{base}}^2) = \textbf{87.7 kN/m}^2 \\ \mathsf{p}_{\text{heel}} &= (\mathsf{R} / \mathsf{I}_{\text{base}}) - (\mathsf{6} \times \mathsf{R} \times \mathsf{e} / \mathsf{I}_{\text{base}}^2) = \textbf{13.2 kN/m}^2 \\ \hline \textit{PASS} - \textit{Maximum bearing pressure is less than allowable bearing pressure} \end{split}$$

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RAFT FOUNDATION DESIGN (BS8110 : PART 1 : 1997)

Tedds calculation version 1.0.13



Soil and raft definition

| Soil definition | |
|---|---|
| Allowable bearing pressure | q _{allow} = 50.0 kN/m ² |
| Number of types of soil forming sub-soil | One type only |
| Soil density | Firm |
| Depth of hardcore beneath slab | $h_{hcoreslab} = 0 \text{ mm}$ (Dispersal allowed for bearing pressure check) |
| Density of hardcore | γ _{hcore} = 20.0 kN/m ³ |
| Basic assumed diameter of local depression | φ _{depbasic} = 1500 mm |
| Diameter under slab modified for hardcore | $\phi_{depslab} = \phi_{depbasic} - h_{hcoreslab} = 1500 \text{ mm}$ |
| Raft slab definition | |
| Max dimension/max dimension between joints | I _{max} = 5.000 m |
| Slab thickness | h _{slab} = 200 mm |
| Concrete strength | f _{cu} = 40 N/mm ² |
| Poissons ratio of concrete | v = 0.2 |
| Slab mesh reinforcement strength | f _{yslab} = 500 N/mm ² |
| Partial safety factor for steel reinforcement | γ _s = 1.15 |
| From C&CA document 'Concrete ground floors' Ta | ble 5 |
| Minimum mesh required in top for shrinkage | A142 |
| Actual mesh provided in top | A393 (A _{sslabtop} = 393 mm ² /m) |
| Mesh provided in bottom | A393 (A _{sslabbtm} = 393 mm²/m) |
| Top mesh bar diameter | $\phi_{\text{slabtop}} = 10 \text{ mm}$ |
| Bottom mesh bar diameter | φ _{slabbtm} = 10 mm |
| Cover to top reinforcement | c _{top} = 35 mm |
| Cover to bottom reinforcement | c _{btm} = 50 mm |
| Average effective depth of top reinforcement | $d_{tslabav} = h_{slab} - c_{top} - \phi_{slabtop} = 155 \text{ mm}$ |
| Average effective depth of bottom reinforcement | $d_{bslabav} = h_{slab} - c_{btm} - \phi_{slabbtm} = 140 \text{ mm}$ |
| Overall average effective depth | $d_{slabav} = (d_{tslabav} + d_{bslabav})/2 = 148 \text{ mm}$ |
| Minimum effective depth of top reinforcement | $d_{tslabmin} = d_{tslabav} - \phi_{slabtop}/2 = 150 \text{ mm}$ |
| Minimum effective depth of bottom reinforcement | $d_{bslabmin} = d_{bslabav} - \phi_{slabbtm}/2 = 135 \text{ mm}$ |
| Slab edge reinforcement | |
| Mesh provided in top | A393 (A _{sedgetop} = 393 mm ² /m) |
| Mesh provided in bottom | A393 (A _{sedgebtm} = 393 mm²/m) |
| | |

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| 130 East Barnet Road | Grou | und Bearing Base | nd Bearing Basement Slab - Preliminary | | | 2 | |
| New Barnet Herts - EN4 8RE | Calcs by SN | Calcs date 09/12/2024 | Checked by | Checked date | Approved by | Approved date | |
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| Internal slab design checks | | | | | | | |
| Basic loading | | | | | | | |
| Slab self weight | w _{slab} = 24 k | $N/m^3 \times h_{slab} = 4$ | 4.8 kN/m² | | | | |
| lardcore Whoreslab = | | | $h_{hcore} 	imes h_{hcoreslab}$ | = 0.0 kN/m ² | | | |
| Applied loading | | | | | | | |
| Uniformly distributed dead load | w _{Dudl} = 3.0 | | | | | | |
| Uniformly distributed live load | w _{Ludl} = 1.5 | kN/m² | | | | | |
| Internal slab bearing pressure | check | | | | | | |
| Total uniform load at formation lo | evel | $w_{udl} = w_{slab}$ | + W _{hcoreslab} + W _[| Dudl + WLudl = 9.3 | kN/m² | | |
| | | $PASS - W_{udl} <$ | = q _{allow} - Appli | ied bearing pres | ssure is less t | han allowab | |
| Internal slab bending and she | ar check | | | | | | |
| Applied bending moments | | | | | | | |
| Span of slab | | I _{slab} = φ _{depsla} | ub + d _{tslabav} = 16 | 55 mm | | | |
| Ultimate self weight udl | w_{swult} = 1.4 × w_{slab} = 6.7 kN/m ² | | | | | | |
| Self weight moment at centre | M _{csw} = w _{swu} | $I_{It} \times I_{slab}^2 \times (1 + 1)$ | v) / 64 = 0.3 kNn | n/m | | | |
| Self weight moment at edge | M _{esw} = w _{swu} | $I_{slab}^2 / 32 =$ | 0.6 kNm/m | | | | |
| Self weight shear force at edge | V _{sw} = w _{swult} | \times I _{slab} / 4 = 2.8 | kN/m | | | | |
| Moments due to applied unifo | rmly distribu | ted loads | | | | | |
| Ultimate applied udl | - | | \times W _{Dudl} + 1.6 \times | w _{Ludl} = 6.6 kN/m | 1 ² | | |
| Moment at centre | | $M_{cudl} = W_{udlt}$ | $_{\rm ult} 	imes {\rm I}_{\rm slab}^2 	imes (1 +$ | v) / 64 = 0.3 kNr | m/m | | |
| Moment at edge | | $M_{eudl} = W_{udlult} \times I_{slab}^2 / 32 = 0.6 \text{ kNm/m}$ | | | | | |
| Shear force at edge | | $V_{udl} = w_{udlult} \times I_{slab} / 4 = 2.7 \text{ kN/m}$ | | | | | |
| Resultant moments and shear | s | | | | | | |
| Total moment at edge | | M _{Σe} = 1.1 kNm/m | | | | | |
| Total moment at centre | | M _{Σc} = 0.7 kNm/m | | | | | |
| Total shear force | | V _Σ = 5.5 kN/m | | | | | |
| Reinforcement required in top | | | | | | | |
| K factor | | K _{slabtop} = M ₂ | $\epsilon_{e}/(f_{cu} \times d_{tslabav}^2)$ |) = 0.001 | | | |
| Lever arm | | $z_{slabtop} = d_{tslabav} \times min(0.95, 0.5 + \sqrt{(0.25 - K_{slabtop}/0.9))} =$ 147.3 mm | | | | | |
| Area of steel required for bending | | $A_{sslabtopbend} = M_{\Sigma e}/((1.0/\gamma_s) \times f_{yslab} \times z_{slabtop}) = 18 \text{ mm}^2/\text{m}$ | | | | | |
| Minimum area of steel required | | $A_{sslabmin} = 0.0013 \times h_{slab} = 260 \text{ mm}^2/\text{m}$ | | | | | |
| Area of steel required | | A _{sslabtopreq} = max(A _{sslabtopbend} , A _{sslabmin}) = 260 mm ² /m | | | | | |
| PASS - Asslabtopreq <= , | A _{sslabtop} - Area | a of reinforceme | nt provided in | top to span loc | al depressior | ns is adequa | |
| Reinforcement required in bot | tom | | | | | | |
| K factor | $K_{slabbtm} = M_{\Sigma c}/(f_{cu} \times d_{bslabav}^2) = 0.001$ | | | | | | |
| Lever arm | $z_{slabbtm}$ = d _{bslabav} × min(0.95, 0.5 + $\sqrt{(0.25 - K_{slabbtm}/0.9))}$ = 133.0 mm | | | | | | |
| Area of steel required for bendin | g | $A_{sslabbtmbend} = M_{\Sigma c}/((1.0/\gamma_s) \times f_{yslab} \times z_{slabbtm}) = 12 \text{ mm}^2/\text{m}$ | | | | | |
| Area of steel required | | A _{sslabbtmreq} = max(A _{sslabbtmbend} , A _{sslabmin}) = 260 mm ² /m | | | | | |
| PASS - Asslabbtmreq <= Asslab | btm - Area of | reinforcement pr | rovided in bot | tom to span loc | al depressior | ns is adequa | |
| Shear check | | | | | | | |
| Applied shear stress | | $v = V_{\Sigma}/d_{tslabmin} = 0.037 \text{ N/mm}^2$ | | | | | |
| Tension steel ratio | | ρ = 100 × A _{sslabtop} /d _{tslabmin} = 0.262 | | | | | |

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| New Barnet Herts - EN4 8RE | Calcs by SN | Calcs date 09/12/2024 | Checked by | Checked date | Approved by | Approved | |
| From BS8110-1:1997 - Table 3.8 | 3 | | | | | | |
| Design concrete shear strength | | v _c = 0.604 | | | | | |
| | | | PASS - v <= | v _c - Shear capa | acity of the sla | ıb is adeqı | |
| Internal slab deflection check | | | | | | | |
| Basic allowable span to depth ratio | | Ratio _{basic} = | | | | | |
| Moment factor | | | $d_{bslabav}^2 = 0.0$ | | 2 1 1/2 | | |
| Steel service stress | | | | $nd/A_{sslabbtm} = 10.03$ | | 2.14 | |
| Modification factor | $\begin{split} MF_{slab} &= min(2.0, 0.55 + [(477 N/mm^2 - f_s)/(120 \times (0.9 N/mm^2 + M_{factor}) \\ MF_{slab} &= \textbf{2.000} \end{split}$ | | | | | | |
| Modified allowable span to depth | n ratio | Ratio _{allow} = | $Ratio_{\text{basic}} \times MF$ | slab = 52.000 | | | |
| Actual span to depth ratio | | | = I _{slab} / d _{bslabav} = | | | | |
| | | PASS - Rat | tio _{actual} <= Rati | o _{allow} - Slab spa | n to depth rat | io is adequ | |
| Slab edge design checks | | | | | | | |
| Basic loading | | | | | | | |
| Hardcore | | $W_{hcoreslab} = \gamma_{hcore} \times h_{hcoreslab} = 0.0 \text{ kN/m}^2$ | | | | | |
| Slab self weight | $w_{slab} = 24 \text{ kN/m}^3 \times h_{slab} = 4.8 \text{ kN/m}^2$ | | | | | | |
| Slab edge bearing pressure ch | neck | | | | | | |
| Total uniform load at formation le | | Wudledge = W | /Dudi + Windi + W | _{slab} + W _{hcoreslab} = 9 |).3 kN/m ² | | |
| | | 5 | | | | | |
| | | PASS - Wudledge < | <= q _{allow} - Appl | ied bearing pres | ssure is less t | han allowa | |
| Slab edge bending check | | PASS - Wudledge < | <= q _{allow} - Appl | ied bearing pres | ssure is less t | han allowa | |
| Slab edge bending check Considering a 1.0m width of slab |) | PASS - Wudledge < | <= q _{allow} - Appl | ied bearing pres | ssure is less t | han allowa | |
| • • | | PASS - W _{udledge} < β _{udl} = 10.0 | <= q _{allow} - Appl | ied bearing pres | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's | | | <= q _{allow} - Appl | ied bearing pres | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments | | β _{udl} = 10.0 | | | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab | | $\beta_{udi} = 10.0$ $I_{edge} = \phi_{deps}$ | lab + dtslabmin = 1 | 1 650 mm | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab Ultimate self weight udl | | $\beta_{udl} = 10.0$ $I_{edge} = \phi_{deps}$ $W_{edgeult} = 1.$ | $_{lab}$ + $d_{tslabmin}$ = 1 4 × w_{slab} = 6.7 | 1 650 mm kN/m² | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab | | β _{udi} = 10.0 I _{edge} = φ _{deps} W _{edgeult} = 1. M _{edgesw} = w | $_{ m lab}$ + d _{tslabmin} = 1 4 × W _{slab} = 6.7 /edgeult × ledge ² /10 | 1 650 mm kN/m² 0 = 1.8 kNm/m | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab Ultimate self weight udl Self weight bending moment Self weight shear force | | $\beta_{udl} = 10.0$ $l_{edge} = \phi_{deps}$ $w_{edgeult} = 1.$ $M_{edgesw} = w$ $V_{edgesw} = w$ | $_{lab}$ + $d_{tslabmin}$ = 1 4 × w_{slab} = 6.7 | 1 650 mm kN/m² 0 = 1.8 kNm/m | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab Ultimate self weight udl Self weight bending moment Self weight shear force Moments due to applied unifor | | β _{udi} = 10.0 I _{edge} = φ _{deps} W _{edgeult} = 1. M _{edgesw} = w V _{edgesw} = w | lab + d _{tslabmin} = 1 4 × W _{slab} = 6.7 /edgeult × ledge ² /10 /edgeult × ledge/2 = | 1 650 mm kN/m ² D = 1.8 kNm/m = 5.5 kN/m | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab Ultimate self weight udl Self weight bending moment Self weight shear force Moments due to applied unifor Ultimate udl | | $\beta_{udl} = 10.0$ $I_{edge} = \phi_{deps}$ $w_{edgeult} = 1.$ $M_{edgesw} = w$ $V_{edgesw} = w$ ited loads $W_{edgeudl} = w$ | lab + d _{tslabmin} = 1 4 × w _{slab} = 6.7 /edgeult × ledge ² /10 /edgeult × ledge/2 = /udlult = 6.6 kN/r | 1 650 mm kN/m ² D = 1.8 kNm/m = 5.5 kN/m | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab Ultimate self weight udl Self weight bending moment Self weight shear force Moments due to applied unifor | | $\beta_{udi} = 10.0$ $l_{edge} = \phi_{deps}$ $w_{edgeult} = 1.$ $M_{edgesw} = w$ $V_{edgesw} = w$ ited loads $w_{edgeudl} = w$ | _{lab} + d _{tslabmin} = 1 4 × W _{slab} = 6.7 /edgeult × ledge ² /10 /edgeult × ledge/2 = /udlult = 6.6 kN/r Vedgeudl × ledge ² /β | 1650 mm kN/m ² 0 = 1.8 kNm/m = 5.5 kN/m m ² i _{udl} = 1.8 kNm/m | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab Ultimate self weight udl Self weight bending moment Self weight shear force Moments due to applied unifor Ultimate udl Bending moment Shear force | rmly distribu | $\beta_{udi} = 10.0$ $l_{edge} = \phi_{deps}$ $w_{edgeult} = 1.$ $M_{edgesw} = w$ $V_{edgesw} = w$ ited loads $w_{edgeudl} = w$ | lab + d _{tslabmin} = 1 4 × w _{slab} = 6.7 /edgeult × ledge ² /10 /edgeult × ledge/2 = /udlult = 6.6 kN/r | 1650 mm kN/m ² 0 = 1.8 kNm/m = 5.5 kN/m m ² i _{udl} = 1.8 kNm/m | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab Ultimate self weight udl Self weight bending moment Self weight shear force Moments due to applied unifor Ultimate udl Bending moment Shear force Resultant moments and shear | rmly distribu s | $\beta_{udi} = 10.0$ $I_{edge} = \phi_{deps}$ $W_{edgeult} = 1.$ $M_{edgesw} = W$ $V_{edgesw} = W$ $Ited loads$ $W_{edgeudi} = W$ $M_{edgeudi} = W$ $V_{edgeudi} = W$ | lab + dtslabmin = 1 4 × Wslab = 6.7 /edgeult × ledge ² /10 /edgeult × ledge/2 = /udlult = 6.6 kN/r Vedgeudi × ledge ² /2 /edgeudi × ledge ² /2 | 1650 mm kN/m ² 0 = 1.8 kNm/m = 5.5 kN/m m ² i _{udl} = 1.8 kNm/m | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab Ultimate self weight udl Self weight bending moment Self weight shear force Moments due to applied unifor Ultimate udl Bending moment Shear force | rmly distribu s | $\beta_{udl} = 10.0$ $l_{edge} = \phi_{deps}$ $w_{edgeult} = 1.$ $M_{edgesw} = w$ $V_{edgesw} = w$ $ited \ loads$ $w_{edgeudl} = w$ $M_{edgeudl} = w$ $V_{edgeudl} = w$ | lab + d _{tslabmin} = 1 4 × w _{slab} = 6.7 /edgeult × ledge ² /10 /edgeult × ledge/2 = /udiult = 6.6 kN/r Vedgeudi × ledge ² /2 /edgeudi × ledge/2 = | 1650 mm kN/m ² 0 = 1.8 kNm/m = 5.5 kN/m m ² i _{udl} = 1.8 kNm/m | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab Ultimate self weight udl Self weight bending moment Self weight shear force Moments due to applied unifor Ultimate udl Bending moment Shear force Resultant moments and shear Total moment (hogging and sage Maximum shear force | rmly distribu s ging) | $\beta_{udi} = 10.0$ $I_{edge} = \phi_{deps}$ $W_{edgeult} = 1.$ $M_{edgesw} = W$ $V_{edgesw} = W$ $Ited loads$ $W_{edgeudi} = W$ $M_{edgeudi} = W$ $V_{edgeudi} = W$ | lab + d _{tslabmin} = 1 4 × w _{slab} = 6.7 /edgeult × ledge ² /10 /edgeult × ledge/2 = /udiult = 6.6 kN/r Vedgeudi × ledge ² /2 /edgeudi × ledge/2 = | 1650 mm kN/m ² 0 = 1.8 kNm/m = 5.5 kN/m m ² i _{udl} = 1.8 kNm/m | ssure is less t | han allowa | |
| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab Ultimate self weight udl Self weight bending moment Self weight shear force Moments due to applied unifor Ultimate udl Bending moment Shear force Resultant moments and shear Total moment (hogging and sage Maximum shear force Reinforcement required in top | rmly distribu s ging) | $\beta_{udl} = 10.0$ $l_{edge} = \phi_{deps}$ $w_{edgeult} = 1.$ $M_{edgesw} = w$ $V_{edgesw} = w$ $ted loads$ $w_{edgeudl} = w$ $M_{edgeudl} = w$ $V_{edgeudl} = w$ $V_{edgeudl} = 1.$ | lab + d _{tslabmin} = 1 4 × w _{slab} = 6.7 /edgeult × ledge ² /10 /edgeult × ledge/2 = /udlult = 6.6 kN/r Vedgeudl × ledge/2 /edgeudl × ledge/2 6 kNm/m .0 kN/m | 1650 mm kN/m ² D = 1.8 kNm/m = 5.5 kN/m m ² _{budl} = 1.8 kNm/m = 5.4 kN/m | ssure is less t | han allowa | |
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| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab Ultimate self weight udl Self weight bending moment Self weight shear force Moments due to applied unifor Ultimate udl Bending moment Shear force Resultant moments and shear Total moment (hogging and sage Maximum shear force Reinforcement required in top K factor Lever arm Area of steel required for bending | rmly distribu s ging) | $\beta_{udi} = 10.0$ $l_{edge} = \phi_{deps}$ $w_{edgeult} = 1.$ $M_{edgesw} = w$ $V_{edgesw} = w$ $V_{edgesw} = w$ $M_{edgeudi} = w$ $M_{edgeudi} = w$ $V_{edgeudi} = w$ $M_{\Sigma edge} = 3.0$ $V_{\Sigma edge} = 11$ $K_{edgetop} = M$ $Z_{edgetop} = dt$ $A_{sedgetopbend}$ | $lab + d_{tslabmin} = 1$ $4 \times w_{slab} = 6.7$ $ledgeult \times ledge2/10$ $redgeult \times ledge/2 = 1$ $ludlult = 6.6 \text{ kN/r}$ $redgeudl \times ledge2/2$ 6 kNm/m 0 kN/m $l_{\Sigma edge}/(f_{cu} \times d_{tslatslabmin} \times min(0.5)$ $r = M_{\Sigma edge}/((1.0))$ | 1650 mm kN/m ² D = 1.8 kNm/m 5.5 kN/m n ² hudi = 1.8 kNm/m = 5.4 kN/m pomin ²) = 0.004 pomin ² | • K _{edgetop} /0.9)) = _{op}) = 59 mm²/m | • 143 mm | |
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| Considering a 1.0m width of slab Divider for moments due to udl's Applied bending moments Span of slab Ultimate self weight udl Self weight bending moment Self weight shear force Moments due to applied unifor Ultimate udl Bending moment Shear force Resultant moments and shear Total moment (hogging and sage Maximum shear force Reinforcement required in top K factor Lever arm Area of steel required for bendin Area of steel required | rmly distribu s ging) g SS - Asedgetor | $\beta_{udl} = 10.0$ $l_{edge} = \phi_{deps}$ $W_{edgeult} = 1.$ $M_{edgesw} = W$ $V_{edgesw} = W$ $Medgeudl = W$ $M_{edgeudl} = W$ $V_{edgeudl} = W$ $M_{edgeudl} = W$ $M_{zedge} = 3.$ $V_{zedge} = 11$ $K_{edgetop} = M$ $Z_{edgetop} = dt$ $A_{sedgetopreq} = 0$ $d_{sedgetopreq} = 0$ | $lab + d_{tslabmin} = f$ $4 \times w_{slab} = 6.7$ $/edgeult \times ledge^2/10$ $/edgeult \times ledge/2 =$ $/udlutt = 6.6 kN/r$ $/edgeudt \times ledge/2$ $/edgeudt \times ledge/2$ $6 kNm/m$ $0 kN/m$ $f_{\Sigma edge}/(f_{cu} \times d_{tslatslabmin} \times min(0.5)$ $h = M_{\Sigma edge}/((1.0))$ $= max(A_{Sedgetopt})$ $A_{\Sigma edge}/(f_{cu} \times d_{bslabmin})$ | 1650 mm kN/m ² D = 1.8 kNm/m = 5.5 kN/m m ² mul = 1.8 kNm/m = 5.4 kN/m bmin ²) = 0.004 D5, 0.5 + √(0.25 - 1/3) × fyslab × Zedgeto pend, Asslabmin) = 26 comment provide | • K _{edgetop} /0.9)) = _{op}) = 59 mm²/m 50 mm²/m 50 mm²/m 50 mm²/m | 143 mm hb is adequ | |

| Area of steel required | sedgebtmreq <= | Ad Bearing Based Calcs date 09/12/2024 Asedgebtmred = Asedgebtm - Area Vedge = VΣed pedge = 100 V _{cedge} = 0.66 PASS - Va Ratio _{basicedg} M _{factoredge} = | Checked by = max(A _{sedgebtm} of reinforcem _{ige} × 1.0m/(100 × A _{sedgetop} × 1. 04 N/mm ² _{edge} <= v _{cedge} - | eliminary Checked date checked checked checked checked checked checked checked checked checked checked checked checked checked checked | Start page no./F Approved by 60 mm ² /m bottom of sla = 0.073 N/mm ² d _{tslabmin}) = 0.262 | 4 Approved d | |
|---|--|---|---|---|---|---------------------------------------|--|
| Area of steel required Area of steel required Area of steel required Applied shear stress Tension steel ratio From BS8110-1:1997 - Table 3.8 Design concrete shear strength Slab edge deflection check Basic allowable span to depth ratio Moment factor Steel service stress Modification factor Modified allowable span to depth ratio | Grour alcs by SN sedgebtmreq <= | Calcs date 09/12/2024 Asedgebtmr - Area $v_{edge} = V_{\Sigma ed}$ $\rho_{edge} = 100$ $v_{cedge} = 0.60$ PASS - v_{ed} Ratiobasicedg Mfactoredge = | Checked by = max(A _{sedgebtm} of reinforcem _{ige} × 1.0m/(100 × A _{sedgetop} × 1. 04 N/mm ² _{edge} <= v _{cedge} - | Checked date (hecked date (head) = 2 (head) (here) = 2 (here) | Approved by 60 mm ² /m bottom of sla = 0.073 N/mm ² d _{tslabmin}) = 0.262 | 4 Approved d | |
| New Barnet Ca Herts - EN4 8RE Ca Area of steel required PASS - As Applied shear stress Pass - As Tension steel ratio From BS8110-1:1997 - Table 3.8 Design concrete shear strength Slab edge deflection check Basic allowable span to depth ratio Moment factor Steel service stress Modification factor Modified allowable span to depth ratio Modepth ratio | sedgebtmreq <= | Calcs date 09/12/2024 Asedgebtmr - Area $v_{edge} = V_{\Sigma ed}$ $\rho_{edge} = 100$ $v_{cedge} = 0.60$ PASS - v_{ed} Ratiobasicedg Mfactoredge = | Checked by = max(A _{sedgebtm} of reinforcem _{ige} × 1.0m/(100 × A _{sedgetop} × 1. 04 N/mm ² _{edge} <= v _{cedge} - | Checked date (hecked date (head) = 2 (head) (here) = 2 (here) | 60 mm ² /m <i>bottom of sla</i> = 0.073 N/mm ² d _{tslabmin}) = 0.262 | Approved d | |
| Herts - EN4 8RE Area of steel required PASS - As Applied shear stress Tension steel ratio From BS8110-1:1997 - Table 3.8 Design concrete shear strength Slab edge deflection check Basic allowable span to depth ratio Moment factor Steel service stress Modification factor Modified allowable span to depth ratio | SN sedgebtmreq <= | 09/12/2024 Asedgebtmred = Asedgebtm - Area Vedge = VΣed pedge = 100 Vcedge = 0.64 PASS - Va Ratiobasicedg Mfactoredge = | = max(A _{sedgebtm} of reinforcem _{ge} × 1.0m/(100 × A _{sedgetop} × 1. 04 N/mm ² _{edge} <= v _{cedge} - | abend, A _{sslabmin}) = 2 ent provided in 0mm × d _{tslabmin}) = 0m/(1000mm × d | 60 mm ² /m <i>bottom of sla</i> = 0.073 N/mm ² d _{tslabmin}) = 0.262 | b is adequ | |
| PASS - As Applied shear stress Tension steel ratio From BS8110-1:1997 - Table 3.8 Design concrete shear strength Slab edge deflection check Basic allowable span to depth ratio Moment factor Steel service stress Modification factor | | Asedgebtm - Area $V_{edge} = V_{\Sigmaed}$ $\rho_{edge} = 100$ $V_{cedge} = 0.64$ <i>PASS</i> - V_{edge} Ratiobasicedg $M_{factoredge} = 0$ | of reinforcem Ige × 1.0m/(100 × A _{sedgetop} × 1. 04 N/mm ² Igedge <= v _{cedge} - | e nt provided in 0mm × d _{tslabmin}) = 0m/(1000mm × c | bottom of sla = 0.073 N/mm ² d _{tslabmin}) = 0.262 | 2 | |
| Applied shear stress Tension steel ratio From BS8110-1:1997 - Table 3.8 Design concrete shear strength Slab edge deflection check Basic allowable span to depth ratio Moment factor Steel service stress Modification factor Modified allowable span to depth ratio | | $v_{edge} = V_{\Sigma edg}$ $\rho_{edge} = 100$ $v_{cedge} = 0.60$ <i>PASS - v</i> Ratio _{basicedg} M _{factoredge} = | _{lge} × 1.0m/(100 × A _{sedgetop} × 1. 04 N/mm ² _{edge} <= v _{cedge} - | 0mm × d _{tslabmin}) = 0m/(1000mm × c | = 0.073 N/mm ² d _{tslabmin}) = 0.262 | 2 | |
| Tension steel ratio From BS8110-1:1997 - Table 3.8 Design concrete shear strength Slab edge deflection check Basic allowable span to depth ratio Moment factor Steel service stress Modification factor Modified allowable span to depth ratio |) | ρ _{edge} = 100 v _{cedge} = 0.6 <i>PASS</i> - v _o Ratio _{basicedg} M _{factoredge} = | × A _{sedgetop} × 1. 04 N/mm ² _{edge} <= v _{cedge} - | 0m/(1000mm × c | d _{tslabmin}) = 0.262 | 2 | |
| From BS8110-1:1997 - Table 3.8 Design concrete shear strength Slab edge deflection check Basic allowable span to depth ratio Moment factor Steel service stress Modification factor Modified allowable span to depth ratio |) | v _{cedge} = 0.6 <i>PASS - v</i> Ratio _{basicedg} M _{factoredge} = | 04 N/mm ² _{edge} <= v _{cedge} - | | · | | |
| Design concrete shear strength Slab edge deflection check Basic allowable span to depth ratio Moment factor Steel service stress Modification factor Modified allowable span to depth ratio |) | PASS - vo Ratio _{basicedg} M _{factoredge} = | _{edge} <= V _{cedge} - | Shear capacity | of the slab is | | |
| Slab edge deflection check Basic allowable span to depth ratio Moment factor Steel service stress Modification factor Modified allowable span to depth ra |) | PASS - vo Ratio _{basicedg} M _{factoredge} = | _{edge} <= V _{cedge} - | Shear capacity | of the slab is | | |
| Basic allowable span to depth ratio Moment factor Steel service stress Modification factor Modified allowable span to depth ra |) | Ratio _{basicedg} M _{factoredge} = | | Shear capacity | of the slab is | | |
| Basic allowable span to depth ratio Moment factor Steel service stress Modification factor Modified allowable span to depth ra |) | M _{factoredge} = | _{je} = 26.0 | | | not excee | |
| Moment factor Steel service stress Modification factor Modified allowable span to depth ra |) | M _{factoredge} = | _{je} = 26.0 | | | | |
| Steel service stress Modification factor Modified allowable span to depth ra | | | | | | | |
| Modification factor Modified allowable span to depth ra | | f | $M_{\Sigma edge}/d_{bslabmin}^2$ | ² = 0.199 N/mm ² | | | |
| Modified allowable span to depth ra | | | | https:/https:/https://https//https://https://https://https | | | |
| | | MF _{edge} =mir | n(2.0,0.55+[(47 | ′7N/mm²-f _{sedge})/(1 | 120×(0.9N/mm ² | ² +M _{factoredge} | |
| | | MF _{edge} = 2 . | 000 | | | | |
| Actual span to depth ratio | atio | $Ratio_{\text{allowedge}} = Ratio_{\text{basicedge}} \times MF_{\text{edge}} = \textbf{52.000}$ | | | | | |
| | | Ratio _{actualedge} = l _{edge} / d _{tslabmin} = 11.000 | | | | | |
| | PA | ISS - Ratio _{actuale} | _{edge} <= Ratio _{allo} | owedge - Slab spai | n to depth rati | o is adequ | |
| Corner design checks | | | | | | | |
| Basic loading | | | | | | | |
| - | | | | | | | |
| Corner bearing pressure check Total uniform load at formation leve | ما | M | Mount Manut M | Vslab + Whcoreslab = 9 | 9 3 kN/m^2 | | |
| | | | | ied bearing pres | | han allow: | |
| | | | | ieu seuring proc | | | |
| Slab corner bending check | | | | /0 - 4400 mana | | | |
| Cantilever span of slab at corner | | Icorner = Ødeps | slab/V(2) + Otslaba | _{av} /2 = 1138 mm | | | |
| Moment and shear due to self we | eight | | | | | | |
| Considering triangular loading | | | | , | | | |
| Maximum ultimate self weight udl | | $w_{swult} = 1.4 \times w_{slab} \times \phi_{depslab} / \sqrt{(2)} = 7.1 \text{ kN/m}$ | | | | | |
| Self weight bending moment | | $M_{cornersw} = w_{swult} \times I_{corner}^2 / (6 \times \phi_{depslab} / \sqrt{2})) = 1.5 \text{ kNm/m}$ | | | | | |
| Self weight shear force | | $V_{cornersw} = W_{swult} \times I_{corner} / (2 \times \phi_{depslab} / \sqrt{2})) = 3.8 \text{ kN/m}$ | | | | | |
| Moment and shear due to udls | | | | | | | |
| Maximum ultimate udl | | $W_{cornerudl} = ((1.4 \times W_{Dudl}) + (1.6 \times W_{Ludl})) \times \phi_{depslab} / \sqrt{2}$ | | | ₀/√(2) = 7.0 kN/ | /m | |
| Bending moment | | $M_{cornerudl} = W_{cornerudl} \times I_{corner}^2/(6 \times \phi_{depslab}/\sqrt{2}) = 1.4 \text{ kNm/m}$ | | | | | |
| Shear force | | $V_{cornerudl} = W_{cornerudl} \times I_{corner}/(2 \times \phi_{depslab}/\sqrt{2})) = 3.8 \text{ kN/m}$ | | | | | |
| Resultant moments and shears | | | | , | | | |
| Total design moment | | $M_{\Sigma corpor} = M$ | Cornersw+ Moorner | udi = 2.9 kNm/m | | | |
| Total design shear force | | $M_{\Sigma corner} = M_{cornersw} + M_{cornerudl} = 2.9 kNm/m$ $V_{\Sigma corner} = V_{cornersw} + V_{cornerudl} = 7.6 kN/m$ | | | | | |
| - | f elah at aar | | | | | | |
| Reinforcement required in top of K factor | i siau at cor | | /(f ~ d | (2) = 0.003 | | | |
| | | $K_{\text{corner}} = M_{\Sigma \text{corner}} / (f_{\text{cu}} \times d_{\text{tslabmin}^2}) = 0.003$ $Z_{\text{corner}} = d_{1} + \dots + \sum_{n} \min(0.95, 0.5 + \sqrt{0.25} - K_{\text{corner}} / (0.9)) = 143 \text{ mm}$ | | | | | |
| Lever arm | | $z_{\text{corner}} = d_{\text{tslabmin}} \times \min(0.95, 0.5 + \sqrt{(0.25 - K_{\text{corner}}/0.9)}) = 143 \text{ mm}$ | | | | | |
| Area of steel required for bending | | $A_{scornerbend} = M_{\Sigma corner}/((1.0/\gamma_s) \times f_{yslab} \times z_{corner}) = 46 \text{ mm}^2/\text{m}$ $A_{scorner} = \max(A_{scornerbend}, A_{sslabmin}) = 260 \text{ mm}^2/\text{m}$ | | | | | |
| Area of steel required | ~ - ^ | | | | | vo io odas: | |
| | ner <= Asedgeto | | forcement pro orner/dtslabmin = 0 | ovided in top of | siad at corner | s is adequ | |
| Applied shear stress | | | corner/Otslabmin = 0 O × A _{sedgetop} /d _{tsla} | | | | |
| Tension steel ratio | | $p_{corner} = 100$ | J × Asedgetop/Utsla | admin – V.202 | | | |

| ads consultancy | Project | Job no. 24078 | | | | |
|---|------------------|------------------------------|-------------------|----------------|----------------|---------------|
| ads consultancy 130 East Barnet Road | Calcs for Gro | Start page no./Revision 5 | | | | |
| New Barnet Herts - EN4 8RE | Calcs by SN | Calcs date 09/12/2024 | Checked by | Checked date | Approved by | Approved date |
| Design concrete shear strength vccorner = 0.604 N/mm² Pass - vcorner <= vccorner - Shear capacity of the slab is not exceeded | | | | | | |
| Slab corner deflection cho | eck | Pass - Vcori | ner <= Vccorner - | Shear capacity | of the slab is | not exceeded |

| Basic allowable span to depth ratio | Ratio _{basiccorner} = 7.0 |
|--|--|
| <i>l</i> oment factor | $M_{factorcorner} = M_{\Sigma corner}/d_{tslabmin}^2 = 0.128 \text{ N/mm}^2$ |
| Steel service stress | $f_{scorner}$ = 2/3 × f_{yslab} × $A_{scornerbend}/A_{sedgetop}$ = 39.369 N/mm ² |
| Iodification factor | MF _{corner} =min(2.0,0.55+[(477N/mm ² -f _{scorner})/(120×(0.9N/mm ² +M _{factorcorner}))]) |
| | MF _{corner} = 2.000 |
| Nodified allowable span to depth ratio | Ratio _{allowcorner} = Ratio _{basiccorner} × MF _{corner} = 14.000 |
| Actual span to depth ratio | Ratio _{actualcorner} = I _{corner} / d _{tslabmin} = 7.588 |
| | PASS - Ratio _{actualcorner} <= Ratio _{allowcorner} - Slab span to depth ratio is adequate |