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Project				Job Ref.	
Bankfield Drive, Holmbridge				119/188	
Section **Private Retaining Wall Replacement Adjacent to Dobb Top Road**					
By	Date	Chk'd by	Date	App'd by	Date
GR	June 26	AH	June 26		

119/188

Design Statement, Calculations, Construction & Maintenance

for

Private Retaining Wall Replacement Adjacent to Dobb Top Road

at

Bankfield Drive, Holmbridge

on behalf of

Orion Homes

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0.Scope

Private Retaining Wall Replacement Adjacent to Dobb Top Road

Design statement, Structural Calculations, construction methodology and maintenance management plan

1. Introduction

This report has been prepared in support of the permanent retaining wall replacement adjacent to Dobb Top Road, Holmbridge.

The retaining wall has been constructed to provide long-term support to retained ground adjacent to the development and highway boundary. The wall comprises a mass concrete retaining structure founded on competent bedrock with associated drainage measures and coping details as shown on Drawing No. 0119/188/1000.

2. Design References and Loading

The retaining wall has been designed in accordance with:

- BS EN 1990 – Basis of Structural Design
- BS EN 1991 – Actions on Structures
- BS EN 1992 – Design of Concrete Structures
- BS EN 1997 – Geotechnical Design
- BS 8002 – Earth Retaining Structures
- Relevant UK National Annexes

A uniform surcharge loading of 10kN/m^2

3. Foundations

The Mass Concrete Retaining Wall is founded within competent Medium Strong Sandstone which with a minimum allowable bearing pressure of 125kN/m^2

Any soft spots, loose material or weathered strata encountered during excavation to be removed and replaced with mass concrete.

Where competent founding material is not encountered at the proposed formation level, the excavation to extend until suitable bearing strata is identified.

The wall is founded on the same strata along its length and significant differential settlement is therefore not anticipated.

4. Structural Design Calculations

RETAINING WALL ANALYSIS

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

Tedds calculation version 2.9.22

Analysis summary

Description	Unit	Capacity	Applied	F o S	Result
Sliding stability	kN/m	96.3	71.2	1.353	PASS
Overturning stability	kNm/m	228.5	99.1	2.306	PASS
Bearing pressure	kN/m^2	125	119.7	1.045	PASS

Retaining wall details

Stem type;	Cantilever with stepped rear face
Stem height;	h_{stem} = **3400** mm
Number of steps;	N_{steps} = **1**
Height of step 1;	h_{s1} = **3400** mm
Thickness of step 1;	t_{s1} = **1850** mm
Angle to rear face of stem;	α = **90** deg
Stem density;	γ_{stem} = **25** kN/m^3
Toe length;	l_{toe} = **350** mm
Base thickness;	t_{base} = **400** mm
Base density;	γ_{base} = **25** kN/m^3
Height of retained soil;	h_{ret} = **3000** mm
Angle of soil surface;	β = **18** deg
Depth of cover;	d_{cover} = **300** mm
Depth of excavation;	d_{exc} = **150** mm

Retained soil properties

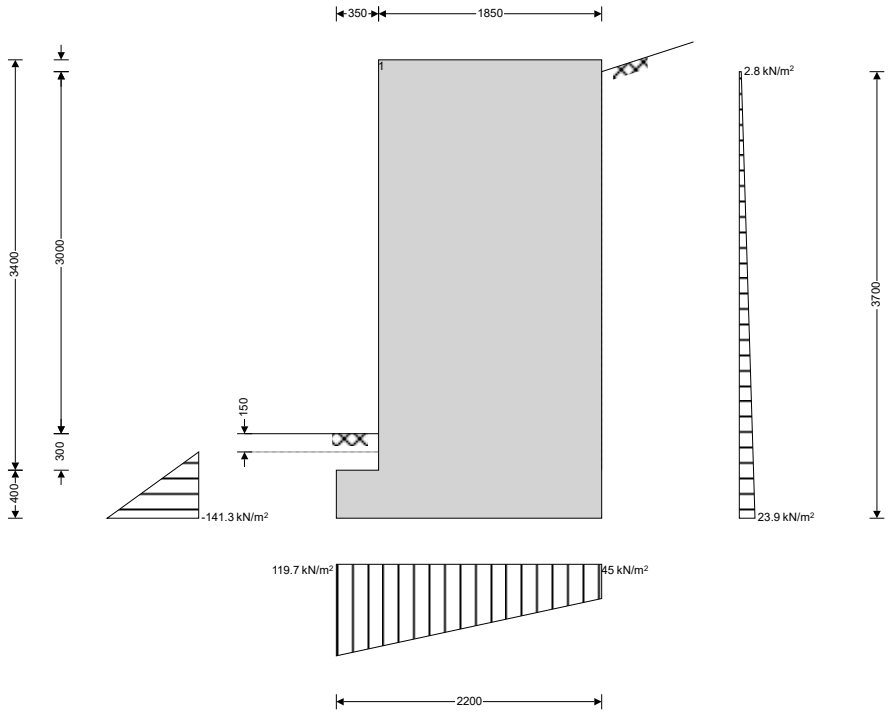
Soil type;	Dense well graded sand
Moist density;	γ_{mr} = **20.3** kN/m^3
Saturated density;	γ_{sr} = **22** kN/m^3
Characteristic effective shear resistance angle;	$\phi'_{r.k}$ = **36** deg
Characteristic wall friction angle;	$\delta_{r.k}$ = **18** deg

Base soil properties

Soil type;	Very dense gravel
Soil density;	γ_b = **18** kN/m^3
Characteristic effective shear resistance angle;	$\phi'_{b.k}$ = **42** deg
Characteristic wall friction angle;	$\delta_{b.k}$ = **21** deg
Characteristic base friction angle;	$\delta_{bb.k}$ = **28** deg
Presumed bearing capacity;	$P_{bearing}$ = **125** kN/m^2

Loading details

Variable surcharge load;	$Surcharge_Q$ = **10** kN/m^2



General arrangement - sketch pressures relate to bearing check

Calculate retaining wall geometry

Base length; $l_{base} = l_{toe} + t_{s1}$ = **2200** mm

Moist soil height; $h_{moist} = h_{soil}$ = **3300** mm

Length of surcharge load; $l_{sur} = (l_{heel} + t_{s1} - t_{s1})$ = **0** mm

- Distance to vertical component; $x_{sur\_v} = l_{base} - (l_{heel} + t_{s1} - t_{s1}) / 2$ = **2200** mm

Effective height of wall; $h_{eff} = h_{base} + d_{cover} + h_{ret} + l_{sur} \times \tan(\beta)$ = **3700** mm

- Distance to horizontal component; $x_{sur\_h} = h_{eff} / 2$ = **1850** mm

Area of wall stem; $A_{stem} = h_{s1} \times t_{s1}$ = **6.29** m^2

- Distance to vertical component; $x_{stem} = l_{base} - (h_{s1} \times t_{s1} \times (l_{heel} + t_{s1} - t_{s1} / 2)) / A_{stem}$ = **1275** mm

Area of wall base; $A_{base} = l_{base} \times t_{base}$ = **0.88** m^2

- Distance to vertical component; $x_{base} = l_{base} / 2$ = **1100** mm

Area of base soil; $A_{pass} = d_{cover} \times l_{toe}$ = **0.105** m^2

- Distance to vertical component; $x_{pass\_v} = l_{base} - (d_{cover} \times l_{toe} \times (l_{base} - l_{toe} / 2)) / A_{pass}$ = **175** mm

- Distance to horizontal component; $x_{pass\_h} = (d_{cover} + h_{base}) / 3$ = **233** mm

Area of excavated base soil; $A_{exc} = h_{pass} \times l_{toe}$ = **0.053** m^2

- Distance to vertical component; $x_{exc\_v} = l_{base} - (h_{pass} \times l_{toe} \times (l_{base} - l_{toe} / 2)) / A_{exc}$ = **175** mm

- Distance to horizontal component; $x_{exc\_h} = (h_{pass} + h_{base}) / 3$ = **183** mm

Using Coulomb theory

Active pressure coefficient; $K_A = \sin(\alpha + \phi'_{r.k})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.k}) \times [1 + \sqrt{[\sin(\phi'_{r.k} + \delta_{r.k}) \times \sin(\phi'_{r.k} - \beta) / (\sin(\alpha - \delta_{r.k}) \times \sin(\alpha + \beta))]]^2})$ = **0.296**

Passive pressure coefficient; $K_P = \sin(90 - \phi'_{b.k})^2 / (\sin(90 + \delta_{b.k}) \times [1 - \sqrt{[\sin(\phi'_{b.k} + \delta_{b.k}) \times \sin(\phi'_{b.k}) / (\sin(90 + \delta_{b.k}))]}]^2) =$ **14.662**

Bearing pressure check

Vertical forces on wall

Wall stem; $F_{stem} = A_{stem} \times \gamma_{stem} =$ **157.3** kN/m

Wall base; $F_{base} = A_{base} \times \gamma_{base} =$ **22** kN/m

Base soil; $F_{pass\_v} = A_{pass} \times \gamma_b =$ **1.9** kN/m

Total; $F_{total\_v} = F_{stem} + F_{base} + F_{pass\_v} =$ **181.1** kN/m

Horizontal forces on wall

Surcharge load; $F_{sur\_h} = K_A \times \cos(\delta_{r.k}) \times Surcharge_Q \times h_{eff} =$ **10.4** kN/m

Moist retained soil; $F_{moist\_h} = K_A \times \cos(\delta_{r.k}) \times \gamma_{mr} \times h_{eff}^2 / 2 =$ **39.1** kN/m

Base soil; $F_{pass\_h} = \max(-K_P \times \cos(\delta_{b.k}) \times \gamma_b \times (d_{cover} + h_{base})^2 / 2, -(F_{moist\_h} + F_{sur\_h})) =$ **-49.5** kN/m

Total; $F_{total\_h} = \max(F_{sur\_h} + F_{moist\_h} + F_{pass\_h} - F_{total\_v} \times \tan(\delta_{bb.k}), 0\ kN/m) =$ **0** kN/m

Moments on wall

Wall stem; $M_{stem} = F_{stem} \times x_{stem} =$ **200.5** kNm/m

Wall base; $M_{base} = F_{base} \times x_{base} =$ **24.2** kNm/m

Surcharge load; $M_{sur} = -F_{sur\_h} \times x_{sur\_h} =$ **-19.2** kNm/m

Moist retained soil; $M_{moist} = -F_{moist\_h} \times x_{moist\_h} =$ **-48.2** kNm/m

Base soil; $M_{pass} = F_{pass\_v} \times x_{pass\_v} - F_{pass\_h} \times x_{pass\_h} =$ **11.9** kNm/m

Total; $M_{total} = M_{stem} + M_{base} + M_{sur} + M_{moist} + M_{pass} =$ **169.1** kNm/m

Check bearing pressure

Distance to reaction; $\bar{x} = M_{total} / F_{total\_v} =$ **934** mm

Eccentricity of reaction; $e = \bar{x} - l_{base} / 2 =$ **-166** mm

Loaded length of base; $l_{load} = l_{base} =$ **2200** mm

Bearing pressure at toe; $q_{toe} = F_{total\_v} / l_{base} \times (1 - 6 \times e / l_{base}) =$ **119.7** kN/m²

Bearing pressure at heel; $q_{heel} = F_{total\_v} / l_{base} \times (1 + 6 \times e / l_{base}) =$ **45** kN/m²

Factor of safety; $FoS_{bp} = P_{bearing} / \max(q_{toe}, q_{heel}) =$ **1.045**

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

Design approach 1

Partial factors on actions - Table A.3 - Combination 1

Partial factor set; A1

Permanent unfavourable action; $\gamma_G =$ **1.350**

Permanent favourable action; $\gamma_{Gf} =$ **1.000**

Variable unfavourable action; $\gamma_Q =$ **1.500**

Variable favourable action; $\gamma_{Qf} =$ **0.000**

Partial factors for soil parameters – Table A.4 - Combination 1

Soil parameter set; M1

Angle of shearing resistance; $\gamma_{\phi'} =$ **1.00**

Effective cohesion; $\gamma_{c'} =$ **1.00**

Weight density; $\gamma_\gamma =$ **1.00**

Retained soil properties

Design moist density; $\gamma_{mr}' = \gamma_{mr} / \gamma_{\gamma} =$ **20.3** kN/m^3

Design saturated density; $\gamma_{sr}' = \gamma_{sr} / \gamma_{\gamma} =$ **22** kN/m^3

Design effective shear resistance angle; $\phi'_{r.d} = \text{atan}(\tan(\phi'_{r.k}) / \gamma_{\phi'}) =$ **36** deg

Design wall friction angle; $\delta_{r.d} = \text{atan}(\tan(\delta_{r.k}) / \gamma_{\phi'}) =$ **18** deg

Base soil properties

Design soil density; $\gamma_b' = \gamma_b / \gamma_{\gamma} =$ **18** kN/m^3

Design effective shear resistance angle; $\phi'_{b.d} = \text{atan}(\tan(\phi'_{b.k}) / \gamma_{\phi'}) =$ **42** deg

Design wall friction angle; $\delta_{b.d} = \text{atan}(\tan(\delta_{b.k}) / \gamma_{\phi'}) =$ **21** deg

Design base friction angle; $\delta_{bb.d} = \text{atan}(\tan(\delta_{bb.k}) / \gamma_{\phi'}) =$ **28** deg

Design effective cohesion; $c'_{b.d} = c'_{b.k} / \gamma_{c'} =$ **0** kN/m^2

Using Coulomb theory

Active pressure coefficient; $K_A = \sin(\alpha + \phi'_{r.d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.d}) \times [1 + \sqrt{[\sin(\phi'_{r.d} + \delta_{r.d}) \times \sin(\phi'_{r.d} - \beta) / (\sin(\alpha - \delta_{r.d}) \times \sin(\alpha + \beta))]}]^2) =$ **0.296**

Passive pressure coefficient; $K_P = \sin(90 - \phi'_{b.d})^2 / (\sin(90 + \delta_{b.d}) \times [1 - \sqrt{[\sin(\phi'_{b.d} + \delta_{b.d}) \times \sin(\phi'_{b.d}) / (\sin(90 + \delta_{b.d}))]}]^2) =$ **14.662**

Sliding check

Vertical forces on wall

Wall stem; $F_{stem} = \gamma_{Gf} \times A_{stem} \times \gamma_{stem} =$ **157.3** kN/m

Wall base; $F_{base} = \gamma_{Gf} \times A_{base} \times \gamma_{base} =$ **22** kN/m

Base soil; $F_{exc\_v} = \gamma_{Gf} \times A_{exc} \times \gamma_b' =$ **0.9** kN/m

Total; $F_{total\_v} = F_{stem} + F_{base} + F_{exc\_v} =$ **180.2** kN/m

Horizontal forces on wall

Surcharge load; $F_{sur\_h} = K_A \times \cos(\delta_{r.d}) \times \gamma_Q \times \text{Surcharge}_Q \times h_{eff} =$ **15.6** kN/m

Moist retained soil; $F_{moist\_h} = \gamma_G \times K_A \times \cos(\delta_{r.d}) \times \gamma_{mr}' \times h_{eff}^2 / 2 =$ **52.7** kN/m

Total; $F_{total\_h} = F_{sur\_h} + F_{moist\_h} =$ **68.3** kN/m

Check stability against sliding

Base soil resistance; $F_{exc\_h} = \gamma_{Gf} \times K_P \times \cos(\delta_{b.d}) \times \gamma_b' \times (h_{pass} + h_{base})^2 / 2 =$ **37.3** kN/m

Base friction; $F_{friction} = F_{total\_v} \times \tan(\delta_{bb.d}) =$ **95.8** kN/m

Resistance to sliding; $F_{rest} = F_{exc\_h} + F_{friction} =$ **133.1** kN/m

Factor of safety; $FoS_{sl} = F_{rest} / F_{total\_h} =$ **1.947**

PASS - Resistance to sliding is greater than sliding force

Overturning check

Vertical forces on wall

Wall stem; $F_{stem} = \gamma_{Gf} \times A_{stem} \times \gamma_{stem} =$ **157.3** kN/m

Wall base; $F_{base} = \gamma_{Gf} \times A_{base} \times \gamma_{base} =$ **22** kN/m

Base soil; $F_{exc\_v} = \gamma_{Gf} \times A_{exc} \times \gamma_b' =$ **0.9** kN/m

Total; $F_{total\_v} = F_{stem} + F_{base} + F_{exc\_v} =$ **180.2** kN/m

Horizontal forces on wall

Surcharge load; $F_{sur\_h} = K_A \times \cos(\delta_{r.d}) \times \gamma_Q \times \text{Surcharge}_Q \times h_{eff} =$ **15.6** kN/m

Moist retained soil; $F_{moist\_h} = \gamma_G \times K_A \times \cos(\delta_{r.d}) \times \gamma_{mr}' \times h_{eff}^2 / 2 =$ **52.7** kN/m

Base soil; $F_{exc\_h} = -\gamma_{Gf} \times K_P \times \cos(\delta_{b.d}) \times \gamma_b' \times (h_{pass} + h_{base})^2 / 2 =$ **-37.3** kN/m

Total; $F_{total\_h} = F_{sur\_h} + F_{moist\_h} + F_{exc\_h} = \mathbf{31.1}$ kN/m

Overturning moments on wall

Surcharge load; $M_{sur\_OT} = F_{sur\_h} \times x_{sur\_h} = \mathbf{28.9}$ kNm/m

Moist retained soil; $M_{moist\_OT} = F_{moist\_h} \times x_{moist\_h} = \mathbf{65}$ kNm/m

Total; $M_{total\_OT} = M_{sur\_OT} + M_{moist\_OT} = \mathbf{93.9}$ kNm/m

Restoring moments on wall

Wall stem; $M_{stem\_R} = F_{stem} \times x_{stem} = \mathbf{200.5}$ kNm/m

Wall base; $M_{base\_R} = F_{base} \times x_{base} = \mathbf{24.2}$ kNm/m

Base soil; $M_{exc\_R} = F_{exc\_v} \times x_{exc\_v} - F_{exc\_h} \times x_{exc\_h} = \mathbf{7}$ kNm/m

Total; $M_{total\_R} = M_{stem\_R} + M_{base\_R} + M_{exc\_R} = \mathbf{231.7}$ kNm/m

Check stability against overturning

Factor of safety; $FoS_{ot} = M_{total\_R} / M_{total\_OT} = \mathbf{2.467}$

PASS - Maximum restoring moment is greater than overturning moment

Design approach 1

Partial factors on actions - Table A.3 - Combination 2

Partial factor set; A2

Permanent unfavourable action; $\gamma_G = \mathbf{1.000}$

Permanent favourable action; $\gamma_{Gf} = \mathbf{1.000}$

Variable unfavourable action; $\gamma_Q = \mathbf{1.300}$

Variable favourable action; $\gamma_{Qf} = \mathbf{0.000}$

Partial factors for soil parameters – Table A.4 - Combination 2

Soil parameter set; M2

Angle of shearing resistance; $\gamma_{\phi'} = \mathbf{1.25}$

Effective cohesion; $\gamma_{c'} = \mathbf{1.25}$

Weight density; $\gamma_\gamma = \mathbf{1.00}$

Retained soil properties

Design moist density; $\gamma_{mr}' = \gamma_{mr} / \gamma_\gamma = \mathbf{20.3}$ kN/m^3

Design saturated density; $\gamma_{sr}' = \gamma_{sr} / \gamma_\gamma = \mathbf{22}$ kN/m^3

Design effective shear resistance angle; $\phi'_{r.d} = \text{atan}(\tan(\phi'_{r.k}) / \gamma_{\phi'}) = \mathbf{30.2}$ deg

Design wall friction angle; $\delta_{r.d} = \text{atan}(\tan(\delta_{r.k}) / \gamma_{\phi'}) = \mathbf{14.6}$ deg

Base soil properties

Design soil density; $\gamma_b' = \gamma_b / \gamma_\gamma = \mathbf{18}$ kN/m^3

Design effective shear resistance angle; $\phi'_{b.d} = \text{atan}(\tan(\phi'_{b.k}) / \gamma_{\phi'}) = \mathbf{35.8}$ deg

Design wall friction angle; $\delta_{b.d} = \text{atan}(\tan(\delta_{b.k}) / \gamma_{\phi'}) = \mathbf{17.1}$ deg

Design base friction angle; $\delta_{bb.d} = \text{atan}(\tan(\delta_{bb.k}) / \gamma_{\phi'}) = \mathbf{23}$ deg

Design effective cohesion; $c'_{b.d} = c'_{b.k} / \gamma_{c'} = \mathbf{0}$ kN/m^2

Using Coulomb theory

Active pressure coefficient; $K_A = \sin(\alpha + \phi'_{r.d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.d}) \times [1 + \sqrt{[\sin(\phi'_{r.d} + \delta_{r.d}) \times \sin(\phi'_{r.d} - \beta) / (\sin(\alpha - \delta_{r.d}) \times \sin(\alpha + \beta))]}]^2) = \mathbf{0.393}$

Passive pressure coefficient; $K_P = \sin(90 - \phi'_{b.d})^2 / (\sin(90 + \delta_{b.d}) \times [1 - \sqrt{[\sin(\phi'_{b.d} + \delta_{b.d}) \times \sin(\phi'_{b.d}) / (\sin(90 + \delta_{b.d}))]}]^2) = \mathbf{7.553}$

Sliding check

Vertical forces on wall

Wall stem; $F_{stem} = \gamma_{Gf} \times A_{stem} \times \gamma_{stem}$ = **157.3** kN/m

Wall base; $F_{base} = \gamma_{Gf} \times A_{base} \times \gamma_{base}$ = **22** kN/m

Base soil; $F_{exc\_v} = \gamma_{Gf} \times A_{exc} \times \gamma_b'$ = **0.9** kN/m

Total; $F_{total\_v} = F_{stem} + F_{base} + F_{exc\_v}$ = **180.2** kN/m

Horizontal forces on wall

Surcharge load; $F_{sur\_h} = K_A \times \cos(\delta_{r.d}) \times \gamma_Q \times Surcharge_Q \times h_{eff}$ = **18.3** kN/m

Moist retained soil; $F_{moist\_h} = \gamma_G \times K_A \times \cos(\delta_{r.d}) \times \gamma_{mr}' \times h_{eff}^2 / 2$ = **52.9** kN/m

Total; $F_{total\_h} = F_{sur\_h} + F_{moist\_h}$ = **71.2** kN/m

Check stability against sliding

Base soil resistance; $F_{exc\_h} = \gamma_{Gf} \times K_P \times \cos(\delta_{b.d}) \times \gamma_b' \times (h_{pass} + h_{base})^2 / 2$ = **19.7** kN/m

Base friction; $F_{friction} = F_{total\_v} \times \tan(\delta_{bb.d})$ = **76.6** kN/m

Resistance to sliding; $F_{rest} = F_{exc\_h} + F_{friction}$ = **96.3** kN/m

Factor of safety; $FoS_{sl} = F_{rest} / F_{total\_h}$ = **1.353**

PASS - Resistance to sliding is greater than sliding force

Overturning check

Vertical forces on wall

Wall stem; $F_{stem} = \gamma_{Gf} \times A_{stem} \times \gamma_{stem}$ = **157.3** kN/m

Wall base; $F_{base} = \gamma_{Gf} \times A_{base} \times \gamma_{base}$ = **22** kN/m

Base soil; $F_{exc\_v} = \gamma_{Gf} \times A_{exc} \times \gamma_b'$ = **0.9** kN/m

Total; $F_{total\_v} = F_{stem} + F_{base} + F_{exc\_v}$ = **180.2** kN/m

Horizontal forces on wall

Surcharge load; $F_{sur\_h} = K_A \times \cos(\delta_{r.d}) \times \gamma_Q \times Surcharge_Q \times h_{eff}$ = **18.3** kN/m

Moist retained soil; $F_{moist\_h} = \gamma_G \times K_A \times \cos(\delta_{r.d}) \times \gamma_{mr}' \times h_{eff}^2 / 2$ = **52.9** kN/m

Base soil; $F_{exc\_h} = -\gamma_{Gf} \times K_P \times \cos(\delta_{b.d}) \times \gamma_b' \times (h_{pass} + h_{base})^2 / 2$ = **-19.7** kN/m

Total; $F_{total\_h} = F_{sur\_h} + F_{moist\_h} + F_{exc\_h}$ = **51.5** kN/m

Overturning moments on wall

Surcharge load; $M_{sur\_OT} = F_{sur\_h} \times x_{sur\_h}$ = **33.9** kNm/m

Moist retained soil; $M_{moist\_OT} = F_{moist\_h} \times x_{moist\_h}$ = **65.2** kNm/m

Total; $M_{total\_OT} = M_{sur\_OT} + M_{moist\_OT}$ = **99.1** kNm/m

Restoring moments on wall

Wall stem; $M_{stem\_R} = F_{stem} \times x_{stem}$ = **200.5** kNm/m

Wall base; $M_{base\_R} = F_{base} \times x_{base}$ = **24.2** kNm/m

Base soil; $M_{exc\_R} = F_{exc\_v} \times x_{exc\_v} - F_{exc\_h} \times x_{exc\_h}$ = **3.8** kNm/m

Total; $M_{total\_R} = M_{stem\_R} + M_{base\_R} + M_{exc\_R}$ = **228.5** kNm/m

Check stability against overturning

Factor of safety; $FoS_{ot} = M_{total\_R} / M_{total\_OT}$ = **2.306**

PASS - Maximum restoring moment is greater than overturning moment

5. Drainage Provisions

Drainage measures have been incorporated to prevent hydrostatic pressure build-up behind the wall and include:

- Free-draining granular backfill.
- Perforated drain at the rear toe of the wall.
- Geotextile filter membrane.
- Positive discharge of collected groundwater.

These measures are intended to minimise water pressures acting on the retaining structure throughout its service life.

6. Construction Methodology – Permanent Works

The permanent works to be constructed generally in accordance with the following sequence:

1. Establish site access and working area.
2. Remove existing wall and unsuitable material where required.
3. Undertake excavation to proposed formation level.
4. Inspect formation and verify competent founding strata.
5. Remove any soft spots or unsuitable material.
6. Deepen excavations where competent Medium Strong Sandstone was not encountered.
7. Make up any over-excavation using mass concrete.
8. Construct retaining wall in accordance with approved drawings.
9. Install drainage pipework, filter membrane and free-draining backfill.
10. Backfill in controlled layers using suitable engineered fill.
11. Install coping units and movement joints.
12. Reinstate adjacent surfaces and drainage features.

7. Bulk Excavation and Material Removal

Bulk excavation works associated with the retaining wall replacement to be undertaken in a controlled manner to maintain the stability of the retained ground and adjacent highway infrastructure.

Excavated materials unsuitable for reuse to be removed from site and disposed of at appropriately licensed waste facilities.

Suitable excavated material to be reused where practical and where compliance with the project specification could be demonstrated.

Excavations to be maintained free from standing water and inspected prior to placement of concrete.

8. Maintenance and Management Plan

- **Routine Inspections**

The retaining wall should be visually inspected periodically by a competent person.

Particular attention should be given to:

- Cracking.
- Bulging or movement.
- Settlement.
- Deterioration of concrete surfaces.
- Damage to coping units.
- Condition of movement joints.
- Blockage of drainage outlets.
- Water seepage or ponding.
- Erosion adjacent to the structure.
- Vegetation growth.

- **Drainage Maintenance**

Drainage outlets and associated drainage features should be kept clear of debris and vegetation to ensure continued operation.

Any blockage or restriction identified should be removed promptly.

- **Vegetation Control**

Trees, shrubs and invasive vegetation should not be permitted to establish adjacent to the retaining wall where root systems may adversely affect drainage systems or structural performance.

- **Defects**

Where significant cracking, movement, settlement or drainage problems are observed, a suitably qualified Structural or Geotechnical Engineer should be appointed to undertake a detailed assessment and recommend any remedial measures.

9. Conclusion

The retaining wall has been constructed as a permanent structure founded on competent Medium Strong Sandstone with an allowable bearing pressure of 125kN/m^2.

Any unsuitable material encountered during excavation was removed and replaced with mass concrete, and where competent founding strata were not present at formation level, excavations were deepened and made up using mass concrete.

Drainage measures have been incorporated to minimise hydrostatic pressures and provide long-term performance of the retaining structure. The wall should be subject to periodic inspection and maintenance to ensure continued serviceability.