Appendix C: Structural Basement Calculations

This information is provided for Planning use only and is not to be used for Building control submissions.
RETAINING WALL - RW1

Loads on to retaining wall
Solid wall + Roof + Ceiling + First + Second + Ground
\[ DL = 5kN/m^2 \times 7m + 5.1m/2 \times 1.03kN/m^2 + 5.1m/2 \times 0.31kN/m^2 + 5.1m/2 \times 0.65kN/m^2 + 5.1m/2 \times 0.65kN/m^2 = 43.390kN/m \]
\[ = 5.1m/2 \times 0.6kN/m^2 + 5.1m/2 \times 0.25kN/m^2 + 5.1m/2 \times 1.5kN/m^2 + 5.1m/2 \times 1.5kN/m^2 = 13.643kN/m \]

RETAINING WALL ANALYSIS (BS 8002:1994)
Wall details
Retaining wall type; Cantilever
Height of wall stem; \( h_{stem} = 3000 \text{ mm} \)
Length of toe; \( l_{toe} = 1600 \text{ mm} \)
Overall length of base; \( l_{base} = 1900 \text{ mm} \)
Height of retaining wall; \( h_{wall} = 3300 \text{ mm} \)
Depth of downstand; \( d_{ds} = 0 \text{ mm} \)
Position of downstand; \( l_{ds} = 1100 \text{ mm} \)
Depth of cover in front of wall; \( d_{cover} = 0 \text{ mm} \)
Height of ground water; \( h_{water} = 3000 \text{ mm} \)
Density of wall construction; \( \gamma_{wall} = 23.6 \text{ kN/m}^3 \)
Angle of soil surface; \( \beta = 0.0 \text{ deg} \)
Mobilisation factor; \( M = 1.5 \)
Moist density; \( \gamma_m = 18.0 \text{ kN/m}^3 \)
Design shear strength; \( \phi' = 24.2 \text{ deg} \)
Design shear strength; \( \phi_b = 24.2 \text{ deg} \)
Moist density; \( \gamma_{mb} = 18.0 \text{ kN/m}^3 \)
Using Coulomb theory
Active pressure; \( K_a = 0.369 \)
At-rest pressure; \( K_0 = 0.590 \)
Loading details
Surcharge load; \( S = 10.0 \text{ kN/m}^2 \)
Vertical dead load; \( W_{dead} = 43.0 \text{ kN/m} \)
Horizontal dead load; \( F_{dead} = 0.0 \text{ kN/m} \)
Position of vertical load; \( l_{load} = 1750 \text{ mm} \)

Loads shown in kN/m, pressures shown in kN/m^2
<table>
<thead>
<tr>
<th>Calculate propping force</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Propping force:</strong>  ( F_{\text{prop}} = 50.2 \text{ kN/m} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Check bearing pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total vertical reaction:</strong>  ( R = 86.0 \text{ kN/m} )</td>
</tr>
<tr>
<td><strong>Distance to reaction:</strong>  ( x_{\text{bar}} = 576 \text{ mm} )</td>
</tr>
<tr>
<td><strong>Bearing pressure at toe:</strong>  ( p_{\text{toe}} = 99.5 \text{ kN/m}^2 )</td>
</tr>
</tbody>
</table>

**Reaction acts outside middle third of base**

**PASS - Maximum bearing pressure is less than allowable bearing pressure**
RETAINING WALL DESIGN (BS 8002:1994)

Ultimate limit state load factors
Dead load factor; $\gamma_{f,d} = 1.4$; Live load factor; $\gamma_{f,l} = 1.6$
Earth pressure factor; $\gamma_{f,e} = 1.4$

Calculate propping force
Propping force; $F_{\text{prop}} = 50.2 \text{kN/m}$

Design of reinforced concrete retaining wall toe (BS 8002:1994)

Material properties
Strength of concrete; $f_{\text{cu}} = 35 \text{ N/mm}^2$; Strength of reinforcement; $f_y = 500 \text{ N/mm}^2$

Base details
Minimum reinforcement; $k = 0.13\%$; Cover in toe; $c_{\text{toe}} = 30 \text{ mm}$

Design of retaining wall toe
Shear at heel; $V_{\text{toe}} = 106.4 \text{kN/m}$; Moment at heel; $M_{\text{toe}} = 176.8 \text{kNm/m}$
Compression reinforcement is not required

Check toe in bending
Reinforcement provided; 12 mm dia.bars @ 50 mm centres
Area required; $A_{s,\text{toe,req}} = 1689.2 \text{ mm}^2/\text{m}$; Area provided; $A_{s,\text{toe,prov}} = 2262 \text{ mm}^2/\text{m}$
PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe
Design shear stress; $\tau_{\text{toe}} = 0.403 \text{ N/mm}^2$; Allowable shear stress; $\tau_{\text{adm}} = 4.733 \text{ N/mm}^2$
PASS - Design shear stress is less than maximum shear stress

Concrete shear stress; $\tau_{c,\text{toe}} = 0.745 \text{ N/mm}^2$
$\tau_{\text{toe}} < \tau_{c,\text{toe}}$ - No shear reinforcement required

Design of reinforced concrete retaining wall stem (BS 8002:1994)

Material properties
Strength of concrete; $f_{\text{cu}} = 35 \text{ N/mm}^2$; Strength of reinforcement; $f_y = 500 \text{ N/mm}^2$

Wall details
Minimum reinforcement; $k = 0.13\%$
Cover in stem; $c_{\text{stem}} = 30 \text{ mm}$; Cover in wall; $c_{\text{wall}} = 30 \text{ mm}$
Design of retaining wall stem

Shear at base of stem; \( V_{\text{stem}} = 16.8 \text{ kN/m} \);
Moment at base of stem; \( M_{\text{stem}} = 140.3 \text{ kNm/m} \)

Compression reinforcement is not required

Check wall stem in bending
Reinforcement provided; 12 mm dia. bars @ 50 mm centres
Area required; \( A_{s_{\text{stem req}}} = 1312.2 \text{ mm}^2/\text{m} \);
Area provided; \( A_{s_{\text{stem prov}}} = 2262 \text{ mm}^2/\text{m} \)
PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem
Design shear stress; \( V_{\text{stem}} = 0.064 \text{ N/mm}^2 \);
Allowable shear stress; \( V_{\text{adm}} = 4.733 \text{ N/mm}^2 \)
PASS - Design shear stress is less than maximum shear stress
Concrete shear stress; \( V_{c_{\text{stem}}} = 0.591 \text{ N/mm}^2 \)

\( V_{\text{stem}} < V_{c_{\text{stem}}} \) - No shear reinforcement required
**Indicative retaining wall reinforcement diagram**

- **Toe bars**: 12 mm dia. @ 50 mm centres - (2262 mm²/m)
- **Stem bars**: 12 mm dia. @ 50 mm centres - (2262 mm²/m)
RETAINING WALL-RW2

Loads on to retaining wall
Solid wall +Roof×2+Ceiling×2+First×2+second×2+Ground×2(including next door load)
;DL=5kN/m²×7m+5.1m/2×1.03kN/m²×2+5.1m/2×0.31kN/m²×2+5.1m/2×0.65kN/m²×4+5.1m/2×0.65kN/m²×2=51.779kN/m
;=5.1m/2×0.6kN/m²×2+5.1m/2×0.25kN/m²×2+5.1m/2×1.5kN/m²×4+5.1m/2×1.5kN/m²×2=27.285kN/m

RETAINING WALL ANALYSIS (BS 8002:1994)

<table>
<thead>
<tr>
<th>Wall details</th>
<th>Cantilever</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retaining wall type;</td>
<td>Wall stem thickness;</td>
</tr>
<tr>
<td>Height of wall stem;</td>
<td>t_stem=3000 mm</td>
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<tr>
<td>Length of toe;</td>
<td>l_toe=1600 mm</td>
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<tr>
<td>Overall length of base;</td>
<td>l_base=1900 mm</td>
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<tr>
<td>Height of retaining wall;</td>
<td>h_wall=3300 mm</td>
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<tr>
<td>Depth of downstand;</td>
<td>d_ds=0 mm</td>
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<tr>
<td>Position of downstand;</td>
<td>l_ds=1300 mm</td>
</tr>
<tr>
<td>Depth of cover in front of wall;</td>
<td>d_cover=0 mm</td>
</tr>
<tr>
<td>Height of ground water;</td>
<td>h_water=3000 mm</td>
</tr>
<tr>
<td>Density of wall construction;</td>
<td>ρ_water=9.81 kN/m³</td>
</tr>
<tr>
<td>Angle of soil surface;</td>
<td>β=0.0 deg</td>
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<tr>
<td>Mobilisation factor;</td>
<td>M=1.5</td>
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<tr>
<td>Moist density;</td>
<td>ρ_m=18.0 kN/m³</td>
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<tr>
<td>Design shear strength;</td>
<td>φ'=24.2 deg</td>
</tr>
<tr>
<td>Design shear strength;</td>
<td>φ_b'=24.2 deg</td>
</tr>
<tr>
<td>Moist density;</td>
<td>ρ_mb=18.0 kN/m³</td>
</tr>
<tr>
<td>Saturated density;</td>
<td>ρ_s=21.0 kN/m³</td>
</tr>
<tr>
<td>Angle of wall friction;</td>
<td>δ=18.6 deg</td>
</tr>
<tr>
<td>Design base friction;</td>
<td>δ_b=18.6 deg</td>
</tr>
<tr>
<td>Allowable bearing;</td>
<td>P_bearing=100 kN/m²</td>
</tr>
</tbody>
</table>

TEDDS calculation version 1.2.01.03
Using Coulomb theory

Active pressure; $K_a = 0.369$; Passive pressure; $K_p = 4.187$

At-rest pressure; $K_0 = 0.590$

Loading details

Surcharge load; Surcharge = 5.0 kN/m$^2$
Vertical dead load; $W_{\text{dead}} = 51.0$ kN/m;
Horizontal dead load; $F_{\text{dead}} = 0.0$ kN/m;
Position of vertical load; $l_{\text{load}} = 1750$ mm;

Vertical live load; $W_{\text{live}} = 27.0$ kN/m;
Horizontal live load; $F_{\text{live}} = 0.0$ kN/m;
Height of horizontal load; $h_{\text{load}} = 0$ mm

Calculate propping force

Propping force; $F_{\text{prop}} = 42.8$ kN/m

Check bearing pressure

Total vertical reaction; $R = 99.7$ kN/m;
Distance to reaction; $x_{\text{bar}} = 833$ mm;
Bearing pressure at toe; $p_{\text{toe}} = 71.9$ kN/m$^2$;

Total moment; $M_{\text{total}} = 83.0$ kNm/m
Eccentricity of reaction; $e = 117$ mm
Bearing pressure at heel; $p_{\text{heel}} = 33.1$ kN/m$^2$

Reaction acts within middle third of base

PASS - Maximum bearing pressure is less than allowable bearing pressure
RETAINING WALL DESIGN (BS 8002:1994)

Ultimate limit state load factors
Dead load factor; \( \gamma_{f,d} = 1.4 \); Live load factor; \( \gamma_{f,l} = 1.6 \)
Earth pressure factor; \( \gamma_{f,e} = 1.4 \)

Calculate propping force
Propping force; \( F_{prop} = 42.8 \) kN/m

Design of reinforced concrete retaining wall toe (BS 8002:1994)

Material properties
Strength of concrete; \( f_{cu} = 35 \) N/mm\(^2\); Strength of reinforcement; \( f_y = 500 \) N/mm\(^2\)

Base details
Minimum reinforcement; \( k = 0.13 \)%; Cover in toe; \( c_{toe} = 30 \) mm

Design of retaining wall toe
Shear at heel; \( V_{toe} = 126.1 \) kN/m; Moment at heel; \( M_{toe} = 151.1 \) kNm/m

Check toe in bending
Reinforcement provided; 12 mm dia.bars @ 50 mm centres
Area required; \( A_{s_{toe,req}} = 1421.9 \) mm\(^2\)/m; Area provided; \( A_{s_{toe,prov}} = 2262 \) mm\(^2\)/m

Check shear resistance at toe
Design shear stress; \( V_{toe} = 0.478 \) N/mm\(^2\); Allowable shear stress; \( V_{adm} = 4.733 \) N/mm\(^2\)
Concrete shear stress; \( V_{c_{toe}} = 0.591 \) N/mm\(^2\)

Design of reinforced concrete retaining wall stem (BS 8002:1994)

Material properties
Strength of concrete; \( f_{cu} = 35 \) N/mm\(^2\); Strength of reinforcement; \( f_y = 500 \) N/mm\(^2\)

Wall details
Minimum reinforcement; \( k = 0.13 \)%
Cover in stem; \( c_{stem} = 30 \) mm; Cover in wall; \( c_{wall} = 30 \) mm
Design of retaining wall stem
Shear at base of stem; $V_{stem} = 20.6 \text{ kN/m}$; Moment at base of stem; $M_{stem} = 117.0 \text{ kNm/m}$

Compression reinforcement is not required

Check wall stem in bending
Reinforcement provided; B1131 mesh
Area required; $A_{s_{stem \_req}} = 1079.6 \text{ mm}^2$/m; Area provided; $A_{s_{stem \_prov}} = 1131 \text{ mm}^2$/m

PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem
Design shear stress; $V_{stem} = 0.078 \text{ N/mm}^2$; Allowable shear stress; $V_{adm} = 4.733 \text{ N/mm}^2$

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress; $V_{c_{stem}} = 0.591 \text{ N/mm}^2$

$v_{stem} < v_{c_{stem}}$ - No shear reinforcement required
Indicative retaining wall reinforcement diagram

Toe bars - 12 mm dia.@ 50 mm centres - (2262 mm²/m)
Stem mesh - B1131 - (1131 mm²/m)
Appendix D: Method Statement
Basement Method Statement

9 Christchurch Street
London
SW3 4AN

For
The Basement Design Studio
Contents
44 Adam & Eve Mews .................................................................................................................. Error! Bookmark not defined.

1. Basement Formation Suggested Method Statement.................................................................2
2. Enabling Works ........................................................................................................................2
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6. Approval................................................................................................................................6
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9 Christchurch Street


1.1. This method statement provides an approach which will allow the basement design to be correctly considered during construction, and the temporary support to be provided during the works. The Contractor is responsible for the works on site and the final temporary works methodology and design on this site and any adjacent sites.

1.2. This method statement 9 Christchurch Street has been written by a Chartered Engineer. The sequencing has been developed considering guidance from ASUC.

1.3. This method has been produced to allow for improved costings and for inclusion in the party wall Award. Should the contractor provide alternative methodology the changes shall be at their own costs, and an Addendum to the Party Wall Award will be required.

1.4. Contact party wall surveyors to inform them of any changes to this method statement.

1.5. The approach followed in this design is; to remove load from above and place loads onto supporting steelwork, then to cast cantilever retaining walls in underpin sections at the new basement level.

1.6. The cantilever pins are designed to be inherently stable during the construction stage without temporary propping to the head. The base benefits from propping, this is provided in the final condition by the ground slab. In the temporary condition the edge of the slab is buttressed against the soil in the middle of the property, also the skin friction between the concrete base and the soil provides further resistance. The central slab is to be poured in a maximum of a 1/3 of the floor area.

1.7. A soil investigation has been undertaken. The soil conditions are made ground bon top flow Gravels.

1.8. The bearing pressures have been limited to 100kN/m². This is standard loadings for local ground conditions and acceptable to building control and their approvals.

2. Enabling Works

2.1. The site is to be hoarded with ply sheet to 2.2m to prevent unauthorised public access.

2.2. Licenses for Skips and conveyors to be posted on hoarding

2.3. Provide protection to public where conveyor extends over footpath. Depending on the requirements of the local authority, construct a plywood bulkhead onto the pavement. Hoarding to have a plywood roof covering, night-lights and safety notices.

2.4. On commencement of construction the contractor will determine the foundation type, width and depth. Any discrepancies will be reported to the structural engineer in order that the detailed design may be modified as necessary.
3. Basement Sequencing

3.1. Excavate Light well to front of property down to 600mm below external ground level.

3.2. Excavate first front corner of light well. (Follow methodology in section 4)

3.3. Excavate second front corner of light well. (Follow methodology in section 4)

3.4. Continue excavating section pins to form front light well. (Follow methodology in section 4)

3.5. Place cantilevered retaining wall to the left side of front opening. After 72 hours place cantilevered retaining wall to the right side of front opening.

3.6. Needle and prop front wall. Insert support

3.7. Excavate out first 1.2m around front opening prop floor and erect conveyor.

3.8. Continue cantilevered wall formation around perimeter of basement following the numbering sequence on the drawings.

   3.8.1. Excavation for the next numbered sections of underpinning shall not commence until at least 8 hours after drypacking of previous works. Excavation of adjacent pin to not commence until 24 hours after drypacking. (24hours possible due to inclusion of Conbextra 100 cement accelerator to dry pack mix)

   3.8.2. Floor over to be propped as excavations progress. Steelwork to support floor to be inserted as works progress.

3.9. Excavate a maximum of a 1/3 of the middle section of basement floor. Place reinforcement to central section of ground bearing slab and pour concrete. Excavate next third and cast slab. Excavate and cast final third and cast.

3.10. Provide structure to ground floor and water proofing to retaining walls as required.

4. Underpinning and Cantilevered Walls

4.1. Prior to installation of new structural beams in the superstructure, the contractor may undertake the local exploration of specific areas in the superstructure. This will confirm the exact form and location of the temporary works that are required. The permanent structural work can then be undertaken whilst ensuring that the full integrity of the structure above is maintained.

4.2. Provide propping to floor where necessary.

4.3. Excavate first section of retaining wall (no more than 1200mm wide). Where excavation is greater than 1.2m deep provide temporary propping to sides of excavation to prevent earth collapse (Health and Safety). A 1200mm width wall has a lower risk of collapse to the heel face.
Figure 1 – Schematic Plan view of Soil Propping

Figure 2 Propping
4.4. Backpropping of rear face. Rear face to be propped in the temporary conditions with a minimum of 2 Trench sheets. Trench sheets are to extend over entire height of excavation. Trench sheets can be placed in short sections as the excavation progresses.

4.4.1. If the ground is stable, trench sheets can be removed as the wall reinforcement is placed and the shuttering is constructed.

4.4.2. Where soft spots are encountered leave in trench sheets or alternatively back prop with Precast lintels or trench sheeting. (If the soil support to the ends of the lintels is insufficient then brace the ends of the PC lintels with 150x150 C24 Timbers and prop with Acrows diagonally back to the floor.)

4.4.3. Where voids are present behind the lintels or trench sheeting. Grout voids behind sacrificial propping; Grout to be 3:1 sand cement packed into voids.

4.4.4. Prior to casting place layer of DPM between trench sheeting (or PC lintels) and new concrete. The lintels are to be cut into the soil by 150mm either side of the pin. A site stock of a minimum of 10 lintels to be present for to prevent delays due to ordering.

4.5. If cut face is not straight, or sacrificial boards noted have been used, place a 15mm cement particle board between sacrificial sheets and or soil prior to casting. Cement particle board is to line up with the adjacent owners face of wall. The method adopted to prevent localised collapse of the soil is to install these progressively one at a time. Cement particle board must be used in any condition where overspill onto the adjacent owners land is possible.

4.6. Excavate base. Mass concrete heels to be excavated. If soil over unstable prop top with PC lintel and sacrificial prop.

4.7. Visually inspect the footings and provide propping to local brickwork, if necessary sacrificial acrow, or pit props, to be sacrificial and cast into the retaining wall.


4.9. Local authority inspection to be carried for approval of excavation base.

4.10. Place reinforcement for retaining wall base & toe. Site supervisor to inspect and sign off works for proceeding to next stage.

4.11. Cast base. (On short stems it is possible to cast base and wall at same time)

4.12. Ensure that Concrete is of sufficient strength, check engineers specifications

4.13. Horizontal temporary prop to base of wall to be inserted. Alternatively cast base against soil.

4.14. Place reinforcement for retaining wall stem. Site supervisor to inspect and sign off works for proceeding to next stage.

4.15. Drive H16 Bars UBars into soil along centre line of stem to act as shear ties to adjacent wall.

4.16. Place shuttering & pour concrete for retaining wall. Stop a minimum of 75mm from the underside of existing footing.

4.17. Ram in drypack between retaining wall and existing masonry. (24 hours after pouring the concrete pin the gap shall be filled using a dry pack mortar.)
4.18. After 24 hours the temporary wall shutters are removed.

4.19. Trim back existing masonry corbel and concrete on internal face.

4.20. Site supervisor to inspect and sign off for proceeding to the next stage. A record will be kept of the sequence of construction, which will be in strict accordance with recognised industry procedures.

5. Supporting existing walls above basement excavation

5.1. Where steel beams need to be installed directly under load bearing walls, temporary works will be required to enable this work. Support comprises the installation of steel needle beams at high level, supported on vertical props, to enable safe removal of brickwork below, and installation of the new beams and columns.

5.1.1. The condition of the brickworks must be inspected by the foreman to determine its condition and to assess the centres of needles. The foreman must inspect upstairs to consider where loads are greatest. Point loads and between windows should be given greater consideration.

5.1.2. Needles are to be spaced to prevent the brickwork above “saw toothing”. Where brickwork is good needles must be placed at a maximum of 1100mm centres. Lighter needles or strong boys should be placed at tighter centres under door thresholds.

5.2. Props are to be placed on Sleepers of firm ground or if necessary temporary footings will be cast.

5.3. Once the props are fully tightened, the brickwork will be broken out carefully by hand. All necessary platforms and crash decks will be provided during this operation.

5.4. Decking and support platforms to enable handling of steel beams and columns will be provided as required.

5.5. Once full structural bearing is provided via beams and columns down to the new basement floor level. The temporary works will be redundant and can be safely removed.

5.6. Any voids between the top of the permanent steel beams and the underside of the existing walls will be packed out as necessary. Voids will be drypacked with a 1:3 (cement: sharp sand) drypack layer, between the top of the steel and underside of brickwork above.

5.7. Any voids in the brickwork left after removal of needle beams can at this point be repaired by bricking up and/or drypacking, to ensure continuity of the structural fabric.

6. Approval

6.1. Building control officer/approved inspector to inspect pin bases and reinforcement prior to casting concrete.

6.2. Contractor to keep list of dates pins inspected & cast

6.3. One month after work completed the contractor is to contact adjacent party wall surveyor to attend site and complete final condition survey and to sign off works.
7. Trench sheet design and temporary prop Calculations

This calculation has been provided for the trench sheet and prop design of standard underpins in the temporary condition. There are gaps left between the sheeting and as such no water pressure will occur. Any water present will flow through the gaps between the sheeting and will be required to pump out.

Trench sheets should be placed at centers to deal with the ground. It is expected that the soil between the trench sheeting will arch. Looser soil will required tighter centers. It is typical for underpins to be placed at 1200c/c, in this condition the highest load on a trench sheet is when 2 nos trench sheets are used. It is for this design that these calculations have been provided.

Soil and ground conditions are variable. Typically one finds that in the temporary condition clays are more stable and the Cu (cohesive) values in clay reduce the risk of collapse. It is this cohesive nature that allows clays to be cut into a vertical slope. For these calculations weak sand and gravels have been assumed. The soil properties are:

- Surcharge: $\text{sur} = 10 \text{ kN/m}^2$
- Soil density: $\delta = 20 \text{ kN/m}^3$
- Angle of friction: $\phi = 25 ^\circ$
- Soil depth: $D_{\text{soil}} = 3000.000 \text{ mm}$

\[ k_a = \frac{1 - \sin(\phi)}{1 + \sin(\phi)} = 0.406 \]
\[ k_p = \frac{1}{k_a} = 2.464 \]

- Soil Pressure bottom: $\text{soil} = k_a \times \delta \times D_{\text{soil}} = 21.916 \text{ kN/m}^2$
- Surcharge pressure: $\text{surcharge} = \text{sur} \times k_a = 4.059 \text{ kN/m}^2$
Standard Lap Trench Sheeting

STANDARD LAP

The overlapping trench sheeting profile is designed primarily for construction work and also temporary deployment.

Sxx = 15.9 cm³
py = 275N/mm²
Ixx = 26.9 cm⁴

A = (1 m² * 32.9 kg/m² ) / ( 330 mm * 7750 kg/m³ ) = 12864.125 mm²
Length a
Length b bottom
Length c Middle
Length d top

a = 2.600 m
b = 0.700 m
c = a – b = 1.900 m
d = Dsoil – a = 0.400 m

CONTINUOUS BEAM ANALYSIS - INPUT

BEAM DETAILS
Number of spans = 3

Material Properties:
Modulus of elasticity = 205 kN/mm²
Material density = 7860 kg/m³

Support Conditions:
Support A    Vertically "Restrained"  Rotationally "Free"
Support B    Vertically "Restrained"  Rotationally "Free"
Support C    Vertically "Restrained"  Rotationally "Free"
Support D  Vertically "Free"  Rotationally "Free"

Span Definitions:
Span 1  Length = 700 mm  Cross-sectional area = 12864 mm²  Moment of inertia = 269.10³ mm⁴
Span 2  Length = 1900 mm  Cross-sectional area = 12864 mm²  Moment of inertia = 269.10³ mm⁴
Span 3  Length = 400 mm  Cross-sectional area = 12864 mm²  Moment of inertia = 269.10³ mm⁴

LOADING DETAILS
Beam Loads:
Load 1  UDL Dead load 4.1 kN/m
Load 2  VDL Dead load 21.9 kN/m to 0.0 kN/m

LOAD COMBINATIONS
Load combination 1
Span 1  1×Dead
Span 2  1×Dead
Span 3  1×Dead

CONTINUOUS BEAM ANALYSIS - RESULTS

Unfactored support reactions

<table>
<thead>
<tr>
<th></th>
<th>Dead (kN)</th>
</tr>
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<tbody>
<tr>
<td>Support A</td>
<td>-1.4 0.0 0.0 0.0 0.0 0.0 0.0 0.0</td>
</tr>
<tr>
<td>Support B</td>
<td>-32.8 0.0 0.0 0.0 0.0 0.0 0.0 0.0</td>
</tr>
<tr>
<td>Support C</td>
<td>-10.8 0.0 0.0 0.0 0.0 0.0 0.0 0.0</td>
</tr>
<tr>
<td>Support D</td>
<td>0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0</td>
</tr>
</tbody>
</table>

Support Reactions - Combination Summary

<table>
<thead>
<tr>
<th></th>
<th>Max react</th>
<th>Min react</th>
<th>Max mom</th>
<th>Min mom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support A</td>
<td>-1.4 kN</td>
<td>-1.4 kN</td>
<td>0.0 kNm</td>
<td>0.0 kNm</td>
</tr>
<tr>
<td>Support B</td>
<td>-32.8 kN</td>
<td>-32.8 kN</td>
<td>0.0 kNm</td>
<td>0.0 kNm</td>
</tr>
<tr>
<td>Support C</td>
<td>-10.8 kN</td>
<td>-10.8 kN</td>
<td>0.0 kNm</td>
<td>0.0 kNm</td>
</tr>
<tr>
<td>Support D</td>
<td>0.0 kN</td>
<td>0.0 kN</td>
<td>0.0 kNm</td>
<td>0.0 kNm</td>
</tr>
</tbody>
</table>

Beam Max/Min results - Combination Summary

Maximum shear = 17.8 kN
Minimum shear = -15.0 kN

Maximum moment = 3.7 kNm
Minimum moment = -5.0 kNm

Maximum deflection = 21.0 mm
Minimum deflection = -14.3 mm
Number of sheets Nos = 2

Mallowable = Sxx \* py \* Nos = 8.745kNm

Shear V = (14.6kN + 13.4kN) / 2 = 14.000kN

Any Acro Prop is acceptable

---

**Safe working loads for Acrow Props - loads given in kN**

<table>
<thead>
<tr>
<th>Height</th>
<th>1.0</th>
<th>1.6</th>
<th>2.2</th>
<th>2.8</th>
<th>3.4</th>
<th>4.0</th>
<th>4.6</th>
<th>5.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prop size 1 or 2</td>
<td>35</td>
<td>36</td>
<td>35</td>
<td>34</td>
<td>31</td>
<td>27</td>
<td>23</td>
<td>22</td>
</tr>
<tr>
<td>Prop size 3</td>
<td>31</td>
<td>27</td>
<td>24</td>
<td>21</td>
<td>19</td>
<td>16</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Prop size 4</td>
<td>32</td>
<td>29</td>
<td>26</td>
<td>23</td>
<td>21</td>
<td>18</td>
<td>16</td>
<td>14</td>
</tr>
</tbody>
</table>

---

**Table for Prop loaded concentrically and erecting vertically**

<table>
<thead>
<tr>
<th>Height</th>
<th>1.0</th>
<th>1.6</th>
<th>2.2</th>
<th>2.8</th>
<th>3.4</th>
<th>4.0</th>
<th>4.6</th>
<th>5.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prop size 1 or 2</td>
<td>35</td>
<td>32</td>
<td>29</td>
<td>26</td>
<td>24</td>
<td>21</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>Prop size 4</td>
<td>24</td>
<td>20</td>
<td>16</td>
<td>12</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

---

**Table for Prop loaded 95 mm essentially and erected 15° max. out of vertical**

<table>
<thead>
<tr>
<th>Height</th>
<th>1.0</th>
<th>1.6</th>
<th>2.2</th>
<th>2.8</th>
<th>3.4</th>
<th>4.0</th>
<th>4.6</th>
<th>5.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prop size 1 or 2</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>16</td>
<td>13</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Prop size 4</td>
<td>16</td>
<td>14</td>
<td>12</td>
<td>9</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

---

**Table for Prop loaded concentrically and erected 15° max. out of vertical and faced with scaffold tubes and fittings**

<table>
<thead>
<tr>
<th>Height</th>
<th>1.0</th>
<th>1.6</th>
<th>2.2</th>
<th>2.8</th>
<th>3.4</th>
<th>4.0</th>
<th>4.6</th>
<th>5.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prop size 2</td>
<td>26</td>
<td>23</td>
<td>23</td>
<td>20</td>
<td>17</td>
<td>14</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Prop size 4</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
</tr>
</tbody>
</table>
KD4

The overlapping trench sheeting profile is a heavier version of the Standard Lap, with a wider gauge and width coverage, designed in large for construction work.

**Technical Information**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width with flaps (mm)</td>
<td>403</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>4.1</td>
</tr>
<tr>
<td>Depth (mm)</td>
<td>50</td>
</tr>
<tr>
<td>Weight per linear meter (kg/m)</td>
<td>21.90</td>
</tr>
<tr>
<td>Weight per kg (kg)</td>
<td>53.2</td>
</tr>
<tr>
<td>Section modulus per metre (mm^3)</td>
<td>101</td>
</tr>
<tr>
<td>Section modulus per cord (mm^3)</td>
<td>40.34</td>
</tr>
<tr>
<td>Takeoff per sheet (m^2)</td>
<td>250</td>
</tr>
<tr>
<td>Total rolled metres per box</td>
<td>45.69</td>
</tr>
</tbody>
</table>

\[ S_{xx} = 48.3 \text{cm}^3 \]
\[ p_y = 275 \text{N/mm}^2 \]
\[ I_{xx} = 26.9 \text{cm}^4 \]

\[ A = \frac{(1 \text{m}^2 \times 55.2 \text{kg/m}^2)}{(400 \text{mm} \times 7750 \text{kg/m}^3)} = 17806.452 \text{mm}^2 \]
Length a \( a = 2.700 \text{ m} \)
Length b bottom \( b = 1.100 \text{ m} \)
Length c Middle \( c = a - b = 1.600 \text{ m} \)
Length d top \( d = D_{	ext{soil}} - a = 0.300 \text{ m} \)

CONTINUOUS BEAM ANALYSIS - INPUT

BEAM DETAILS

Number of spans = 3

Material Properties:
- Modulus of elasticity = \( 205 \text{ kN/mm}^2 \)
- Material density = \( 7860 \text{ kg/m}^3 \)

Support Conditions:
- Support A: Vertically "Restrained"  Rotationally "Free"
- Support B: Vertically "Restrained"  Rotationally "Free"
- Support C: Vertically "Restrained"  Rotationally "Free"
- Support D: Vertically "Free"  Rotationally "Free"

Span Definitions:
- Span 1: Length = 1100 mm  Cross-sectional area = 17806 mm\(^2\)  Moment of inertia = \(269 \times 10^3\) mm\(^4\)
- Span 2: Length = 1600 mm  Cross-sectional area = 17806 mm\(^2\)  Moment of inertia = \(269 \times 10^3\) mm\(^4\)
Span 3  Length = 300 mm  Cross-sectional area = 17806 mm$^2$  Moment of inertia = 269.10$^3$ mm$^4$

LOADING DETAILS

Beam Loads:
Load 1  VDL Dead load 21.9 kN/m to 0.0 kN/m
Load 2  UDL Dead load 4.1 kN/m

LOAD COMBINATIONS

Load combination 1
Span 1  1×Dead
Span 2  1×Dead
Span 3  1×Dead

CONTINUOUS BEAM ANALYSIS - RESULTS

Support Reactions - Combination Summary
Support A  Max react = -9.5 kN  Min react = -9.5 kN  Max mom = 0.0 kNm  Min mom = 0.0 kNm
Support B  Max react = -28.0 kN  Min react = -28.0 kN  Max mom = 0.0 kNm  Min mom = 0.0 kNm
Support C  Max react = -7.5 kN  Min react = -7.5 kN  Max mom = 0.0 kNm  Min mom = 0.0 kNm
Support D  Max react = 0.0 kN  Min react = 0.0 kN  Max mom = 0.0 kNm  Min mom = 0.0 kNm

Beam Max/Min results - Combination Summary

Maximum shear = 13.4 kN  Minimum shear $F_{min} = -14.6$ kN
Maximum moment = 2.0 kNm  Minimum moment = -3.6 kNm
Maximum deflection = 7.7 mm  Minimum deflection = -4.9 mm

Number of sheets Nos = 2

Mallowable = Sxx * py * Nos = 26.565 kNm
Shear $V = \frac{(14.6\text{kN} + 13.4\text{kN})}{2} = 14.000\text{kN}$

Any Acro Prop is acceptable
Sheeting requirements

Full sheeting

Sheeting requirements

Ground prep
Foot level

Half sheeting
shown for 1.5 m deep trench
Sheeting requirements

Quarter sheeting

Design to CIRIA 97

Notes:
- For standard Spudshores horizontal rows and spacing are the same for 129 x 89 RSC.
- Heavy duty Spudshores have a capacity of 15.3 kN/metre
- Set of walls at 3.3 metre horizontal rite spacing.

Any pre-placed tenders should be checked against the contractor's typical foundations.

Effective depth of embedment (m)

Use for:
- Granular soils
- Mixed soils
- Sheet steel sheeting in clay
- Area access sewer

Maximum vertical spacing of walling (m)

250 x 250 Timber
300 x 150 L. Timber
250 x 250 Timber
275 x 75 Timber
150 x 75 Timber
Note:
For standard Speedshore hydraulic strut and walling or equivalent see the curve for 95x89 RSC.
Heavy duty Speedshores have a capacity of 35.5 kN/metre run of walling at 3.2m horizontal strut spacing.

Any proprietary system should be checked against manufacturer's latest information.

Use for:
Granular soils
Mixed soils
Short term trenches in clay
(see notes opposite)
Appendix E: Soil Investigation Report
Factual Report

Client: Basement Design Studio
Site: 9 Christchurch Street, London, SW3 4AN
CSI Ref: FACT/4500B
Dated: 8th September 2014
### Description of Strata

<table>
<thead>
<tr>
<th>Depth Mtrs.</th>
<th>Description of Strata</th>
<th>Thickness</th>
<th>Legend</th>
<th>Sample</th>
<th>Test Type</th>
<th>Result</th>
<th>Root Information</th>
<th>Depth to Water</th>
<th>Depth Mtrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.L.</td>
<td>TARMAC/TYP1</td>
<td>0.2</td>
<td></td>
<td>D</td>
<td>D</td>
<td></td>
<td>No roots observed.</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MADE GROUND: medium compact, brown, clayey silty fine to coarse sand with brick fragments.</td>
<td>2.4</td>
<td></td>
<td>D</td>
<td>D M 10</td>
<td>12 12 15</td>
<td></td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>Medium dense, brown/orange, clayey silty gravelly fine to coarse SAND.</td>
<td>1.6</td>
<td></td>
<td>D</td>
<td>D M 14</td>
<td>16 16 15</td>
<td></td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>Firm/medium dense, orange/brown, laminated CLAY SILT and fine SAND.</td>
<td></td>
<td></td>
<td>D</td>
<td>D M 29</td>
<td>28 30 31</td>
<td></td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td>Borehole ends at 6.0m</td>
<td></td>
<td></td>
<td>D</td>
<td>D M 25</td>
<td>27 29 30</td>
<td></td>
<td>6.0</td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:** Slight groundwater seepage at 4.9m. Borehole wet and open on completion.
REPORT NOTES

Equipment Used

Hand tools, Mechanical Concrete Breaker and Spade, Hand Augers, 100mm/150mm diameter Mechanical Flight Auger Rig, GEO205 Flight Auger Rig, Window Sampling Rig, and Large or Limited Access Shell & Auger Rig upon request and/or access permitting.

On Site Tests

By Pilcon Shear-Vane Tester (Kn/m²) in clay soils, and/or Mackintosh Probe in granular soils or made ground and/or upon request Continuous Dynamic Probe Testing and Standard Penetration Testing.

Note:

Details reported in trial-pits and boreholes relate to positions investigated only as instructed by the client or engineer on the date shown.

We are therefore unable to accept any responsibility for changes in soil conditions not investigated i.e. variations due to climate, season, vegetation and varying ground water levels.

Full terms and conditions are available upon request.