

Queensgate Market Offices  
Princess Alexandra Walk  
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West Yorkshire

Kirklees Council  
Streetscene and Housing  
Highways and Operations  
Operational Manager  
Kathryn Broadbent

## **TECHNICAL APPROVAL IN PRINCIPLE FOR DESIGN OF**

### **PROPOSED PRIVATE BURR WALL TO SUPPORT EXISTING HIGHWAY AT HAYFIELD CLOSE, SCHOLES, HOLMFIRTH, HD9 1UA**

|                                 |                      |
|---------------------------------|----------------------|
| <b>Revision:-</b>               | <b>C</b>             |
| <b>Kirklees Structure no.:-</b> | <b>K60867</b>        |
| <b>Date:-</b>                   | <b>November 2018</b> |
| <b>Report prepared by:-</b>     | <b>C. Devenish</b>   |
| <b>Checked by:-</b>             | <b>S. McCormick</b>  |

## TECHNICAL APPROVAL OF HIGHWAY STRUCTURES

Scheme: 32 Paris Road, Scholes, Holmfirth, HD9 1UA

Structure: Proposed private burr wall to support adjacent highway    Date:- November 2018

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**1.    Name of Scheme:**

Proposed Detached Dwelling at 32 Paris Road, Scholes, Holmfirth, HD9 1UA

**2.    Name of Structure:**

**2.1**

2.1.1    Name: Private Burr wall to support adjacent public highway

2.1.2    Structure Reference Number :K60867

2.2    Location and OS Map / Grid Ref:  
32 Paris Road, Scholes, Holmfirth, HD9 1UA  
E = 415833, N = 407564

2.3    Type of Highway: Unclassified Road

2.4    Permitted traffic speed: 30mph

2.5    Existing weight restriction: None

2.6    Obstacle crossed: None

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### 3. **Proposed Structure:**

#### 3.1 Description of Structure

Private Burr wall supporting adjacent public highway (Hayfield Close) on land at 32 Paris Road, Scholes, Holmfirth.

The new burr wall will be an independent structure.

#### 3.2 Structural Type

##### *Description*

Masonry faced mass Concrete gravity retaining wall.

##### *Reasons for Choice*

To facilitate quicker construction on site, simplify construction and to avoid the need for any reinforcement/steel fixers which could lead to a possible slow-down in construction on site.

#### 3.3 Foundation Type

##### *Description*

Mass concrete spread footing/base founded off the natural competent mudstone rock formation.

##### *Reasons for Choice*

To suit site conditions and wall construction choice.

#### 3.4 Maximum Retained Height / Span Arrangements

##### *Description*

The proposed burr wall has a maximum retained height level difference of 2.7m to suit the level difference between the upper road level and the proposed lower ground level of the site. The burr wall runs approximately 13m in length adjacent the highway with the level difference tapering down to 0m.

##### *Reasons for Choice*

To suit proposed site layout and constraints.

#### 3.5 Articulation Arrangements

Movement joints to be provided in burr wall stem at regular intervals of approximately 6m spacings.

##### *Description*

20mm thick movement joint to comprise of 20mm compressible filler material sealed with 20x20mm polysulphide sealant.

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### *Reasons for Choice*

To control thermal movement of the burr wall stem.

### 3.6 Pedestrian / Road Restraint System Type

1.1m high un-reinforced natural stone masonry wall 360mm thick to head of new burr wall to act as parapet.

Parapet will be adjacent garage to the new dwelling. Refer to Designers risk evaluation (Risk Assessment Calculations) in compliance with BS6779-1999 Part 4 App. A at rear of AIP.

### 3.7 Proposed Arrangements for Inspection and Maintenance

#### 3.7.1 Traffic Management

Highway may remain open for inspections, but a partial closure notice may be required from the Highways Authority for anything but simple maintenance.

#### 3.7.2 Access

Access to the structure for inspection and maintenance can be gained from the private land owner if required and from the public highway.

### 3.8 Materials and Finishes

| Item           | Material                                                                                                                                                                                                 | Finish                                                                                        |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Burr Wall Stem | Grade C25/30 (or better) mass concrete.                                                                                                                                                                  | Wall stem to be faced with natural stone masonry.                                             |
| Burr Wall Base | Grade C25/30 (or better) mass concrete.                                                                                                                                                                  |                                                                                               |
| Drainage       | 100mm diameter perforated pvc land drain provided to rear of wall encased in no-fines concrete. 100mm diameter weep pipes to be also installed at 2.0m centres set at 150mm above finished ground level. | Perforated longitudinal land drain behind wall taken to and discharged to a suitable outfall. |
| Parapet        | 360mm thick un-reinforced natural stone parapet wall 1.1m high.                                                                                                                                          | Stone Finish                                                                                  |

## TECHNICAL APPROVAL OF HIGHWAY STRUCTURES

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### 3.9 Risks and Hazards Considered

- Buried services and drains
- General works including working at heights.
- Maintenance of vehicular / pedestrian access.
- Live traffic and site deliveries.
- Excavations adjacent to public highway.
- Stability of excavations and the adjoining highway.

### 3.10 Estimated Cost and Other Structural Forms Considered

Estimated costs to be confirmed upon receiving tender costs from contractor.

### 3.11 Proposed Arrangement for Construction

#### 3.11.1        Traffic Management

Vehicles and pedestrians will be allowed to continue using the public highway but should a temporary lane closure/ diversion / closure be required then any management of such will need to be agreed with Kirklees Council Highway Services prior to commencement of works.

#### 3.11.2        Service diversions

All statutory service plans and records are to be obtained and the presence of any services in and around the proposed works is to be verified prior to works commencing on site.

#### 3.11.3        Interface with existing structures

The burr wall will be constructed at the same time as the returning boundary wall on the boundary between the proposed site No. 32 and the neighbouring land site of No. 34. This will be of identical construction and will be constructed monolithically with the highway burr wall.

## TECHNICAL APPROVAL OF HIGHWAY STRUCTURES

Scheme: 32 Paris Road, Scholes, Holmfirth, HD9 1UA

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### 4. Design/Assessment Criteria

#### 4.1 Actions:

|       |                                                                                                                                                           |                                                                                                                                                                                                                                                                                     |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.1.1 | Permanent Actions                                                                                                                                         | All permanent actions as outlined in BS EN 1991-1-1:2002 and associated National Annex                                                                                                                                                                                              |
| 4.1.2 | Snow, Wind and Thermal Actions                                                                                                                            | Snow loading not considered (NA to BS EN 1991-1-3 NA.4.1.1).<br>Wind loading not considered.<br>Thermal actions not considered.                                                                                                                                                     |
| 4.1.3 | Loading relating to normal traffic under AW regulations and C&U regulations.                                                                              | 20kN/m <sup>2</sup> surcharge in accordance with BS 8002:2015                                                                                                                                                                                                                       |
| 4.1.4 | Loading relating to General Order Traffic under STGO regulations                                                                                          | 30kN/m <sup>2</sup> surcharge in accordance with BS 8002:2015                                                                                                                                                                                                                       |
| 4.1.5 | Footway or Footbridge live loading                                                                                                                        | 5kN/m <sup>2</sup> surcharge in accordance with BS 8002:2015                                                                                                                                                                                                                        |
| 4.1.6 | Loading relating to Special Order Traffic, provision for exceptional abnormal indivisible loads including location of vehicle track on deck cross section | N/A                                                                                                                                                                                                                                                                                 |
| 4.1.7 | Accidental Actions                                                                                                                                        | Accidental actions to be in accordance with 4.7.3.1 of BS EN 1991-2 and NA to BS EN 1991-2.                                                                                                                                                                                         |
| 4.1.8 | <i>Actions during Execution</i>                                                                                                                           | The burr wall is to be backfilled in accordance with the MCHW and surcharge loadings are to be derived based on the requirements of PD 6694-1:2011. Therefore, compaction pressures imposed on the wall during construction do not need to be considered. (PD6694-1:2011 CI 7.3.3). |

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- |        |                                                                  |                  |
|--------|------------------------------------------------------------------|------------------|
| 4.1.9  | High or Heavy Load route requirements                            | N/A              |
| 4.1.10 | <i>Minimum headroom provided</i>                                 | N/A              |
| 4.1.11 | <i>Authorities Consulted and Any Special Conditions required</i> | Kirklees Council |

#### 4.2 List of Relevant Documents from the TAS (Dated June 2018) See Appendix A

4.2.1 *Additional Relevant DOT Standards Published Since the Above Edition of the TAS Including Amendments - See Appendix*

#### 4.3 Proposed Departures from Standards Given in 4.2 and 4.2.1

Hayfield Close forms part of a cul-de-sac and is not subject to a weight limit, the public road is too narrow and has a limited use for vehicular access and as such a live load surcharge of 20kN/m<sup>2</sup> has been used in the global stability.

#### 4.4 Proposed method of Dealing with Aspects Not Covered by Standards in 4.2 and 4.2.1

The proposed burr wall will be a private wall and it's maintenance liability will solely rest with the adjoining land title owner.

All party wall notices are to be undertaken and served by the project Co-ordinator, Wake Architects and will be dealt accordingly by the Architect and appointed party wall surveyors.

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### 5. Structural Analysis

#### 5.1 Methods of Analysis

Rankine's theory for lateral earth pressures.

The method of analysis employed is to BS EN 1997-1:2004 incorporating Corrigendum dated February 2009 and UK National Annex incorporating Corrigendum No 1.

#### 5.2 Description and Diagram of Idealised Structure to be used for Analysis

The proposed burr wall structure is to be designed as a gravity retaining wall structure of mass construction to support the lateral earth pressures & surcharge loadings from the adjacent highway.

Refer to 'SGM Structural Design Ltd' drawing number 2018/149-100 Rev C accompanying this submission.

#### 5.3 Assumptions Intended for Calculation of Structural Element Stiffness

- Allowable Ground Bearing Pressure (G.B.P.) of 200kN/m<sup>2</sup>
- Backfill / retained earth density of 18kN/m<sup>3</sup>
- Angle of Internal Friction' of soil as 30 degrees.
- Effective Cohesion of 0kN/m<sup>2</sup>.
- Surcharge loading of 20kN/m<sup>2</sup> to be taken.

#### 5.4 Proposed Earth Pressure Coefficients (Ka, Ko or Kp) to be used in the design of earth retaining elements.

Proposed earth pressure coefficient,  $K_o = 0.5$   
 $K_a = 0.33$

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### 6.     **Ground Conditions**

#### 6.1     Ground Investigations

Ground Investigation has been carried out and report prepared by 'Rogers Geotechnical Services Ltd' report reference number J4251/18/E/G dated 25/06/18.

#### 6.2     Acceptance of Interpretative Recommendations of the Soils Report

- Allowable Ground Bearing Pressure (G.B.P.) of 200kN/m<sup>2</sup>
- Backfill / retained earth density of 18kN/m<sup>3</sup>
- Angle of Internal Friction' of soil as 30 degrees.
- Effective Cohesion of 0kN/m<sup>2</sup>.

#### 6.3     Description of Foundations

Mass gravity retaining wall with 'spread' footing/base founded on competent natural mudstone rock formation.

#### 6.4     Differential Settlement to be allowed for in Design of the structure

N/A

#### 6.5     Anticipated Ground Movements or Settlement Due to Embankment Loading, Mineral Extraction or Flow of Water

N/A

#### 6.6     Results of Tests of Ground Water and Any Counteracting Measures Proposed

N/A

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### 7.     **Checking**

#### 7.1     Proposed Category of Structure

Category 1

#### 7.2     If Category 3, name of proposed independent checker

N/A

#### 7.3     Erection Proposals and Temporary Works

Temporary support is to be installed in the form of trench boxes all designed and detailed in accordance with the temporary works sub-contractor, Groundforce Shorco. All design, details and proposals together with method statements etc are to be forwarded prior to commencement of works.

#### Outline Method Statement:

1. Contractor to check location of existing services etc. prior to commencement of works, using CAT scans and STATS plans as necessary.
2. Any temporary vehicular / pedestrian (if deemed necessary) to be discussed and agreed with the Local Authority.
3. Contractor to carefully install temporary works trench boxes in strict accordance with supplier's requirements and excavate earth within trench boxes.
4. Contractor to construct mass concrete base, wall stem and install drainage in accordance with construction drawing.
5. Rear of retaining wall to be carefully backfilled with pourous no fines concrete at same time as slowly raising the trench boxes to ensure void between wall and retained earth is fully filled all in accordance with construction drawings only after mortar/concrete has reached adequate design strength.
6. Contractor to install timber parapet fencing and make good and satisfactorily clear up.
7. Remove any temporary diversions.

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### 8. Drawings and Documents

8.1 List of Drawings and documents accompanying the submission.

‘SGM Structural Design Ltd’ drawing numbers:

8.2 List of Tender Drawings.

| Drawing No.           | Title                                              |
|-----------------------|----------------------------------------------------|
| 2018/149-100<br>Rev C | Boundary Retaining Wall Layout and Section Details |

## TECHNICAL APPROVAL OF HIGHWAY STRUCTURES

Scheme: 32 Paris Road, Scholes, Holmfirth, HD9 1UA

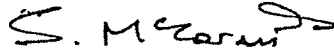
Structure: Proposed private burr wall to support adjacent highway Date:- November 2018  
(Ref K60867)

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9. The above is submitted for acceptance

AIP Rev(C)

Signed :



Name:

S. McCormick

Position Held

Design Team Leader

Engineering Qualification

B Eng (Hons), C Eng, MI Struct E

Name of Organisation

SGM Structural Design Ltd

Date

15-11-18

10. The above is ~~rejected~~ agreed subject to the amendments and conditions shown below (\*)

Signed:-



Name:

F Khatibi

Position Held:-

Principal Engineer (Structures Section)

Engineering Qualification:

BSc.(Hons) Civil Eng, MSc.

TAA:-

Kirklees Council (Highway Authority)

Date:-

16/11/18

For and on behalf of Kirklees Council

\*

- (i) Submission of satisfactory structural calculations to Eurocodes for the design of proposed mass concrete burr wall.
- (ii) Submission of satisfactory Design + check certificate (Category 1) in compliance with the approved AIP RevC for the new mass concrete burr wall.
- (iii) Submission of "Construction Compliance Certificate" in accordance with BD2/12.

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### **APPENDIX A**

#### **LIST OF RELEVANT DESIGN DOCUMENTS**

## TECHNICAL APPROVAL OF HIGHWAY STRUCTURES

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### Technical Approval Schedule "TAS"(June 2018)

Schedule of Documents Relating to Design of Highway Bridges and Structures using Structural Eurocodes

#### British Standards

*Non-conflicting with Eurocodes.*

| Used | Document Ref | Title                                            | Date |
|------|--------------|--------------------------------------------------|------|
|      | BS 6031      | Code of practice for earthworks.                 | 2009 |
|      | BS 8002      | Code of Practice for earth retaining structures. | 2015 |

#### Eurocodes and Associated UK National Annexes

*All national annexes will be used with the list of documents below. Users to confirm latest Amendments and Corrigenda.*

| Used                                         | Eurocode Part  | Title                                                                                         | Publication Date | UK National Annex Publication Date |
|----------------------------------------------|----------------|-----------------------------------------------------------------------------------------------|------------------|------------------------------------|
| <b>Eurocode 0 Basis of Structural Design</b> |                |                                                                                               |                  |                                    |
|                                              | BS EN 1990     | Eurocode 0: Basis of structural design.                                                       | 2002             | 2004                               |
| <b>Eurocode 1 Actions on Structures</b>      |                |                                                                                               |                  |                                    |
|                                              | BS EN 1991-1-1 | Actions on structures – Part 1-1: General actions – Densities, self-weight and imposed loads. | 2002             | 2005                               |
|                                              | BS EN 1991-1-6 | Actions on structures – Part 1-6: General actions – Actions during execution                  | 2005             | 2008                               |
| <b>Eurocode 7 Geotechnical Design</b>        |                |                                                                                               |                  |                                    |
|                                              | BS EN 1997-1   | Geotechnical design – Part 1: General rules.                                                  | 2004             | 2007                               |
|                                              | BS EN 1997-2   | Geotechnical design – Part 2: Ground investigation and testing.                               | 2007             | 2009                               |

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### BSI Published Documents

| Used | Document Reference | Title                                                                                                                                               | Date of Issue |
|------|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|      | PD 6688-1-1        | Background paper to the UK National Annex to BS EN 1991-1-1<br>[Actions on structures – General Actions – Densities, self-weight and imposed loads] | 2011          |
|      | PD 6694-1          | Recommendations for the design of structures subject to traffic loading to BS EN 1997-1<br>[Geotechnical Design – General rules]                    | 2011          |

### The Manual of Contract Documents for Highway Works (MCDHW)

| Used | Title                                                               | Date of Issue |
|------|---------------------------------------------------------------------|---------------|
|      | Volume 1: Specification for Highway Works                           | Feb 2016      |
|      | Volume 2: Notes for Guidance on the Specification for Highway Works | Feb 2016      |
|      | Volume 3: Highway Construction Details                              | Nov 2008      |

### The Design Manual for Roads and Bridges (DMRB)

*The following have been reproduced from the current alpha-numeric index in the DMRB, Volume 1, Section 0, Part 1, dated Mar 2015.*

| Bridges and Structures, Advice Notes (BA Series) |          |                                                 |          |        |
|--------------------------------------------------|----------|-------------------------------------------------|----------|--------|
|                                                  | BA 19/85 | The Use of BS 5400; Part 3; 1982                | Jan 1985 | 1.3    |
| Bridges and Structures, Standards (BD Series)    |          |                                                 |          |        |
|                                                  | BD 02/12 | Technical Approval of Highway Structures        | May 2012 | 1.1.1  |
|                                                  | BD 30/87 | Backfilled Retaining Walls and Bridge Abutments | Aug 1987 | 2.1    |
|                                                  | BD 37/01 | Loads for Highway Bridges                       | Aug 2001 | 1.3.14 |
|                                                  | BD 74/00 | Foundations                                     | May 2000 | 2.1.8  |

## **TECHNICAL APPROVAL OF HIGHWAY STRUCTURES**

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### **APPENDIX B**

#### **DESCRIPTION AND DIAGRAM OF IDEALISED STRUCTURE TO BE USED FOR ANALYSIS**

|             |                                                               |             |    |
|-------------|---------------------------------------------------------------|-------------|----|
| Project     | Proposed Detached Dwelling, 32 Paris Road, Scholes, Holmfirth | Prepared by | CD |
| Sub section | Risk Assessment Calculations                                  | Checked by  |    |

**Step 2: Consequence – number of vehicles affected.**

Using flow chart I2

From **Figure 2a:**

- Debris exit velocity = 6m/s.
- Vehicle Contained.

From **Table 8:** (Parapet mid-point at 0.55m (min.) to 2.5m (max.) above land/road below.

- Distance (spread) of debris = 8.0m

From equation **G3:** (vehicles on local road speed of 30mph (50km/h), AADT =100)

- Spacing =  $[50/(100/24)] \times 1000 = 12,000\text{m}$

From equation **G4:**  
 Calculate direct vulnerable vehicles struck per impact  
 $N_{\text{direct}} = 8/12000 = 0.00066$

Use table **G4:** road speed 40mph (64km/h)

- Total distance slowing to safer speed is **32.8m**

From equation **G5:** calculate indirect vulnerable vehicles struck per impact  
 $N_{\text{indirect}} = 32.8/12000 = 0.00273$

Using equation 1: (Note; from fig 2a, vehicle is contained so  $N_{\text{errant}} = 0$ )  
 Total vulnerable vehicles struck per impact  $N = 0 + 0.00066 + 0.00273 = 0.003396$

**Step 3: Fatal Accident Rate, (FAR)**

From **equation 3:**

$$\begin{aligned} \text{FAR} &= 100,000,000 / (\text{To} / N_{\text{total}}) \\ &= 100,000,000 / [(365 \times 24 \times 35) / (0.003396)] \\ &= 1.10 \end{aligned}$$

Comparing this to Table 6, this is ever-so-slightly more dangerous than travel by bus (1) and less dangerous than travel by car or by air (15).

**Therefore,** Un-reinforced stone masonry parapet wall considered acceptable as low FAR value calculated and no further action is required.

|                                                                              |                          |
|------------------------------------------------------------------------------|--------------------------|
| Project <b>Proposed Detached Dwelling, 32 Paris Road, Scholes, Holmfirth</b> | Prepared by<br><b>CD</b> |
| Sub section <b>Risk Assessment Calculations</b>                              | Checked by               |

**Risk Evaluation (Risk Assessment Calculation – In compliance with BS 6779:1999:Pt4:App A)**

Calculations provided as requested by Kirklees Highways, as dwelling is located on the adjacent elevation which faces the parapet to the proposed residential dwelling.

Parapet:-  
1.1m high un-reinforced masonry stone wall 350mm thick with coping to head of parapet. Wall length 11m approximately.

Highway Conditions:-  
Unclassified Road with a permitted traffic speed of 30mph. Hayfield Close is not subject to a weight limit, however the road is too narrow for use by a LGV vehicles.

A single footpath with kerb runs up Hayfield Close adjacent to the parapet wall and proposed site.

Parapet Containment:-

From Figure E1 (Appdx E):  
parapet wall can contain an impact speed capacity of 50km/h (30mph).

From Figure 2a Parapet Performance Chart (for N1 – 80km/h containment):  
Debris exit velocity = 6m/s.  
**Vehicle Contained.**

**CALCULATIONS:-**

***Step 1: Likelihood return period of vehicle impact.***

**Using flow chart I1**

From table G1: Environmental Factor:

| Factor                                     | Score             |
|--------------------------------------------|-------------------|
| Road Alignment (horizontal) factor         | Score = 3         |
| Road Alignment (vertical) factor           | Score = 3         |
| Speed of Traffic                           | Score = 3         |
| Road Verges & Footpaths                    | Score = 3         |
| Other Hazards increasing likelihood of RTA | Score = 9         |
| <b>Overall Total</b>                       | <b>Score = 21</b> |

From table G2: For AADT = 100 (minor two lane – unclassified) AADT Score = 2

From table G3: for EF of 21, AADT score of 2 : Return Period **To = 35 years**

**SGM**  
**STRUCTURAL**  
**DESIGN**

SPRINGFIELD LODGE  
4 THORNHILL ROAD  
HUDDERSFIELD  
HD3 3AU

TELEPHONE  
01484 435876

*Project at:*

**Proposed Detached Dwelling  
32 Paris Road, Scholes,  
Holmfirth, HD9 1UA**

*Client:* **Mr David Antich**

*Title:* **Private Retaining Wall Design**

**Structural Calculations  
for Building Regulations  
and Construction Purposes**

**Project No : 2018/149**  
**Date : November 2018**



# CALCULATION SHEET

Project Number 2018/149  
Sheet Number R.1  
Date Nov. 2018

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b>Project</b> Detached Dwelling, 32 Paris Road, Scholes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Prepared by</b><br>CD |
| <b>Sub Section</b> Introduction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                          |
| <b><u>Introduction</u></b><br><br>The existing detached house on the site is to be demolished and a new detached domestic dwelling constructed at the above named site location.<br><br>As part of the development, it is intended to construction a new highway retaining wall structure adjacent to Hayfield Close to the rear of the site.<br><br>The proposal is to construct a new mass retaining wall using masonry & mass concrete fill with a natural stone facing tied back to the wall. The wall is to be constructed off a solid mass concrete spread footing base, which is to be founded off competent natural Mudstone Rock formation with an allowable ground bearing pressure (G.B.P.) of 200 kN/m <sup>2</sup> or greater to the satisfaction of the Engineer.<br><br>As the retaining structure is directly adjacent the existing Public Bridleway, the proposed retaining wall is to be designed & detailed in strict accordance with the Local Authority Highways Standards, using all relevant sections of the 'Eurocodes', British Standards, Department of Transport Design Manuel for Roads & Bridges (DMRB), and the relevant BD series and BA series advice notes. |                          |



SGM Structural Design Ltd  
Springfield Lodge  
4 Thornhill Road, Edgerton  
Huddersfield, HD3 3DD

|                                                   |                         |                                 |               |
|---------------------------------------------------|-------------------------|---------------------------------|---------------|
| Project<br>32 PARIS ROAD, SCHOLLES, HOLMFIRTH     |                         | Job no.<br>2018/149             |               |
| Calcs for<br>EXTERNAL WORKS RETAINING WALL DESIGN |                         | Start page no./Revision<br>R. 2 |               |
| Calcs by<br>CD                                    | Calcs date<br>NOV. 2018 | Checked by                      | Checked date  |
|                                                   |                         | Approved by                     | Approved date |

## 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 2.9.05

### Retaining wall details

|                            |                                            |
|----------------------------|--------------------------------------------|
| Stem type                  | Cantilever with stepped rear face          |
| Stem height                | $h_{\text{stem}} = 2350 \text{ mm}$        |
| Number of steps            | $N_{\text{steps}} = 1$                     |
| Height of step 1           | $h_{s1} = 2350 \text{ mm}$                 |
| Thickness of step 1        | $t_{s1} = 1100 \text{ mm}$                 |
| Angle to rear face of stem | $\alpha = 90 \text{ deg}$                  |
| Stem density               | $\gamma_{\text{stem}} = 24 \text{ kN/m}^3$ |
| Toe length                 | $l_{\text{toe}} = 250 \text{ mm}$          |
| Heel length                | $l_{\text{heel}} = 150 \text{ mm}$         |
| Base thickness             | $t_{\text{base}} = 350 \text{ mm}$         |
| Base density               | $\gamma_{\text{base}} = 24 \text{ kN/m}^3$ |
| Height of retained soil    | $h_{\text{ret}} = 2200 \text{ mm}$         |
| Angle of soil surface      | $\beta = 0 \text{ deg}$                    |
| Depth of cover             | $d_{\text{cover}} = 150 \text{ mm}$        |

### Retained soil properties

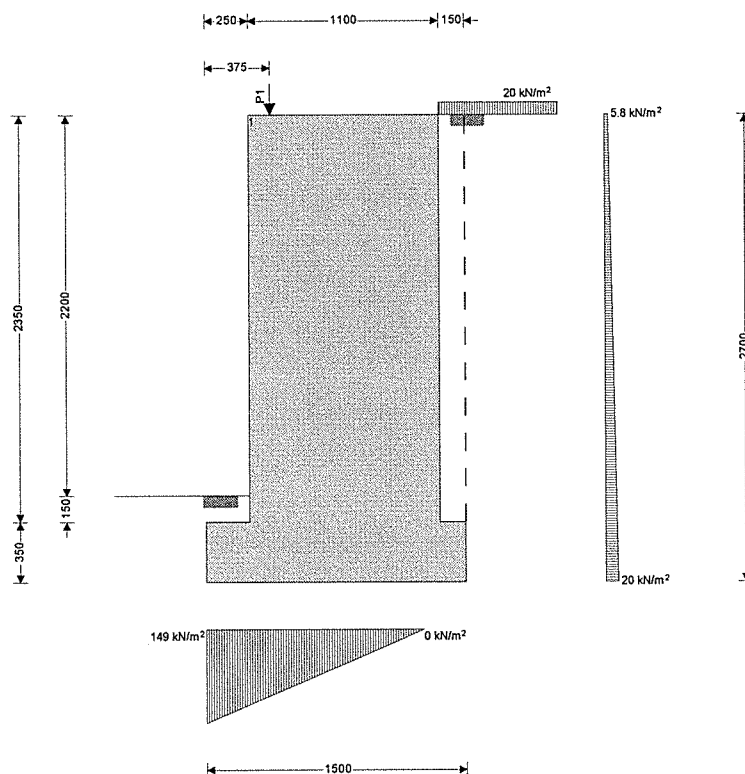
|                                                 |                                          |
|-------------------------------------------------|------------------------------------------|
| Moist density                                   | $\gamma_{\text{mr}} = 18 \text{ kN/m}^3$ |
| Saturated density                               | $\gamma_{\text{sr}} = 18 \text{ kN/m}^3$ |
| Characteristic effective shear resistance angle | $\phi'_{r,k} = 30 \text{ deg}$           |
| Characteristic wall friction angle              | $\delta_{r,k} = 15 \text{ deg}$          |

### Base soil properties

|                                                 |                                           |
|-------------------------------------------------|-------------------------------------------|
| Soil density                                    | $\gamma_b = 18 \text{ kN/m}^3$            |
| Characteristic effective shear resistance angle | $\phi'_{b,k} = 30 \text{ deg}$            |
| Characteristic wall friction angle              | $\delta_{b,k} = 15 \text{ deg}$           |
| Characteristic base friction angle              | $\delta_{bb,k} = 30 \text{ deg}$          |
| Presumed bearing capacity                       | $P_{\text{bearing}} = 200 \text{ kN/m}^2$ |

### Loading details

|                              |                                               |
|------------------------------|-----------------------------------------------|
| Variable surcharge load      | Surcharge <sub>q</sub> = 20 kN/m <sup>2</sup> |
| Vertical line load at 375 mm | $P_{G1} = 9 \text{ kN/m}$                     |



General arrangement

### Calculate retaining wall geometry

Base length

$$l_{base} = l_{toe} + t_{s1} + l_{heel} = 1500 \text{ mm}$$

Moist soil height

$$h_{moist} = h_{soil} = 2350 \text{ mm}$$

Length of surcharge load

$$l_{sur} = (l_{heel} + t_{s1} - t_{s1}) = 150 \text{ mm}$$

- Distance to vertical component

$$x_{sur_v} = l_{base} - (l_{heel} + t_{s1} - t_{s1}) / 2 = 1425 \text{ mm}$$

Effective height of wall

$$h_{eff} = h_{base} + d_{cover} + h_{ret} = 2700 \text{ mm}$$

- Distance to horizontal component

$$x_{sur_h} = h_{eff} / 2 = 1350 \text{ mm}$$

Area of wall stem

$$A_{stem} = h_{s1} \times t_{s1} = 2.585 \text{ m}^2$$

- Distance to vertical component

$$x_{stem} = l_{base} - (h_{s1} \times t_{s1} \times (l_{heel} + t_{s1} - t_{s1} / 2)) / A_{stem} = 800 \text{ mm}$$

Area of wall base

$$A_{base} = l_{base} \times t_{base} = 0.525 \text{ m}^2$$

- Distance to vertical component

$$x_{base} = l_{base} / 2 = 750 \text{ mm}$$

Area of moist soil

$$A_{moist} = l_{heel} \times h_{s1} = 0.353 \text{ m}^2$$

- Distance to vertical component

$$x_{moist_v} = l_{base} - (l_{heel} \times h_{s1} \times l_{heel} / 2) / A_{moist} = 1425 \text{ mm}$$

- Distance to horizontal component

$$x_{moist_h} = h_{eff} / 3 = 900 \text{ mm}$$

Area of base soil

$$A_{pass} = d_{cover} \times l_{toe} = 0.038 \text{ m}^2$$

- Distance to vertical component

$$x_{pass_v} = l_{base} - (d_{cover} \times l_{toe} \times (l_{base} - l_{toe} / 2)) / A_{pass} = 125 \text{ mm}$$

- Distance to horizontal component

$$x_{pass_h} = (d_{cover} + h_{base}) / 3 = 167 \text{ mm}$$

Area of excavated base soil

$$A_{exc} = h_{pass} \times l_{toe} = 0.038 \text{ m}^2$$

- Distance to vertical component

$$x_{exc_v} = l_{base} - (h_{pass} \times l_{toe} \times (l_{base} - l_{toe} / 2)) / A_{exc} = 125 \text{ mm}$$

- Distance to horizontal component

$$x_{exc_h} = (h_{pass} + h_{base}) / 3 = 167 \text{ mm}$$

|                                                                                                                                                                                                  |                                                   |                         |            |                                 |                              |
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### Using Coulomb theory

Active pressure coefficient

$$K_A = \sin(\alpha + \phi'_{r,k})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r,k}) \times [1 + \sqrt{[\sin(\phi'_{r,k} + \delta_{r,k}) \times \sin(\phi'_{r,k} - \beta) / (\sin(\alpha - \delta_{r,k}) \times \sin(\alpha + \beta))}]^2) = \mathbf{0.301}$$

Passive pressure coefficient

$$K_P = \sin(90 - \phi'_{b,k})^2 / (\sin(90 + \delta_{b,k}) \times [1 - \sqrt{[\sin(\phi'_{b,k} + \delta_{b,k}) \times \sin(\phi'_{b,k}) / (\sin(90 + \delta_{b,k}))}]^2) = \mathbf{4.977}$$

### Bearing pressure check

#### Vertical forces on wall

Wall stem

$$F_{stem} = A_{stem} \times \gamma_{stem} = \mathbf{62 \text{ kN/m}}$$

Wall base

$$F_{base} = A_{base} \times \gamma_{base} = \mathbf{12.6 \text{ kN/m}}$$

Surcharge load

$$F_{sur\_v} = \text{Surcharge}_Q \times (l_{heel} + t_{s1} - t_{s1}) = \mathbf{3 \text{ kN/m}}$$

Line loads

$$F_{P\_v} = P_{G1} = \mathbf{9 \text{ kN/m}}$$

Moist retained soil

$$F_{moist\_v} = A_{moist} \times \gamma_{mr} = \mathbf{6.3 \text{ kN/m}}$$

Base soil

$$F_{pass\_v} = A_{pass} \times \gamma_b = \mathbf{0.7 \text{ kN/m}}$$

Total

$$F_{total\_v} = F_{stem} + F_{base} + F_{moist\_v} + F_{pass\_v} + F_{sur\_v} + F_{P\_v} = \mathbf{93.7 \text{ kN/m}}$$

#### Horizontal forces on wall

Surcharge load

$$F_{sur\_h} = K_A \times \cos(\delta_{r,k}) \times \text{Surcharge}_Q \times h_{eff} = \mathbf{15.7 \text{ kN/m}}$$

Moist retained soil

$$F_{moist\_h} = K_A \times \cos(\delta_{r,k}) \times \gamma_{mr} \times h_{eff}^2 / 2 = \mathbf{19.1 \text{ kN/m}}$$

Base soil

$$F_{pass\_h} = -K_P \times \cos(\delta_{b,k}) \times \gamma_b \times (d_{cover} + h_{base})^2 / 2 = \mathbf{-10.8 \text{ kN/m}}$$

Total

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

### Moments on wall

Wall stem

$$M_{stem} = F_{stem} \times x_{stem} = \mathbf{49.6 \text{ kNm/m}}$$

Wall base

$$M_{base} = F_{base} \times x_{base} = \mathbf{9.5 \text{ kNm/m}}$$

Surcharge load

$$M_{sur} = F_{sur\_v} \times x_{sur\_v} - F_{sur\_h} \times x_{sur\_h} = \mathbf{-16.9 \text{ kNm/m}}$$

Line loads

$$M_P = P_{G1} \times p_1 = \mathbf{3.4 \text{ kNm/m}}$$

Moist retained soil

$$M_{moist} = F_{moist\_v} \times x_{moist\_v} - F_{moist\_h} \times x_{moist\_h} = \mathbf{-8.2 \text{ kNm/m}}$$

Base soil

$$M_{pass} = F_{pass\_v} \times x_{pass\_v} - F_{pass\_h} \times x_{pass\_h} = \mathbf{1.9 \text{ kNm/m}}$$

Total

$$M_{total} = M_{stem} + M_{base} + M_{moist} + M_{pass} + M_{sur} + M_P = \mathbf{39.2 \text{ kNm/m}}$$

### Check bearing pressure

Distance to reaction

$$\bar{x} = M_{total} / F_{total\_v} = \mathbf{419 \text{ mm}}$$

Eccentricity of reaction

$$e = \bar{x} - l_{base} / 2 = \mathbf{-331 \text{ mm}}$$

Loaded length of base

$$l_{load} = 3 \times \bar{x} = \mathbf{1257 \text{ mm}}$$

Bearing pressure at toe

$$q_{toe} = 2 \times F_{total\_v} / l_{load} = \mathbf{149 \text{ kN/m}^2}$$

Bearing pressure at heel

$$q_{heel} = \mathbf{0 \text{ kN/m}^2}$$

Factor of safety

$$FoS_{bp} = P_{bearing} / \max(q_{toe}, q_{heel}) = \mathbf{1.342}$$

**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

$$\gamma_G = \mathbf{1.35}$$

Permanent favourable action

$$\gamma_{Gf} = \mathbf{1.00}$$

Variable unfavourable action

$$\gamma_Q = \mathbf{1.50}$$

Variable favourable action

$$\gamma_{Qf} = \mathbf{0.00}$$



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#### 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               | $\gamma_{\gamma} = 1.00$ |

Library item Partial factors output

#### Retained soil properties

|                                         |                                                                                   |
|-----------------------------------------|-----------------------------------------------------------------------------------|
| Design moist density                    | $\gamma_{mr}' = \gamma_{mr} / \gamma_{\gamma} = 18 \text{ kN/m}^3$                |
| Design saturated density                | $\gamma_{sr}' = \gamma_{sr} / \gamma_{\gamma} = 18 \text{ kN/m}^3$                |
| Design effective shear resistance angle | $\phi'_{r,d} = \text{atan}(\tan(\phi'_{r,k}) / \gamma_{\phi}) = 30 \text{ deg}$   |
| Design wall friction angle              | $\delta_{r,d} = \text{atan}(\tan(\delta_{r,k}) / \gamma_{\phi}) = 15 \text{ deg}$ |

#### Base soil properties

|                                         |                                                                                     |
|-----------------------------------------|-------------------------------------------------------------------------------------|
| Design soil density                     | $\gamma_b' = \gamma_b / \gamma_{\gamma} = 18 \text{ kN/m}^3$                        |
| Design effective shear resistance angle | $\phi'_{b,d} = \text{atan}(\tan(\phi'_{b,k}) / \gamma_{\phi}) = 30 \text{ deg}$     |
| Design wall friction angle              | $\delta_{b,d} = \text{atan}(\tan(\delta_{b,k}) / \gamma_{\phi}) = 15 \text{ deg}$   |
| Design base friction angle              | $\delta_{bb,d} = \text{atan}(\tan(\delta_{bb,k}) / \gamma_{\phi}) = 30 \text{ deg}$ |
| Design effective cohesion               | $c'_{b,d} = c'_{b,k} / \gamma_c = 0 \text{ kN/m}^2$                                 |

#### Using Coulomb theory

|                              |                                                                                                                                                                                                                                                          |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Active pressure coefficient  | $K_A = \sin(\alpha + \phi'_{r,d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r,d}) \times [1 + \sqrt{[\sin(\phi'_{r,d} + \delta_{r,d}) \times \sin(\phi'_{r,d} - \beta) / (\sin(\alpha - \delta_{r,d}) \times \sin(\alpha + \beta))]}]^2) = 0.301$ |
| Passive pressure coefficient | $K_P = \sin(90 - \phi'_{b,d})^2 / (\sin(90 + \delta_{b,d}) \times [1 - \sqrt{[\sin(\phi'_{b,d} + \delta_{b,d}) \times \sin(\phi'_{b,d}) / (\sin(90 + \delta_{b,d}))]}]^2) = 4.977$                                                                       |

#### Sliding check

##### Vertical forces on wall

|                     |                                                                                                                                    |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Wall stem           | $F_{\text{stem}} = \gamma_{Gf} \times A_{\text{stem}} \times \gamma_{\text{stem}} = 62 \text{ kN/m}$                               |
| Wall base           | $F_{\text{base}} = \gamma_{Gf} \times A_{\text{base}} \times \gamma_{\text{base}} = 12.6 \text{ kN/m}$                             |
| Line loads          | $F_{P\_v} = \gamma_{Gf} \times P_{G1} = 9 \text{ kN/m}$                                                                            |
| Moist retained soil | $F_{\text{moist\_v}} = \gamma_{Gf} \times A_{\text{moist}} \times \gamma_{mr}' = 6.3 \text{ kN/m}$                                 |
| Base soil           | $F_{\text{exc\_v}} = \gamma_{Gf} \times A_{\text{exc}} \times \gamma_b' = 0.7 \text{ kN/m}$                                        |
| Total               | $F_{\text{total\_v}} = F_{\text{stem}} + F_{\text{base}} + F_{\text{moist\_v}} + F_{\text{exc\_v}} + F_{P\_v} = 90.7 \text{ kN/m}$ |

##### Horizontal forces on wall

|                     |                                                                                                                                           |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Surcharge load      | $F_{\text{sur\_h}} = K_A \times \cos(\delta_{r,d}) \times \gamma_Q \times \text{Surcharge}_Q \times h_{\text{eff}} = 23.6 \text{ kN/m}$   |
| Moist retained soil | $F_{\text{moist\_h}} = \gamma_G \times K_A \times \cos(\delta_{r,d}) \times \gamma_{mr}' \times h_{\text{eff}}^2 / 2 = 25.8 \text{ kN/m}$ |
| Total               | $F_{\text{total\_h}} = F_{\text{moist\_h}} + F_{\text{sur\_h}} = 49.4 \text{ kN/m}$                                                       |

#### Check stability against sliding

|                       |                                                                                                                                                              |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Base soil resistance  | $F_{\text{exc\_h}} = \gamma_{Gf} \times K_P \times \cos(\delta_{b,d}) \times \gamma_b' \times (h_{\text{pass}} + h_{\text{base}})^2 / 2 = 10.8 \text{ kN/m}$ |
| Base friction         | $F_{\text{friction}} = F_{\text{total\_v}} \times \tan(\delta_{bb,d}) = 52.3 \text{ kN/m}$                                                                   |
| Resistance to sliding | $F_{\text{rest}} = F_{\text{exc\_h}} + F_{\text{friction}} = 63.2 \text{ kN/m}$                                                                              |
| Factor of safety      | $FoS_{\text{sl}} = F_{\text{rest}} / F_{\text{total\_h}} = 1.279$                                                                                            |

**PASS - Resistance to sliding is greater than sliding force**

#### Overtipping check

##### Vertical forces on wall

|           |                                                                                                      |
|-----------|------------------------------------------------------------------------------------------------------|
| Wall stem | $F_{\text{stem}} = \gamma_{Gf} \times A_{\text{stem}} \times \gamma_{\text{stem}} = 62 \text{ kN/m}$ |
|-----------|------------------------------------------------------------------------------------------------------|



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Wall base  $F_{base} = \gamma_{Gf} \times A_{base} \times \gamma_{base} = 12.6 \text{ kN/m}$   
 Line loads  $F_{P\_v} = \gamma_{Gf} \times P_{G1} = 9 \text{ kN/m}$   
 Moist retained soil  $F_{moist\_v} = \gamma_{Gf} \times A_{moist} \times \gamma_{mr}' = 6.3 \text{ kN/m}$   
 Base soil  $F_{exc\_v} = \gamma_{Gf} \times A_{exc} \times \gamma_b' = 0.7 \text{ kN/m}$   
 Total  $F_{total\_v} = F_{stem} + F_{base} + F_{moist\_v} + F_{exc\_v} + F_{P\_v} = 90.7 \text{ kN/m}$

#### Horizontal forces on wall

Surcharge load  $F_{sur\_h} = K_A \times \cos(\delta_{r,d}) \times \gamma_Q \times \text{Surcharge}_Q \times h_{eff} = 23.6 \text{ kN/m}$   
 Moist retained soil  $F_{moist\_h} = \gamma_G \times K_A \times \cos(\delta_{r,d}) \times \gamma_{mr}' \times h_{eff}^2 / 2 = 25.8 \text{ kN/m}$   
 Base soil  $F_{exc\_h} = -\gamma_{Gf} \times K_P \times \cos(\delta_{b,d}) \times \gamma_b' \times (h_{pass} + h_{base})^2 / 2 = -10.8 \text{ kN/m}$   
 Total  $F_{total\_h} = F_{moist\_h} + F_{exc\_h} + F_{sur\_h} = 38.6 \text{ kN/m}$

#### Overturning moments on wall

Surcharge load  $M_{sur\_OT} = F_{sur\_h} \times X_{sur\_h} = 31.8 \text{ kNm/m}$   
 Moist retained soil  $M_{moist\_OT} = F_{moist\_h} \times X_{moist\_h} = 23.2 \text{ kNm/m}$   
 Total  $M_{total\_OT} = M_{moist\_OT} + M_{sur\_OT} = 55 \text{ kNm/m}$

#### Restoring moments on wall

Wall stem  $M_{stem\_R} = F_{stem} \times X_{stem} = 49.6 \text{ kNm/m}$   
 Wall base  $M_{base\_R} = F_{base} \times X_{base} = 9.5 \text{ kNm/m}$   
 Line loads  $M_{P\_R} = \text{abs}(\gamma_{Gf} \times P_{G1}) \times p_1 = 3.4 \text{ kNm/m}$   
 Moist retained soil  $M_{moist\_R} = F_{moist\_v} \times X_{moist\_v} = 9 \text{ kNm/m}$   
 Base soil  $M_{exc\_R} = F_{exc\_v} \times X_{exc\_v} - F_{exc\_h} \times X_{exc\_h} = 1.9 \text{ kNm/m}$   
 Total  $M_{total\_R} = M_{stem\_R} + M_{base\_R} + M_{moist\_R} + M_{exc\_R} + M_{P\_R} = 73.4 \text{ kNm/m}$

#### Check stability against overturning

Factor of safety  $FoS_{ot} = M_{total\_R} / M_{total\_OT} = 1.333$

**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  $\gamma_G = 1.00$   
 Permanent favourable action  $\gamma_{Gf} = 1.00$   
 Variable unfavourable action  $\gamma_Q = 1.30$   
 Variable favourable action  $\gamma_{Qf} = 0.00$

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

Soil parameter set M2  
 Angle of shearing resistance  $\gamma_{\phi'} = 1.25$   
 Effective cohesion  $\gamma_{c'} = 1.25$   
 Weight density  $\gamma_Y = 1.00$

Library item Partial factors output

#### Retained soil properties

Design moist density  $\gamma_{mr}' = \gamma_{mr} / \gamma_Y = 18 \text{ kN/m}^3$   
 Design saturated density  $\gamma_{sr}' = \gamma_{sr} / \gamma_Y = 18 \text{ kN/m}^3$   
 Design effective shear resistance angle  $\phi'_{r,d} = \text{atan}(\tan(\phi'_{r,k}) / \gamma_{\phi'}) = 24.8 \text{ deg}$   
 Design wall friction angle  $\delta_{r,d} = \text{atan}(\tan(\delta_{r,k}) / \gamma_{\phi'}) = 12.1 \text{ deg}$



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### Base soil properties

Design soil density

$$\gamma_b' = \gamma_b / \gamma_r = 18 \text{ kN/m}^3$$

Design effective shear resistance angle

$$\phi'_{b,d} = \text{atan}(\tan(\phi'_{b,k}) / \gamma_\phi) = 24.8 \text{ deg}$$

Design wall friction angle

$$\delta_{b,d} = \text{atan}(\tan(\delta_{b,k}) / \gamma_\phi) = 12.1 \text{ deg}$$

Design base friction angle

$$\delta_{bb,d} = \text{atan}(\tan(\delta_{bb,k}) / \gamma_\phi) = 24.8 \text{ deg}$$

Design effective cohesion

$$c'_{b,d} = c'_{b,k} / \gamma_c = 0 \text{ kN/m}^2$$

### Using Coulomb theory

Active pressure coefficient

$$K_A = \sin(\alpha + \phi'_{r,d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r,d}) \times [1 + \sqrt{[\sin(\phi'_{r,d} + \delta_{r,d}) \times \sin(\phi'_{r,d} - \beta) / (\sin(\alpha - \delta_{r,d}) \times \sin(\alpha + \beta))]}]^2) = 0.371$$

Passive pressure coefficient

$$K_P = \sin(90 - \phi'_{b,d})^2 / (\sin(90 + \delta_{b,d}) \times [1 - \sqrt{[\sin(\phi'_{b,d} + \delta_{b,d}) \times \sin(\phi'_{b,d} - \beta) / (\sin(90 + \delta_{b,d}))]}]^2) = 3.473$$

### Sliding check

#### Vertical forces on wall

Wall stem

$$F_{\text{stem}} = \gamma_{Gf} \times A_{\text{stem}} \times \gamma_{\text{stem}} = 62 \text{ kN/m}$$

Wall base

$$F_{\text{base}} = \gamma_{Gf} \times A_{\text{base}} \times \gamma_{\text{base}} = 12.6 \text{ kN/m}$$

Line loads

$$F_{P_v} = \gamma_{Gf} \times P_{G1} = 9 \text{ kN/m}$$

Moist retained soil

$$F_{\text{moist}_v} = \gamma_{Gf} \times A_{\text{moist}} \times \gamma_{mr}' = 6.3 \text{ kN/m}$$

Base soil

$$F_{\text{exc}_v} = \gamma_{Gf} \times A_{\text{exc}} \times \gamma_b' = 0.7 \text{ kN/m}$$

Total

$$F_{\text{total}_v} = F_{\text{stem}} + F_{\text{base}} + F_{\text{moist}_v} + F_{\text{exc}_v} + F_{P_v} = 90.7 \text{ kN/m}$$

#### Horizontal forces on wall

Surcharge load

$$F_{\text{sur}_h} = K_A \times \cos(\delta_{r,d}) \times \gamma_Q \times \text{Surcharge}_Q \times h_{\text{eff}} = 25.5 \text{ kN/m}$$

Moist retained soil

$$F_{\text{moist}_h} = \gamma_G \times K_A \times \cos(\delta_{r,d}) \times \gamma_{mr}' \times h_{\text{eff}}^2 / 2 = 23.8 \text{ kN/m}$$

Total

$$F_{\text{total}_h} = F_{\text{moist}_h} + F_{\text{sur}_h} = 49.3 \text{ kN/m}$$

### Check stability against sliding

Base soil resistance

$$F_{\text{exc}_h} = \gamma_{Gf} \times K_P \times \cos(\delta_{b,d}) \times \gamma_b' \times (h_{\text{pass}} + h_{\text{base}})^2 / 2 = 7.6 \text{ kN/m}$$

Base friction

$$F_{\text{friction}} = F_{\text{total}_v} \times \tan(\delta_{bb,d}) = 41.9 \text{ kN/m}$$

Resistance to sliding

$$F_{\text{rest}} = F_{\text{exc}_h} + F_{\text{friction}} = 49.5 \text{ kN/m}$$

Factor of safety

$$FoS_{Sl} = F_{\text{rest}} / F_{\text{total}_h} = 1.005$$

**PASS - Resistance to sliding is greater than sliding force**

### Overtipping check

#### Vertical forces on wall

Wall stem

$$F_{\text{stem}} = \gamma_{Gf} \times A_{\text{stem}} \times \gamma_{\text{stem}} = 62 \text{ kN/m}$$

Wall base

$$F_{\text{base}} = \gamma_{Gf} \times A_{\text{base}} \times \gamma_{\text{base}} = 12.6 \text{ kN/m}$$

Line loads

$$F_{P_v} = \gamma_{Gf} \times P_{G1} = 9 \text{ kN/m}$$

Moist retained soil

$$F_{\text{moist}_v} = \gamma_{Gf} \times A_{\text{moist}} \times \gamma_{mr}' = 6.3 \text{ kN/m}$$

Base soil

$$F_{\text{exc}_v} = \gamma_{Gf} \times A_{\text{exc}} \times \gamma_b' = 0.7 \text{ kN/m}$$

Total

$$F_{\text{total}_v} = F_{\text{stem}} + F_{\text{base}} + F_{\text{moist}_v} + F_{\text{exc}_v} + F_{P_v} = 90.7 \text{ kN/m}$$

#### Horizontal forces on wall

Surcharge load

$$F_{\text{sur}_h} = K_A \times \cos(\delta_{r,d}) \times \gamma_Q \times \text{Surcharge}_Q \times h_{\text{eff}} = 25.5 \text{ kN/m}$$

Moist retained soil

$$F_{\text{moist}_h} = \gamma_G \times K_A \times \cos(\delta_{r,d}) \times \gamma_{mr}' \times h_{\text{eff}}^2 / 2 = 23.8 \text{ kN/m}$$

Base soil

$$F_{\text{exc}_h} = -\gamma_{Gf} \times K_P \times \cos(\delta_{b,d}) \times \gamma_b' \times (h_{\text{pass}} + h_{\text{base}})^2 / 2 = -7.6 \text{ kN/m}$$

Total

$$F_{\text{total}_h} = F_{\text{moist}_h} + F_{\text{exc}_h} + F_{\text{sur}_h} = 41.6 \text{ kN/m}$$



SGM Structural Design Ltd  
Springfield Lodge  
4 Thornhill Road, Edgerton  
Huddersfield, HD3 3DD

|                                                   |                         |                                 |              |
|---------------------------------------------------|-------------------------|---------------------------------|--------------|
| Project<br>32 PARIS ROAD, SCHOLES, HOLMFIRTH      |                         | Job no.<br>2018/149             |              |
| Calcs for<br>EXTERNAL WORKS RETAINING WALL DESIGN |                         | Start page no./Revision<br>R. 8 |              |
| Calcs by<br>CD                                    | Calcs date<br>NOV. 2018 | Checked by                      | Checked date |
| Approved by                                       |                         | Approved date                   |              |

#### Overturning moments on wall

Surcharge load

$$M_{sur\_OT} = F_{sur\_h} \times X_{sur\_h} = 34.4 \text{ kNm/m}$$

Moist retained soil

$$M_{moist\_OT} = F_{moist\_h} \times X_{moist\_h} = 21.4 \text{ kNm/m}$$

Total

$$M_{total\_OT} = M_{moist\_OT} + M_{sur\_OT} = 55.8 \text{ kNm/m}$$

#### Restoring moments on wall

Wall stem

$$M_{stem\_R} = F_{stem} \times X_{stem} = 49.6 \text{ kNm/m}$$

Wall base

$$M_{base\_R} = F_{base} \times X_{base} = 9.5 \text{ kNm/m}$$

Line loads

$$M_{P\_R} = \text{abs}(\gamma_{Gf} \times P_{G1}) \times p_1 = 3.4 \text{ kNm/m}$$

Moist retained soil

$$M_{moist\_R} = F_{moist\_v} \times X_{moist\_v} = 9 \text{ kNm/m}$$

Base soil

$$M_{exc\_R} = F_{exc\_v} \times X_{exc\_v} - F_{exc\_h} \times X_{exc\_h} = 1.4 \text{ kNm/m}$$

Total

$$M_{total\_R} = M_{stem\_R} + M_{base\_R} + M_{moist\_R} + M_{exc\_R} + M_{P\_R} = 72.9 \text{ kNm/m}$$

#### Check stability against overturning

Factor of safety

$$FoS_{ot} = M_{total\_R} / M_{total\_OT} = 1.306$$

**PASS - Maximum restoring moment is greater than overturning moment**

## **TECHNICAL APPROVAL OF HIGHWAY STRUCTURES**

Scheme: 32 Paris Road, Scholes, Holmfirth, HD9 1UA

Structure: Proposed private burr wall to support adjacent highway    Date:- November 2018

---

### **APPENDIX C**

#### **GENERAL ARRANGEMENT DRAWING**



## **TECHNICAL APPROVAL OF HIGHWAY STRUCTURES**

Scheme: 32 Paris Road, Scholes, Holmfirth, HD9 1UA

Structure: Proposed private burr wall to support adjacent highway    Date:- November 2018

---

### **APPENDIX D**

#### **SITE INVESTIGATION REPORT**

**Environmental  
Geotechnical  
Specialists**



# REPORT

|                                                                         |                                    |
|-------------------------------------------------------------------------|------------------------------------|
| job number<br><b>J4251/18/E/G</b>                                       | date<br><b>25.06.18</b>            |
| site address<br><b>Paris Road</b><br><b>Scholes</b><br><b>Holmfirth</b> |                                    |
| written by<br><b>R.A. Palmer</b>                                        | checked by<br><b>J. Farnsworth</b> |
| issued by<br><b>R.A. Palmer</b>                                         |                                    |

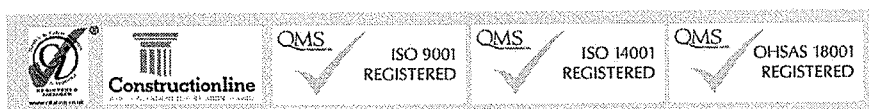
**Rogers Geotechnical Services Ltd**

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GEO TECHNICAL  
ENVIRONMENTAL



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## Report on a Geotechnical Investigation

Location: **Paris Road**  
Scholes, Holmfirth

For: Antich & Sons (Huddersfield) Ltd

Consultants: S. G. M. Structural Design.

Report No. J4251/18/E/G

Report date: June 2018

For and on behalf of **Rogers Geotechnical Services Ltd**

**Rob Palmer** MSc FGS ACIEH  
Senior Geo-environmental Engineer

**James Farnsworth** BEng FGS  
Principal Engineer

## Report Summary<sup>1</sup>

| Item                | Comments                                                                                                                                                                                                     | Section   |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Development         | Demolition of existing property and garage, followed by reconstruction of a new property and garage, albeit at a lower level. Temporary piled structure to be constructed to retain neighbouring structures. | 1.        |
| Geology             | No superficial geology over Rough Rock (sandstone)                                                                                                                                                           | 4.        |
| Strata Conditions   | Nominal thickness of made ground over very sandy gravel (weathered rock). Rock at 1.1m (BH1 – raised area next to existing garage).                                                                          | 5. & 5.1. |
| Groundwater         | None recorded.                                                                                                                                                                                               | 5.2.      |
| Foundation Design   | Shallow strip or spread foundations.                                                                                                                                                                         | 8.1.      |
| Ground-floor        | Suspended ground-floor slab.                                                                                                                                                                                 | 8.3.      |
| Effect of Sulphates | DS-1. ACEC Classification AC-1s.                                                                                                                                                                             | 8.4.      |

<sup>1</sup> This summary should not be relied upon to provide a comprehensive review. All of the information contained in this document should be considered.



## 1. Introduction

---

It is understood that the site is to be developed by the demolition of the existing property and garage, followed by the construction of a new detached house and garage, albeit at a lower level. It should be appreciated that the property and garage has already been demolished at the time of the fieldworks and it is understood that the remnant foundations have been removed. Furthermore, a temporary piled structure is going to be installed prior to the construction phase in order to retain a neighbouring garage and road. Once undertaken, a permanent retaining structure will be constructed.

Consequently, a site investigation has been undertaken in accordance with the instruction from the client. This work was required in order to determine the nature of the underlying soils, to assess their engineering properties and to assist in the design of safe and economical foundations for the proposed development. This report describes the work undertaken, presents the data obtained and discusses the ground conditions in relation to the proposed works.

## 2. Limitations

---

The recommendations made and opinions expressed in this report are based on the ground conditions revealed by the site works, together with an assessment of the site and of the laboratory test results. Whilst opinions may be expressed relating to sub-soil conditions in parts of the site not investigated, for example between borehole and probe positions, these are for guidance only and no liability can be accepted for their accuracy.

This report has been prepared in accordance with our understanding of current best practice. However, new information or legislation, or changes to best practice may necessitate revision of the report after the date of issue.

It should be appreciated that this report does not consider any environmental contamination issues including the effects of hazardous ground gasses (e.g. carbon dioxide, methane or radon).

## 3. Fieldworks

---

The fieldworks were undertaken on the 14<sup>th</sup> April 2017 and included the following:

- One windowless sample and rotary borehole.
- Two dynamic probes; one adjacent to the borehole and one at the base of the existing excavation.

The investigatory locations are shown on the site plan which is presented in Appendix 1 to this report. It should be further appreciated that photographs of the excavation have been included within this appendix in order to demonstrate the outcrop/profile below the top of wall level of the borehole.



### 3.1 Windowless Sample and Rotary Borehole

The borehole was initially sunk using a Dando Terrier by windowless sampling in 1m lengths, using 90mm diameter shell. Upon meeting rock, an 86mm diameter core barrel was employed to provide cores of the solid geology. The cores were described in general accordance with BS5930: 2015 and full descriptions are given on the borehole records presented in Appendix 2.

### 3.2 Dynamic Probes

A dynamic penetration tests was undertaken adjacent to the windowless sample borehole, and the base of the excavation, in accordance with the procedure given in BS1377: 1990: Part 9, using the super heavy penetrometer (DPSH). This probe consists of a 63.5kg mass falling through 750mm onto an anvil, which drives a 50mm diameter cone into the ground. The number of blows required to drive the cone through successive 100mm increments are recorded as the  $N_{100}$  values. The results of the dynamic penetration tests are tabulated and presented as bar charts of  $N_{100}$  values versus depth in Appendix 3.

## 4. Geology

The available published geological data for the site has been examined and the following table presents the anticipated geology.

| Table 1: Geological Data for the Site |                          |                            |                                                     |
|---------------------------------------|--------------------------|----------------------------|-----------------------------------------------------|
| Strata Type                           | Strata Name <sup>2</sup> | Previous Name <sup>3</sup> | Description <sup>3</sup>                            |
| Superficial Geology                   | None recorded            | -                          | -                                                   |
| Solid Geology                         | Rough Rock               | Rough Rock Formation       | Coarse-grained feldspathic sandstone, cross-bedded. |

It should be appreciated that no superficial deposits are shown to be present beneath the site. The Rough Rock, a named sandstone unit, is indicated to be present directly beneath the site. It should be appreciated that the Rossendale Formation, an older siltstone and mudstone formation, is indicated to outcrop within the surrounding areas. Markers within the same faulted block on the geological map suggest that the stratum generally dips at about 4° to the north-east.

<sup>2</sup> Sources: British Geological Survey (NERC) Map Sheets 86; Glossop; Solid and Drift Edition, and Geology of Britain Viewer [online resource from [www.bgs.ac.uk](http://www.bgs.ac.uk)]

<sup>3</sup> Sources: British Geological Survey (NERC) Lexicon of Named Rock Units [online resource from [www.bgs.ac.uk](http://www.bgs.ac.uk)]



## 5. Strata Conditions

In accordance with the geology of the area, the succession has been shown to include the following:

**Table 2: Generalised Strata Profile**

| Depth<br>m below ground<br>level to underside<br>of layer | Strata Type                     | Groundwater<br>Strikes<br>m below ground level |
|-----------------------------------------------------------|---------------------------------|------------------------------------------------|
| 0.2                                                       | Made ground (Granular)          | None                                           |
| 1.1                                                       | Very sandy GRAVEL               | None                                           |
| 2.35                                                      | SANDSTONE (Rough Rock)          | None                                           |
| +3.85                                                     | MUDSTONE (Rossendale Formation) | None                                           |

'+' denotes that the strata extended below the termination depth of the investigated positions, thus the extent of the deposit is only proven to the depths indicated.

### 5.1 General Strata

The borehole location was found to be capped by 0.2m of granular made ground comprising very sandy gravel of sandstone and rare mortar. This layer was underlain by very sandy angular and sub-angular gravel of sandstone to 1.1m. These granular soils are anticipated to represent the weathered fraction of the underlying rock.

Beneath the soils, 1.25m of sandstone was initially recovered, followed by mudstone which was revealed to 3.85m, whereupon the borehole was terminated. The sandstone is considered to be associated with the Rough Rock, however, the mudstone may represent the Rossendale Formation.

It should be appreciated that the windowless sampler and dynamic probe refused at 1.1m, which was anticipated to be on the underlying rock. However, poor recovery was recorded within the sandstone. Given the profile/outcrop exposed within the excavation (photographs within Appendix 1), it is anticipated that the sandstone is present as sandy coarse gravel and cobbles (corestones) of sandstone, rather than complete 'intact' rock. This would explain the poor recovery, as finer materials will have been washed out by the flush introduced during the drilling process. Therefore, only the coarse gravel and corestones were retained, producing poor recovery.

Furthermore, similar circumstances occurred within the mudstone, where poor recovery was also observed. The mudstone was noted as being extremely weak and possessed a thinly laminated structure. Therefore, again, any finer weak material may have been susceptible to wash out by the flush introduced during drilling. Nevertheless, it is considered that the mudstone was present as 'intact' rock, albeit in an extremely weak thinly laminated condition.



## 5.2 Groundwater

No groundwater was observed during this investigation. However, it should be appreciated that the normal rate of boring does not permit the recording of an equilibrium water level for any one strike. Moreover, groundwater levels are subject to seasonal variation or changes on local drainage conditions.

## 6. Insitu Testing

Dynamic penetration tests were undertaken adjacent to the windowless sample borehole position (DP1) and at the base of the excavation (DP2), where the new property will be constructed. A summary of the results is presented below:

**Table 3: Summary of Dynamic Penetration Tests**

| Position | Blows/100mm                                         |        |     | Refusal type<br>(Effective/<br>Abrupt) <sup>4</sup> | Comments                                                                                                                                                       |
|----------|-----------------------------------------------------|--------|-----|-----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | 0 - 2                                               | 3 - 10 | 10+ |                                                     |                                                                                                                                                                |
|          | Depth to which blow count range was<br>observed (m) |        |     |                                                     |                                                                                                                                                                |
| DP1      | 0.1                                                 | 0.3    | 1.2 | Effective                                           | Variable results recorded until refusal. This is<br>anticipated to have been caused by the<br>presence of gravels within the made ground<br>and natural soils. |
|          | 0.4                                                 | 1      |     |                                                     |                                                                                                                                                                |
| DP2      | 1                                                   | 1.5    | 1.8 | Abrupt                                              | Low blow counts recorded until 1m,<br>whereupon results significantly increase until<br>refusal.                                                               |

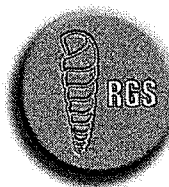
## 7. Laboratory Testing - Geotechnical

The following programme of laboratory testing has been undertaken on samples obtained during this investigation:

- |                                          |                         |
|------------------------------------------|-------------------------|
| ▪ Particle size distribution (Dry sieve) | BS 1377: 1990: Pt2: 9.3 |
| ▪ Soluble sulphate content               | BS 1377: 1990: Pt3: 5   |
| ▪ pH value                               | BS 1377: 1990: Pt3: 9   |
| ▪ Point Load Strength Index Test         | ISRM (1984)             |

The test results are presented in Appendix 4 and are summarised below:

<sup>4</sup> Abrupt refusal: obstruction or bedrock encountered. Effective refusal: +25 blows/100mm.

**Table 4: Summary of Geotechnical Test Results**

| Test type                              | Number of tests                | Range of results                   |                             | Comments                                                                                                                   |
|----------------------------------------|--------------------------------|------------------------------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Particle size distribution (Dry sieve) | 1                              | Gravel<br>Sand<br>Silt/Clay        | 71%<br>29%<br>1%            | Gap-graded very sandy GRAVEL<br>Uniformity coefficient 33<br>Curvature coefficient 0.53                                    |
| Soluble sulphate & pH                  | 1                              | SO <sub>4</sub><br>pH              | <0.01 g/l<br>4.9            | DS-1, ACEC Classification AC-1                                                                                             |
| Point Load Strength Index              | 2                              | Is <sub>(50)</sub> Axial           | 0.9 & 1.2 MN/m <sup>2</sup> | Equivalent UCS, 18 to 24MN/m <sup>2</sup> axial assuming UCS=Is <sub>(50)</sub> *20<br>Rock strength indicated to be weak. |
| Description                            | Angle of friction, $\phi'$ (°) | Coefficient of Earth Pressure (ka) |                             | Effective cohesion c' (kN/m <sup>2</sup> )                                                                                 |
| Very sandy GRAVEL                      | 30                             | 0.5                                |                             | 0                                                                                                                          |

## 8. Discussion of Ground Conditions - Geotechnical

It is understood that the site is to be developed by the demolition of the existing property and garage, followed by the construction of a new detached house and garage, albeit at a lower level. It should be appreciated that the property and garage have already been demolished and it is understood that the remnant foundations have been removed. Furthermore, a temporary piled structure is going to be installed prior to the construction phase in order to retain a neighbouring garage and road. Once undertaken, a permanent retaining structure will be constructed. The precise structural details are not currently known, thus the discussion below is of a generalised nature.

### 8.1 Foundations

It cannot be recommended that foundations be constructed directly within any made ground or soft cohesive, and/or loose granular, near surface soils associated with the underlying Rough Rock. These soils are present in a weak and variable condition such that excessive total and or differential settlement could occur under moderately light surface loading.

Consequently, it is considered that foundations could include the provision of shallow strip and spread footings constructed on the underlying rock, which the dynamic probe (DP2) indicated to be present at



1m depth at the base of the excavation. This material would possess a significant bearing capacity, probably being in excess of 200kN/m<sup>2</sup>. Therefore, at a typical foundation load for a house the factor of safety against general shear failure will be high, probably exceeding 10. In addition, it is considered that nominal settlements will occur under the action of the proposed increase in load.

Notwithstanding the above, some caution will be necessary to ensure that footings for each dwelling are placed wholly within the rock and that the bases of the excavations are free of compressible strata such as granular or cohesive soils. It should be appreciated that this may occur at depths of greater than 1m.

Should any weak zones be revealed in the excavation bases, they should be removed and replaced by suitably compacted granular soil or lean-mixed concrete. In addition, it is recommended that care is taken to ensure that any remnant sub-structure of the former works is fully removed from footing excavations. Following this, careful inspection will be necessary to establish that rock is present, or the approach for weak zones given above should be undertaken.

Should excavations be required to stand open for any length of time, it will be necessary to place a blinding layer of lean-mixed concrete over the sub-grade. This expedient will reduce loosening or softening of the underling soil due to both physical disturbance and the ingress of surface water. If seepages of groundwater are encountered it is considered that they could be dealt with using a simple form of de-watering. Such a system could include the excavation of sumps from which the water could be pumped.

The stability of the excavation faces cannot be guaranteed thus temporary support to the excavation faces may become necessary unless the foundations are constructed using trench-fill techniques. In this method the foundation trenches should be excavated, inspected and backfilled with concrete as a continuous operation. Under no circumstances should operatives be allowed to enter unsupported excavations.

## 8.2 Wall Structure

It is understood that the neighbouring garage and road needs to be retained by a temporary structure, prior to the construction phase, after which a permanent retaining wall is to be constructed. Furthermore, it is understood that a piled temporary wall is the preferred method of construction, with a permanent gravity retaining wall to be constructed afterwards.

Whilst core stones within the sandstone possess a weak strength, it is reasoned that for the purposes of this discussion, the sandstone should be considered as a dense gravel, although it should be appreciated that there may be less weathered zones present which may contain a greater volume of intact rock.

In order to assist in the design of any retaining structures, the soil parameters, in terms of effective stress, for the very sandy gravel (including the sandstone), are required. For design and estimating purposes it is considered that the parameters detailed in Table 4 may be utilised.



It is considered that the mudstone revealed in this investigation will provide a suitable bearing stratum for a retaining structure. Taking into consideration the visual inspection of the mudstone obtained during this investigation, it is considered that the underlying mudstone bedrock is extremely weak. Therefore, for design purposes an unconfined compression strength (UCS) of 0.6MPa could be adopted for design. This may conservatively be taken as an undrained cohesion,  $c_u$ , of 300kN/m<sup>2</sup>.

It should be appreciated that given the shallow depth of rock, the retaining wall may be retaining rock at depth, rather than soil. Therefore, in this instance, the rock mechanics will ultimately control the behaviour upon the wall. However, given the thinly laminated structure of the mudstone, and the near horizontal dip observed both in the borehole and upon the geological map, it is anticipated that the forces exerted by lateral movement (sliding) upon the wall will be relatively low.

It is understood that the neighbouring garage needs to be supported, prior to the construction of the retaining wall. Given the shallow depth of bedrock, and the potential for obstructions (core stones) within the sandstone unit, it is likely that a driven sheet piled temporary wall will not be suitable. Therefore, the most economical alternative method is likely to be a king post wall, where steel 'H' section columns are concreted into suitably spaced boreholes. Concrete planking is then placed between the columns to form the wall. The depth/spacing of the boreholes, size of the king posts and reinforcement within the planking needs to be designed.

As it is anticipated that there is relatively competent rock at shallow depth, the use of continuous flight augers to form the boreholes are likely to be unsuitable. Therefore, it is expected that the use of drilled piling techniques, such as Odex or Symmetrex, will be necessary. As such, the king post wall has the advantage over a contiguous piled wall as there are less boreholes required in its construction.

It is anticipated that the wall will be designed as a temporary structure. Whilst it is expected that a permanent wall should be design using effective stress parameters, it should be appreciated that no cohesive soils were revealed within the borehole. Therefore, it could be reasoned that given the granular nature of the retained soils, the design would be similar in the temporary and permanent designs. Therefore, a more economic and suitable method may be to install a permanent embedded wall from the outright, rather than a temporary embedded wall followed by the construction of a permanent gravity wall. In any event, a detailed retaining wall design will be necessary.

### 8.3 Ground-floors

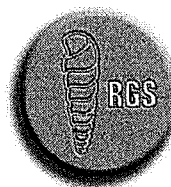
In light of the weak near surface soils, which were revealed to depths of up to 1m, it cannot be recommended that ground bearing ground floor slabs be employed. In this instance it would be necessary to suspend floors between foundation positions, such that the floor loads are transmitted via the foundations to competent soils at depth.

### 8.4 Effect of Sulphates

In view of the nature of the underlying soils it is considered that the design sulphate class be assessed with reference to Table C2<sup>5</sup>, which is provided in BRE Special Digest 1, *Concrete in aggressive ground*:

---

<sup>5</sup> Table C2, *Aggressive Chemical Environment for Concrete (ACEC) classification for brown field locations*



Part C. On the basis of this table and considering the soluble sulphate contents recorded, it can be shown that well compacted buried concrete should be designed in accordance with Class DS-1 requirements. Assuming mobile groundwater, the table also indicates that the aggressive chemical environment for concrete (ACEC) classification is AC-1.

In order to evaluate the design chemical (DC) class for the buried concrete at this site reference should be made to Table D1<sup>6</sup>, which can be found in Part D, *Specifying concrete for general cast-in-situ use*, of BRE Special Digest 1. From this table it may be shown that for an intended working life of at least 50 years the concrete design class DC-1 is required.

## 9. Further Work

---

- This report should be forwarded to the relevant authorities as soon as practicable to ensure they have sufficient time to review and discuss any issues.
- Design of the temporary and permanent retaining structures.
- Detailed design of the sub-structure.

## 10. References

---

- British Standards Institution (1990) BS1377: *British standard methods of test for soils for civil engineering purposes*, B.S.I., London.
- British Standards Institution (2015) BS5930: *Code of practice for site investigations*, B.S.I., London.
- British Geological Survey (NERC) (2018), BGS, Keyworth.
  - Geology of Britain Viewer:  
([http://maps.bgs.ac.uk/geologyviewer\\_google/googleviewer.html](http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html))
  - Lexicon of Named Rock Units:  
(<http://www.bgs.ac.uk/lexicon/>)
- Building Research Establishment (BRE) Special Digest 1 (2005), Third Edition: Concrete in aggressive ground.
  - Part C: *Assessing the aggressive chemical environment*.
  - Part D: *Specifying concrete for general cast-in-situ use*.
- NHBC Standards, Chapter 4.2, *Building near trees*

---

<sup>6</sup> Table D1, *Selection of the DC Class and the number of APMs for concrete elements where the hydraulic gradient due to groundwater is 5 or less: for general in-situ use of concrete*.



---

## **Appendix 1**

### **Site Plan**

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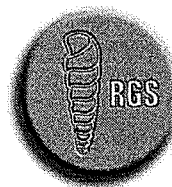


Title: **Investigation Location Plan**

 **Rogers Geotechnical Services Ltd**

Site Name:  
**Paris Rd, Scholes**

Job No:  
**J4251/18/E**



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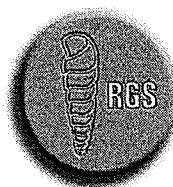
## **Appendix 2**

### **Borehole Records**

---

|  |                  |                             |      |              |                          |         |   |               |              | <h1>Borehole Log</h1> |                                                                                                                                                                                                                                                                     |    | Borehole No.<br><b>BH1</b><br>Sheet 1 of 1 |  |
|-----------------------------------------------------------------------------------|------------------|-----------------------------|------|--------------|--------------------------|---------|---|---------------|--------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|--------------------------------------------|--|
| Project Name: Paris Road                                                          |                  |                             |      |              | Project No. J4251/18/E/G |         |   | Co-ords:      |              | Hole Type<br>WLS+RC   |                                                                                                                                                                                                                                                                     |    |                                            |  |
| Location: Scholes                                                                 |                  |                             |      |              | Level:                   |         |   | Scale<br>1:50 |              | Logged By<br>RAP      |                                                                                                                                                                                                                                                                     |    |                                            |  |
| Client: SGM Structural Design                                                     |                  |                             |      |              | Dates:                   |         |   |               |              |                       |                                                                                                                                                                                                                                                                     |    |                                            |  |
| Well                                                                              | Water<br>Strikes | Samples and In Situ Testing |      |              |                          |         |   | Depth<br>(m)  | Level<br>(m) | Legend                | Stratum Description                                                                                                                                                                                                                                                 |    |                                            |  |
|                                                                                   |                  | Depth<br>(m)                | Type | Dia.<br>(mm) | TCR<br>(%)               | Results |   |               |              |                       |                                                                                                                                                                                                                                                                     |    |                                            |  |
|                                                                                   |                  | 0.80                        | D    | 75           | 100                      |         |   | 0.20          |              |                       | MADE GROUND (Greyish brown silty gravelly fine to coarse SAND. Gravel is sub-angular fine and to coarse of sandstone and rare mortar).<br>Brown very sandy angular and sub-angular fine to coarse GRAVEL of sandstone. Low cobble content. Sand is fine and medium. | 1  |                                            |  |
|                                                                                   |                  | 1.50                        | C    | 75           | 82                       | 43      | 0 | 1.10          |              |                       | Weak very closely spaced brown coarse grained SANDSTONE. Very poor recovery.                                                                                                                                                                                        | 2  |                                            |  |
|                                                                                   |                  | 2.00                        | C    | 75           | 60                       | 16      | 0 | 2.35          |              |                       | Extremely weak and weak thinly laminated very closely spaced greyish brown MUDSTONE. Clayey gravel infill between fractures. Very poor recovery.                                                                                                                    | 3  |                                            |  |
|                                                                                   |                  |                             |      | 75           | 25                       | 12      | 0 | 3.85          |              |                       | End of Borehole at 3.85m                                                                                                                                                                                                                                            | 4  |                                            |  |
|                                                                                   |                  |                             |      |              |                          |         |   |               |              |                       |                                                                                                                                                                                                                                                                     | 5  |                                            |  |
|                                                                                   |                  |                             |      |              |                          |         |   |               |              |                       |                                                                                                                                                                                                                                                                     | 6  |                                            |  |
|                                                                                   |                  |                             |      |              |                          |         |   |               |              |                       |                                                                                                                                                                                                                                                                     | 7  |                                            |  |
|                                                                                   |                  |                             |      |              |                          |         |   |               |              |                       |                                                                                                                                                                                                                                                                     | 8  |                                            |  |
|                                                                                   |                  |                             |      |              |                          |         |   |               |              |                       |                                                                                                                                                                                                                                                                     | 9  |                                            |  |
|                                                                                   |                  |                             |      |              |                          |         |   |               |              |                       |                                                                                                                                                                                                                                                                     | 10 |                                            |  |

|         |  |  |  |  |  |  |  |  |  |                                                                                       |  |
|---------|--|--|--|--|--|--|--|--|--|---------------------------------------------------------------------------------------|--|
| Remarks |  |  |  |  |  |  |  |  |  |  |  |
|---------|--|--|--|--|--|--|--|--|--|---------------------------------------------------------------------------------------|--|



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## Appendix 3

### Dynamic Probe Results

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# Probe Log

Probe No.

DP1

Sheet 1 of 1

Project Name: Paris Road

Project No.  
J4251/18/E/G

Co-ords:

Hole Type  
DCP

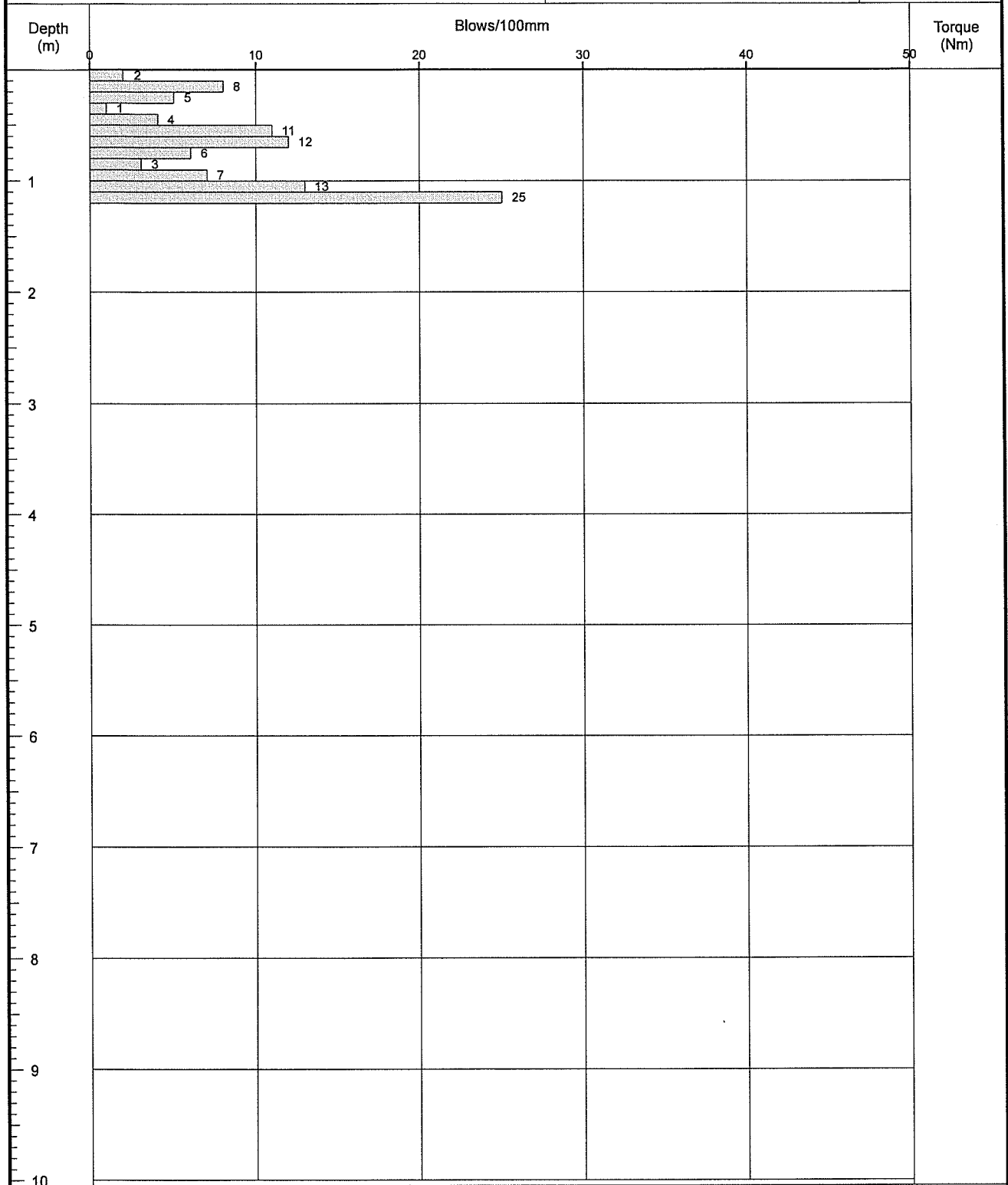
Location: Scholes

Level:

Scale  
1:50

Client: SGM Structural Design

Dates:

Logged By  
RM

Remarks:

Fall Height 750mm

Cone Base Diameter 50.5mm

Hammer Wt 63.5kg

Final Depth 1.2m

Probe Type DPSH-B





# Probe Log

Probe No.

**DP2**

Sheet 1 of 1

Project Name: Paris Road

Project No.  
J4251/18/E/G

Co-ords:

Hole Type  
DCP

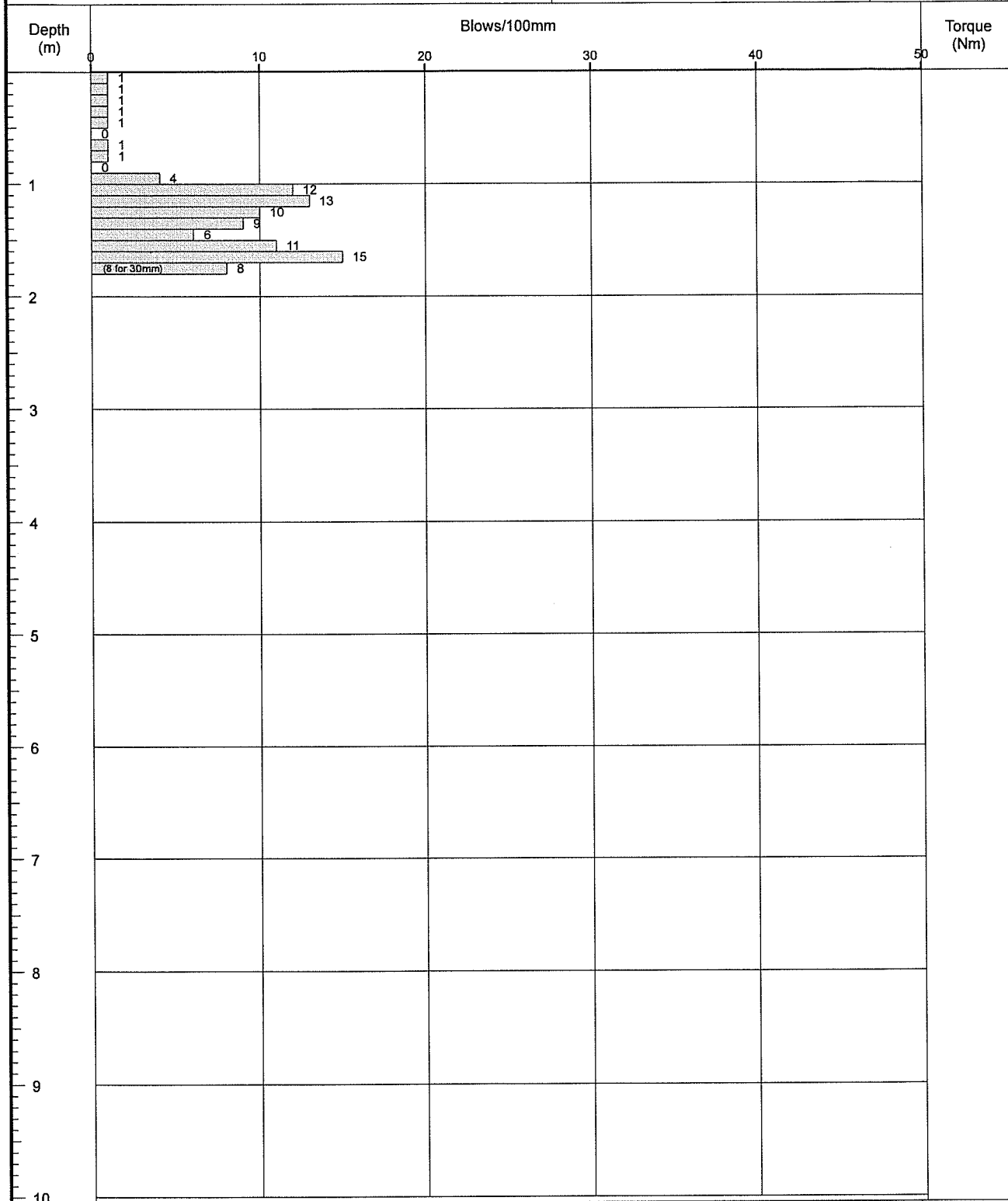
Location: Scholes

Level:

Scale  
1:50

Client: SGM Structural Design

Dates:

Logged By  
RM

Remarks:

Fall Height 750mm

Cone Base Diameter 50.5mm

Hammer Wt 63.5kg

Final Depth 1.8m

Probe Type DPSH-B





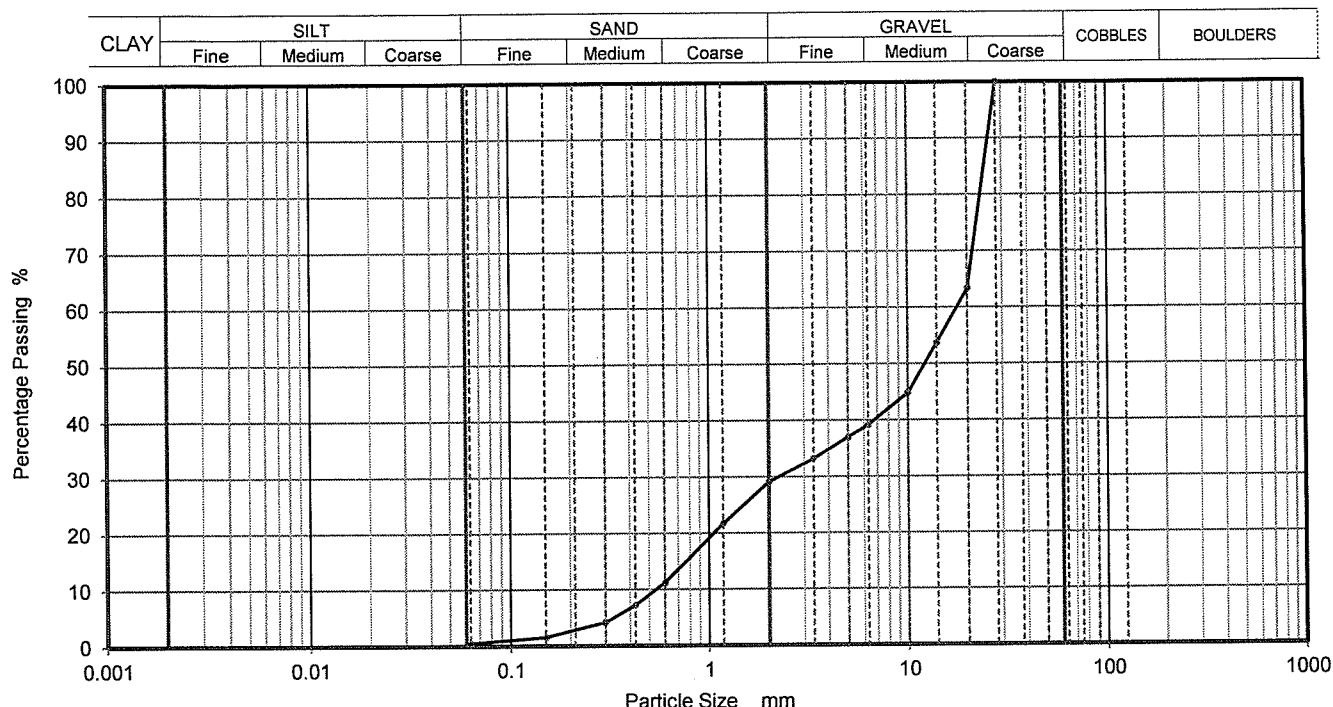
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## **Appendix 4**

### **Laboratory Testing - Geotechnical**

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|                                   |                                 |                |       |                  |               |
|-----------------------------------|---------------------------------|----------------|-------|------------------|---------------|
| <b>PARTICLE SIZE DISTRIBUTION</b> |                                 |                |       | Job Ref          | J4251/18/E/G  |
|                                   |                                 |                |       | Borehole/Pit No. | BH1           |
| Site Name                         | Paris Road                      |                |       | Sample No.       | 1             |
| Soil Description                  | Brown silty very gravelly SAND. |                |       | Depth, m         | 0.80          |
| Specimen Reference                |                                 | Specimen Depth | 0.8 m | Sample Type      | D             |
| Test Method                       | BS1377:Part 2:1990, clause 9.3  |                |       | KeyLAB ID        | RGS_201806132 |



| Sieving          |           | Sedimentation    |           |
|------------------|-----------|------------------|-----------|
| Particle Size mm | % Passing | Particle Size mm | % Passing |
|                  |           |                  |           |
|                  |           |                  |           |
|                  |           |                  |           |
|                  |           |                  |           |
|                  |           |                  |           |
|                  |           |                  |           |
|                  |           |                  |           |
| 28               | 100       |                  |           |
| 20               | 63        |                  |           |
| 14               | 54        |                  |           |
| 10               | 45        |                  |           |
| 6.3              | 39        |                  |           |
| 5                | 37        |                  |           |
| 3.35             | 33        |                  |           |
| 2                | 29        |                  |           |
| 1.18             | 22        |                  |           |
| 0.6              | 11        |                  |           |
| 0.425            | 7         |                  |           |
| 0.3              | 4         |                  |           |
|                  |           |                  |           |
| 0.15             | 2         |                  |           |
| 0.063            | 1         |                  |           |

Dry Mass of sample, g

1874

| Sample Proportions | % dry mass |
|--------------------|------------|
| Very coarse        | 0          |
| Gravel             | 71         |
| Sand               | 29         |
|                    |            |
| Fines <0.063mm     | 1          |

| Grading Analysis       |          |
|------------------------|----------|
| D100                   | mm 28    |
| D60                    | mm 17.6  |
| D30                    | mm 2.25  |
| D10                    | mm 0.542 |
| Uniformity Coefficient | 33       |
| Curvature Coefficient  | 0.53     |

Remarks

Preparation and testing in accordance with BS1377 unless noted below

|          |         |          |               |                  |
|----------|---------|----------|---------------|------------------|
| Operator | Checked | Approved | Sheet printed | Fig 1<br>Sheet 1 |
| Harry    | Jude    | Jude     | 14/06/2018    |                  |

|  |                                                                                                              |
|--|--------------------------------------------------------------------------------------------------------------|
|  | <p align="center"><b>Point Load Strength Index Tests</b></p> <p align="center"><b>Summary of Results</b></p> |
|--|--------------------------------------------------------------------------------------------------------------|

Project No. J4251/18/E/G

|              |            |
|--------------|------------|
| Project Name | Paris Road |
|--------------|------------|

[illegible]

1



## Final Report

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**Report No.:** 18-16869-1

**Initial Date of Issue:** 20-Jun-2018

**Client** Rogers Geotechnical Services Ltd

**Client Address:** Unit 4, Barncliffe Business Park  
Near Bank  
Shelley  
Huddersfield  
West Yorkshire  
HD8 8LU

**Contact(s):** Rob Palmer

**Project** J4251/18/E Paris Road, Scholes

**Quotation No.:** **Date Received:** 14-Jun-2018

**Order No.:** 0618-16 **Date Instructed:** 14-Jun-2018

**No. of Samples:** 1

**Turnaround (Wkdays):** 5 **Results Due:** 20-Jun-2018

**Date Approved:** 18-Jun-2018

**Approved By:**  


**Details:** Glynn Harvey, Laboratory Manager

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| Client: Rogers Geotechnical Services Ltd        |         | Chemtest Job No.:    |       | 18-16869    |
|-------------------------------------------------|---------|----------------------|-------|-------------|
| Quotation No.:                                  |         | Chemtest Sample ID.: |       | 637824      |
| Order No.: 0618-16                              |         | Client Sample Ref.:  |       | BH1         |
|                                                 |         | Client Sample ID.:   |       | D           |
|                                                 |         | Sample Type:         |       | SOIL        |
|                                                 |         | Top Depth (m):       |       | 0.50        |
|                                                 |         | Date Sampled:        |       | 12-Jun-2018 |
| Determinand                                     | Accred. | SOP                  | Units | LOD         |
| pH                                              | M       | 2010                 |       | N/A         |
| Sulphate (2:1 Water Soluble) as SO <sub>4</sub> | M       | 2120                 | g/l   | 0.010       |
| Moisture                                        | N       | 2030                 | %     | 0.020       |
| Soil Colour                                     | N       | 2040                 |       | N/A         |
| Other Material                                  | N       | 2040                 |       | N/A         |
| Soil Texture                                    | N       | 2040                 |       | N/A         |
|                                                 |         |                      |       | Sand        |

| SOP  | Title                                                      | Parameters included                  | Method summary                                                                                       |
|------|------------------------------------------------------------|--------------------------------------|------------------------------------------------------------------------------------------------------|
| 2010 | pH Value of Soils                                          | pH                                   | pH Meter                                                                                             |
| 2030 | Moisture and Stone Content of Soils(Requirement of MCERTS) | Moisture content                     | Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C. |
| 2040 | Soil Description(Requirement of MCERTS)                    | Soil description                     | As received soil is described based upon BS5930                                                      |
| 2120 | Water Soluble Boron, Sulphate, Magnesium & Chromium        | Boron; Sulphate; Magnesium; Chromium | Aqueous extraction / ICP-OES                                                                         |

## **Report Information**

### **Key**

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- U UKAS accredited
- M MCERTS and UKAS accredited
- N Unaccredited
- S This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
- SN This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
- T This analysis has been subcontracted to an unaccredited laboratory
- I/S Insufficient Sample
- U/S Unsuitable Sample
- N/E not evaluated
- < "less than"
- > "greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

### **Sample Deviation Codes**

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- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container
- E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

### **Sample Retention and Disposal**

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All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:  
[customerservices@chemtest.co.uk](mailto:customerservices@chemtest.co.uk)

## **TECHNICAL APPROVAL OF HIGHWAY STRUCTURES**

Scheme: 32 Paris Road, Scholes, Holmfirth, HD9 1UA

Structure: Proposed private burr wall to support adjacent highway    Date:- November 2018

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### **APPENDIX E**

#### **FEASIBILITY REPORT**

(if required)