Job Number: 161202

CROFT STRUCTURAL ENGINEERS

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Basement Impact Assessment

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Summary and design and construction proposals

Property:

31 St Marks Crescent
Camden
NW1 7TT

Client:

Basement Design Studio

Structural Design Reviewed by	Above Ground Drainage Reviewed by
Chris Tomlin MEng CEng MIStructE	Phil Henry BEng MEng MICE

BIA Main Report [separate report]
Dr Martin Preene CEng FICE CGeol

Revision	Date	Comment
-	15.03.2017	First Issue

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Contents

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Executive (non-technical) Summary	
	The London Borough of Camden requires a Basement Impact Assessment (BIA) to be prepared for developments that include basements and lightwells. This BIA follows the requirements contained within Camden Council's planning guidance CGP4 – Basements and Lightwells (2015). In summary, the council will only allow basement construction to proceed if it does not: • cause harm to the built or natural environment and local amenity • result in flooding • lead to ground instability. In order to comply with the above clauses, a BIA must undertake five stages detailed in CPG 4. This report has been produced in line with Camden planning guidance and associated supporting documents such as CPG1, DP23, DP26, DP25 and DP27. Technical information from 'Camden geological, hydrogeological and hydrological study - Guidance for subterranean development', Issue 01, November 2010 (GSD, hereafter) was also used and is referred to in this assessment. For the basement proposal at 31 St Marks Crescent, Chelmer produced a BIA [ref BIA/8084A] to the requirements of CPG4. This is a separate document and should be used in conjunction this report. This report summarises the conclusions of the BIA by Chelmer and also presents design and construction proposals that account for the recommendations in the BIA.
Existing Property	The site comprises a semi-detached property, which is three-storeys high above street level and also has a lower ground floor. The rear of the property contains a garden which backs directly onto Regents Canal.
Proposed Development	The proposed development involves the construction of a new basement below the existing building. The basement will also extend partially into, and below, the rear garden.
Stage 1 – Screening	The BIA identified the following issues which were considered for carrying forward to the scoping stage:

	Subterranean (ground water) flow • The ground water level is approximately 0.4m above the proposed basement founding level. • The basement will extend approximately 4m into the rear garden, beyond the footprint of existing hard surfaces • The proximity of the canal was addressed, however, this was not considered to have an impact on the development and vice-versa. Slope Stability • Trees are present in the rear garden, which may be affected by the development • The proximity of the canal was addressed, however, this was not considered to have an impact on the development and vice-versa. • The site is within 5m of a pedestrian right of way • The basement will increase the differential depth of the foundations relative to the neighbouring properties. • A tunnel of the proposed High Speed 2 line will run to the north-east of the site. However, this is not considered to have any impact on the development. Surface Flow and Flooding • There will be a change in hardstanding which will affect the drainage of surface water Further details of the above are contained within Appendix A of the BIA by Chelmer.
Stage 2 – Scoping	The Scoping stage identifies in more detail the potential impacts of the basement and sets the parameters required for further study. Part of this was incorporated into the screening stage. Areas of further study were identified, and subsequently examined by means of a desk study (refer to Section 3 of the BIA by Chelmer). This studied the physical setting of the site and the surrounding area.
Stage 3 – Site Investigation and Study	The desk study was complemented by a site investigation. This included site visits by both Croft and Chelmer and also ground investigation works by Chelmer. The most relevant site features identified are: • London Clay exists at the proposed formation level of the basement • Ground water was recorded at approximately 3.1m below ground level

	• The site is on relatively level ground • The site is not on a street that was flooded in 1975 or 2002 The BIA by Chelmer also includes a conceptual site model which was carried forward for the impact assessment.
Stage 4 – Impact Assessment	**Land Stability** The BIA has concluded that the basement will not make the area unstable. A ground movement analysis has concluded that the maximum damage category to any part of the neighbouring buildings is 1 (Very Slight). Best practice construction methods are mitigate any potential damage. **Hydrogeology** The BIA has concluded that the permanent basement structure is not anticipated to have any impact on the groundwater flow which would adversely affect the neighbouring properties. Monitoring and measures to control groundwater during construction are recommended. **Drainage & Surface Water Flow** The BIA concluded that there will no significant risks of flooding associated with the development. The BIA also advised that SUDS measures should be considered at detailed design stage which could offset the loss in permeable areas due to the new development.

1. Screening Stage

	This stage identifies any areas for concern that should be investigated further. This has been carried out by Chelmer. Refer to BIA/8084A.

2. Scoping Stage

	This stage identifies the potential impacts of the areas of concern highlighted in the Screening phase. This has been carried out by Chelmer. Refer to BIA/8084A.

3. Site Investigation and Desk Study

	This section identifies the relevant features of the site and its immediate surroundings, providing further scoping where required. A detailed site investigation and desk study is contained within the BIA by Chelmer [Ref BIA/8084A]. Facets most relevant to the structural design of the basement are re-presented in this section. Additional features that will have impacts on the construction are also described here.
Walkover Survey	A structural engineer from Croft visited the site on 10 January 2017 The site comprises a Victorian semi-detached property with an front yard and a rear garden. The main building is four storeys high. This includes a Lower Ground floor below street level. To the front of this, there is a lightwell. The rear garden is at a lower level than the street level and forms a boundary with Regents Canal. The existing layouts are shown on architectural drawings by Sher + White (1701 series). The property is constructed from traditional building materials (brickwork and timber). No structural defects were noted. With the exception of flower beds, the front yard is covered with hard surfaces. The rear garden is soft landscaped, save a small area covered with paving slabs immediately behind the rear wall.

	 *Figure 1: Rear View of property* Additional photos of the property are appended to the BIA by Chelmer. There is a semi-mature tree in the rear garden and also shrubs and trees close to the boundary, in the neighbouring property.
Proposed Development	The proposed development involves the construction of a new basement below the existing building. The basement will also extend partially into, and below, the rear garden. The basement will be constructed from reinforced concrete. The Lower ground floor will be replaced with a new reinforced concrete slab. Further details of the proposed construction are presented in Section 4. Architectural drawings illustrating the scope of the proposals have been produced by Sher + White (1701 series). Deliveries of construction materials may involve occupation of the pavement in the front. It is also possible that delivery of building materials and removal of spoil will be involve the use of a barge on the canal at the rear. Further details on construction traffic management are presented in a CTMP, which is available as a separate document. The area occupied for construction is indicated below. In addition to the basement area, this also includes areas that are likely to be temporarily occupied for construction purposes.

<table>
<tr><td></td><td>

Figure 2: Extract from survey with approx. site area indicated

The outline construction sequence is appended to this report.</td></tr>
<tr><td>Site history</td><td>Historical maps show that the site and the surrounding area has been built up for over 100 years. Historical maps are appended to the BIA by Chelmer.

The Aggregate Night Time Bomb Census records bombs reported between 7th October 1940 to 6 June 1941. This shows that the nearest reported bomb was more than 200m away from the site; no bombs were reported in the immediate vicinity. An extract from a map showing this is presented below.</td></tr>
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	 *Figure 3: Extract from bomb census map*
Listed Buildings and Conservation Areas	The existing building is not listed. Data from Historic England shows that there are no listed buildings close by. The site is in the Primrose Hill Conservation Area.
Geology	Refer to the Ground Investigation report and the Hydrogeological and Land Stability assessment.
Highways & public footpaths	The site is not within 5m of the public highway. But the front lightwell is within 5m of the pavement.
London Underground and Network Rail	The site is more than 30m away from the nearest national rail line and the nearest subterranean train line. These are unlikely to be affected by the new basement. The BIA by Chelmer has identified the route of HS2 also passing more than 30m away from the site. This not likely to be affected by the site.
Other	The Regent's Canal runs directly behind the site. As explained in the BIA by

infrastructure	Chelmer, the basement structure is not likely to have an impact on the canal and vice-versa. However construction activity is likely to affect the use of the canal. The contractor should liaise with the necessary authoritative body, ie Canal & River Trust regarding any works affecting the use of the canal. The contractor has already initiated procedures for this. A copy of recent communication with the Infrastructure Services Team of the Canal and River Trust is appended.
UK Power Networks	There are no significant items of electrical infrastructure (such as pylons or substations) in the immediate vicinity.
Proximity of Trees	As mentioned previously, there is a tree within the footprint of the proposed basement. This will require removal. In the garden of the neighbouring property, No 59 Gloucester Avenue, there is a tree close to the boundary of the proposed basement. This has a similar height and is on a slightly higher level of ground. The garden wall closest to this drops to a lower level to form the side boundary of the existing patio at the rear. The base of this wall is therefore significantly lower than the ground surrounding the tree. This would form a permanent obstruction to any root spread. Any tree roots are therefore likely to be migrating away from this wall and further into the garden of the neighbouring property. Consequently, the basement wall that would be constructed below the existing garden wall is unlikely to have a significant impact on the roots. However, as a precaution, the contractor should follow guidance from BS 5837: 2005 *Trees in relation to construction*.
	Adjacent Properties The external facades of the neighbouring properties have been inspected. Handed descriptions of the properties below are given when facing the properties from St Marks Crescent.
No. 1 Marks Crescent – Property to Left	1 St Marks Crescent is a similar property to No 31 and also has a Lower Ground floor. A search on Camden Council's planning website has not shown and basements proposed below this level. No external defects were noted during the structural engineer's site visit.
No. 57 Gloucester Avenue – Property to	57 Gloucester Avenue is of a similar age and construction to 31 St Marks Crescent. A search on Camden Council's planning website has shown that there is a Lower Ground Floor, to a similar depth below street level but no basement further below. No external defects were noted during the

Right	structural engineer's site visit.

Ground Investigation

Ground Investigation Brief	The ground investigation was completed by Chelmer. Croft considered that their brief should cover: • Two trial pits to confirm the extent of the existing foundations. The purpose is to consider the effect of the works on the neighbouring properties and the find the ground conditions below the site. • Two boreholes to a depth of at least 7m below the external ground level (i.e. more than twice the depth of the proposed basement). • Stand pipe to be inserted to monitor ground water; record initial strike and return for repeat readings. • Site testing to determine in-situ soil parameters. SPT testing to be undertaken. • Laboratory testing to confirm soil make up and properties. • Factual report on soil conditions. The ground investigation report is submitted as a separate document and is appended to the BIA by Chelmer.

4. Basement Impact Assessment

	Impacts relating to Land Stability, Groundwater and Surface Water are described within the BIA produced by Chelmer. Proposed measures to mitigate these, which should be developed further at detailed design stage, are presented in this section.

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Mitigation Measures

The BIA by Chelmer emphasised the requirement for best practice construction methods to limit any ground movements and associated damage to the neighbouring properties.

The design and construction methodology described in this report aims to limit damage to acceptable levels. For this development, suitable temporary propping during the construction phase will limit the amount of movement due to the basement works. This is described in the Basement Method Statement (appended).

A method statement, appended, has been formulated with Croft's experience of over 500 basements completed without error. As mentioned previously, the procedures described in this statement will mitigate the impacts that the construction of the basement will have on nearby properties.

The works must be carried out in accordance with the Party Wall Act and condition surveys will be necessary at the beginning and the end of the works. The Party Wall Approval procedure will reinforce the use of the proposed method statement and, if necessary, require it to be developed in more detail with more stringent requirements than those required at planning stage.

It is not expected that any cracking will occur in nearby structures during the works. However, Croft's experience advises that there is a risk of movement to the neighbouring property.

To reduce the risk to the development:

- Employ a reputable firm that has extensive knowledge of basement works.
- Employ suitably qualified consultants Croft Structural Engineers has completed over 500 basements in the last five years.
- Provide method statements for the contractors to follow
- Investigate the ground this has now been done.
- Record and monitor the properties close by. This is completed by a condition survey under the Party Wall Act, before and after the works are completed. Refer to the end of the appended Basement

	Construction Method Statement. • Provide additional temporary support at the head of the retaining walls. This will give a 'high stiffness' propping model, as identified under CIRIA C580; this will limit the movements even further than those predicted in the GMA by Chelmer, which assumed a worst case 'low support stiffness'.

Monitoring of Structures

	In order to safeguard the existing structures during underpinning and new basement construction, movement monitoring is to be undertaken.
Risk Assessment	(see below)

Monitoring Level proposed	Type of Works.
Monitoring 4 Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical monitoring movement by standard optical equipment Lateral movement between walls by laser measurements	New basements greater than 2.5m and shallower than 4m deep in gravels Basements up to 4.5m deep in clays Underpinning works to grade I listed building

Before the works begin, a detailed monitoring report is required to confirm the implementation of the monitoring. The items that this should cover are:

- Risk Assessment to determine level of monitoring
- Scope of Works
- Applicable standards
- Specification for Instrumentation
- Monitoring of Existing cracks
- Monitoring of movement
- Reporting
- Trigger Levels using a RED / AMBER / GREEN System

Recommend levels are shown within the proposed monitoring statement (appended).

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Basement Design & Construction Impacts and Initial Design Considerations	
Design Concept	Reinforced concrete (RC) cantilevered retaining walls will form the new foundation of the property. These will be designed to resist the lateral loads around the perimeter of the basement. The walls will be propped at the head by the new RC lower ground floor, and by the basement ceiling RC slab at the rear. The lateral load applied to the walls will be transferred along the basement slab (and also by the Lower ground floor and ceiling slab) and will be resisted by the wall and the retained soil on the opposite side. The RC perimeter wall will also transfer vertical loads to the ground (refer to appended drawing SL-10). The investigations highlight that water is present. The walls will be designed to resist the hydrostatic pressure. The water table was recorded as being not much higher than the formation level of the basement. The design of the walls considers long term scenarios. It is possible that a water main may break causing a local high water table. To account for this, the wall is designed for water 1m from the top of the wall. The design also considers floatation as a risk. The design has accounted for the weight of the building and the uplift forces from the water. The weight of the building is greater than the uplift, resulting in a stable structure. The central slab of the basement should be designed to resist local uplift. The stability of the walls should be designed using K_a & K_p values. The BIA predicts heave below the basement. This will be less than 10mm and can be accommodated by installing compressible material or a void former (Clayboard or similar) between the basement slab and the ground.

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Additional loading requirements	Below ground level, the reinforced concrete retaining walls are designed to carry the lateral loading applied from above. The lateral earth pressure exerts a horizontal force on the retaining walls. The retaining walls will be checked for resistance to the overturning force this produces. Lateral forces will be applied from: • Soil loads • Hydrostatic pressures • Surcharge loading from behind the retaining walls These produce retaining wall thrust. This will be resisted by the opposite retaining wall. <u>Surcharge Loading</u> The following will be applied as surcharge loads to the retaining walls: • 5kN/m^2 if within 45° of pavement • Garden surcharge 2.5kN/m^2 + 1m of soil (present above basement ceiling) 20kN/m^2 • Surcharge for adjacent property 1.5kN/m^2 + 4kN/m^2 for concrete ground bearing slab <u>Adjacent Properties:</u> All adjacent property footings within 45° to have additional geotechnical engineers input. A line at 45º from the base of the neighbours' wall footing would be intersected by the basement retaining wall. This should be accounted for in the design. The appended calculations show the design of one of the most heavily loaded retaining wall. The most critical parameters have been used for this.
Mitigation Measures - Internal Flooding	To mitigate the risks associated with failure of infrastructure, Croft would recommend the following measures to reduce damage associated with flooding: • To reduce the likelihood of flooding into the lightwells, these should be designed (at detailed design stage) with upstands above ground level. • A pumping system should be installed for the proposed basement. There is a likelihood that this may fail and allow excess water to accumulate. If this were to occur, the build-up of water would be gradual and noticeable before it becomes a significant life-threatening hazard.

	• The pumping system should be a dual mechanism to maintain operation in the event of a failure. This should include a battery backup and a suitable alarm system for warning purposes. • Install all electrical wiring at high level
Mitigation Measures - Drainage and Damp-proofing	The design of drainage and damp-proofing is not within the scope of this assessment and would not normally be expected to be part of the structural engineer's remit at detailed design stage. A common and anticipated detailed design stage approach is to use internal membranes (Delta or similar). These will be integral to the waterproofing of the basement. Any water from this will enter a drainage channel below the slab. This will be pumped and discharged into the exiting sewer system. It is recommended that a waterproofing specialist is employed to ensure all the water proofing requirements are met. The waterproofing specialist must name their structural waterproofer. The structural waterproofer must inspect the structural details and confirm that he is happy with the robustness. Due to the segmental construction nature of the basement, it is not possible to water proof the joints. All waterproofing must be made by the waterproofing specialist. He should review the structural engineer's design stage details and advise if water bars and stops are necessary. The waterproofing designer must not assume that the structure is watertight. To help reduce water flow through the joints in the segmental pins, the following measures should be applied: • All faces should be cleaned of all debris and detritus • Faces between pins should be needle hammered to improve key for bonding • All pipe work and other penetrations should have puddle flanges or hydrophilic strips
Additional Drainage and SUDS Considerations	The rear light-well and the area above the rear of the basement (which extends into the rear garden) will create additional hard surfaced areas. The BIA has proposed the use of SUDS to mitigate the additional surface water flow. It is worth noting that there is a considerable amount of soft land-scaping to the rear, even with the proposed layout. In relation to the area of the whole site, the reduction in permeable areas is not likely to exceed 10% of the total area. SUDS solutions should be considered at detailed design stage but only

	where they are practicable and in proportion to the scale of the development. Features may include: • Permeable paving at the rear with closed channels/pipes to allow surface water to discharge into the rear garden soil behind the basement • Rainwater harvesting by means of water collection butts • Additional planting above the rear terraced area With these measures adopted, the additional surface water entering the existing drainage system will be negligible.
Temporary Works	Temporary propping details will be required. This must be provided by the contractor. Their details should be forwarded to the design stage engineer. Water levels should be monitored for at least one month prior to starting on site and throughout the construction process. Localised dewatering to pin excavations may be necessary. To demonstrate the feasibility of the works, a proposed basement construction method statement is appended.

Construction Management	**The site is in a conservation area**. The contractor should strictly control the impacts on the local amenity. A management plan for demolition and construction will be required at detailed design stage.

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Appendix A: Structural Calculations

CPG4 section 5 highlights that other permits and requirements will be necessary after planning. Item 5.1 highlights that Building Regulations will be required. As part of the building control pack full calculations must be undertaken and provided at detailed design stage once planning permission is granted. The calculations must be completed to a recognised Standard (BS or Euro Codes). The calculations must take into account the findings of this report and the recommendations of the auditors.

The design must resist:

- Vertical loads from the proposed works and adjacent properties
- Lateral loads from wind, soil water and adjacent properties
- Loadings in the temporary condition
- All other applied loads on the building
- Uplift forces from hydrostatic effects and soil heave

The final proposed scheme must:

- Provide stability in the temporary condition to all forces
- Provide stability to all forces in the permanent condition

As part of the planning Croft structural engineers has considered some of the pertinent parts of the basement structure to ensure that it can be constructed. The following calculations are not a full set of calculations for the final design which must be provided for building regulations. The structural calculations Croft considers pertinent and included in this appendix for this development are:

1. Retaining wall below party wall

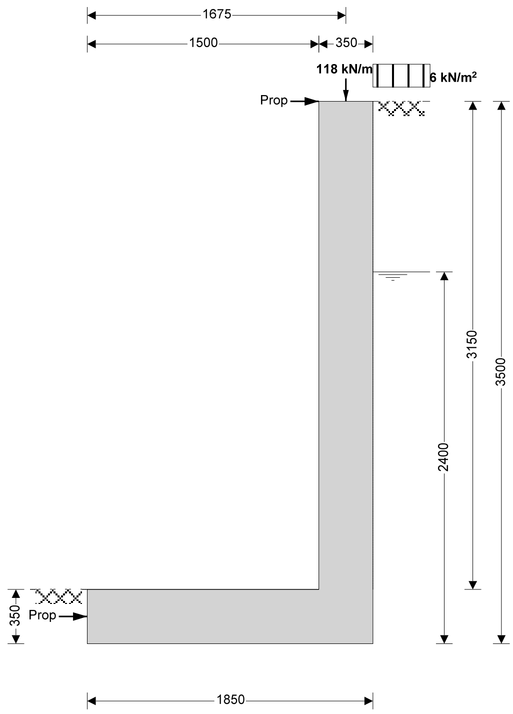
2. Uplift calculations

W 1, RETAINING WALL BELOW PARTY WALL WITH NO. 1

Based on a depth of 3.5m, and a related Pilcon vane value of 100 (refer to the ground investigation report by Chelmer), use an allowable ground bearing pressure of 150 kN/m^2.

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type	**Cantilever**		
Height of wall stem	h_{stem} = **3150** mm	Wall stem thickness	t_{wall} = **350** mm
Length of toe	l_{toe} = **1500** mm	Length of heel	l_{heel} = **0** mm
Overall length of base	l_{base} = **1850** mm	Base thickness	t_{base} = **350** mm
Height of retaining wall	h_{wall} = **3500** mm		
Depth of downstand	d_{ds} = **0** mm	Thickness of downstand	t_{ds} = **350** mm
Position of downstand	l_{ds} = **1350** mm		
Depth of cover in front of wall	d_{cover} = **0** mm	Unplanned excavation depth	d_{exc} = **0** mm
Height of ground water	h_{water} = **2400** mm	Density of water	γ_{water} = 9.81 kN/m^3
Density of wall construction	γ_{wall} = **23.6** kN/m^3	Density of base construction	γ_{base} = **23.6** kN/m^3
Angle of soil surface	β = **0.0** deg	Effective height at back of wall	h_{eff} = **3500** mm
Mobilisation factor	M = **1.5**		
Moist density	γ_m = **15.0** kN/m^3	Saturated density	γ_s = **18.0** kN/m^3
Design shear strength	ϕ' = **8.1** deg	Angle of wall friction	δ = **6.1** deg

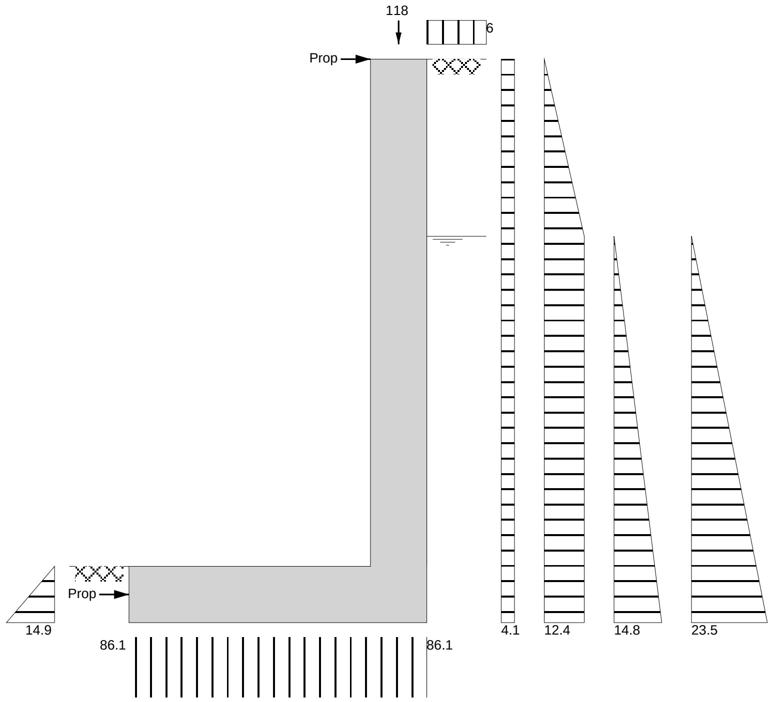
Design shear strength	ϕ'_b = **24.0** deg	Design base friction	δ_b = **18.0** deg
Moist density	γ_{mb} = **18.0** kN/m^3	Allowable bearing	$P_{bearing}$ = **150** kN/m^2

Using Rankine theory

Active pressure	K_a =**0.753**	Passive pressure	K_p = **2.371**
At-rest pressure	K_0 = **0.859**		

Loading details

Surcharge load	Surcharge = **5.5** kN/m^2		
Vertical dead load	W_{dead} = **98.0** kN/m	Vertical live load	W_{live} = **20.0** kN/m
Horizontal dead load	F_{dead} = **0.0** kN/m	Horizontal live load	F_{live} = **0.0** kN/m
Position of vertical load	l_{load} = **1675** mm	Height of horizontal load	h_{load} = **0** mm



Loads shown in kN/m, pressures shown in kN/m^2

Calculate propping force

Propping force F_{prop} = **49.3** kN/m

Check bearing pressure

Total vertical reaction	R = **159.3** kN/m	Distance to reaction	x_{bar} = **925** mm
Eccentricity of reaction	e = **0** mm		

Reaction acts within middle third of base

Bearing pressure at toe	p_{toe} = **86.1** kN/m^2	Bearing pressure at heel	p_{heel} = **86.1** kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

Calculate propping forces to top and base of wall

Propping force to top of wall	F_{prop_top} = **10.143** kN/m	Propping force to base of wall	F_{prop_base} = **39.142** kN/m

RETAINING WALL DESIGN (BS 8002:1994)

TEDDS calculation version 1.2.01.06

Ultimate limit state load factors

Dead load factor γ_{f_d} = **1.4** Live load factor γ_{f_l} = **1.6**

Earth pressure factor γ_{f_e} = **1.4**

Calculate propping force

Propping force F_{prop} = **49.3** kN/m

Calculate propping forces to top and base of wall

Propping force to top of wall $F_{prop\_top\_f}$ = **5.637** kN/m Propping force to base of wall $F_{prop\_base\_f}$ = **80.264** kN/m

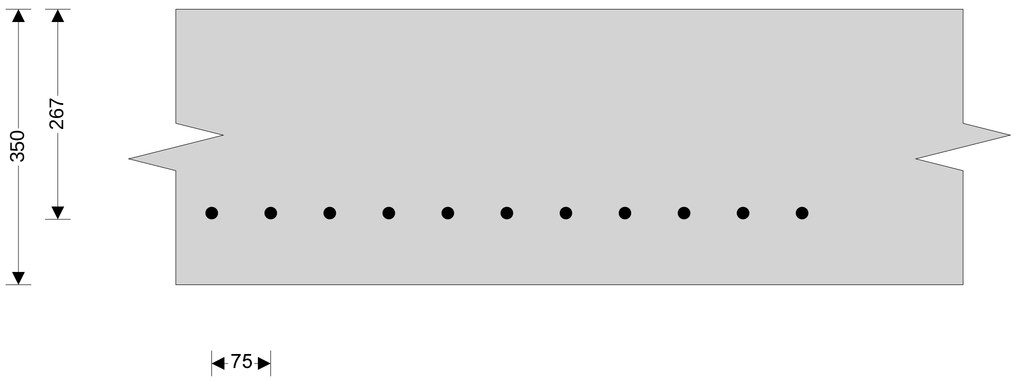
Design of reinforced concrete retaining wall toe (BS 8002:1994)

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} = **75** mm



Design of retaining wall toe

Shear at heel V_{toe} = **166.7** kN/m Moment at heel M_{toe} = **155.9** kNm/m

Compression reinforcement is not required

Check toe in bending

Reinforcement provided **16 mm dia.bars @ 75 mm centres**

Area required $A_{s\_toe\_req}$ = **1451.4** mm^2/m Area provided $A_{s\_toe\_prov}$ = **2681** mm^2/m

PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe

Design shear stress v_{toe} = **0.624** N/mm^2 Allowable shear stress v_{adm} = **4.733** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_toe} = **0.783** N/mm^2

v_{toe} < v_{c_toe} - No shear reinforcement required

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

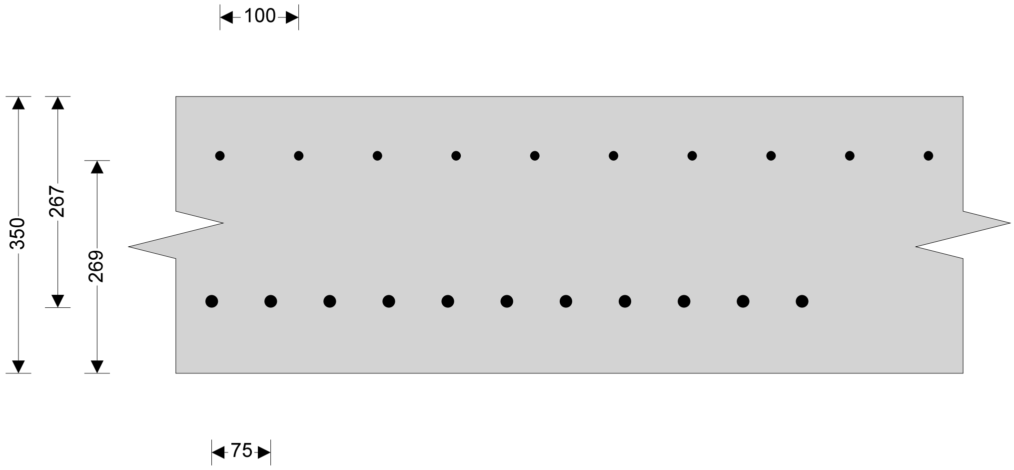
Material properties

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} = **75** mm Cover in wall c_{wall} = **75** mm



Design of retaining wall stem

Shear at base of stem V_{stem} = **96.3** kN/m Moment at base of stem M_{stem} = **54.5** kNm/m

Compression reinforcement is not required

Check wall stem in bending

Reinforcement provided **16 mm dia.bars @ 75 mm centres**

Area required $A_{s\_stem\_req}$ = **493.5** mm^2/m Area provided $A_{s\_stem\_prov}$ = **2681** mm^2/m

PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem

Design shear stress v_{stem} = **0.361** N/mm^2 Allowable shear stress v_{adm} = **4.733** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_stem} = **0.783** N/mm^2

$v_{stem} < v_{c\_stem}$ - No shear reinforcement required

Design of retaining wall at mid height

Moment at mid height M_{wall} = **26.9** kNm/m

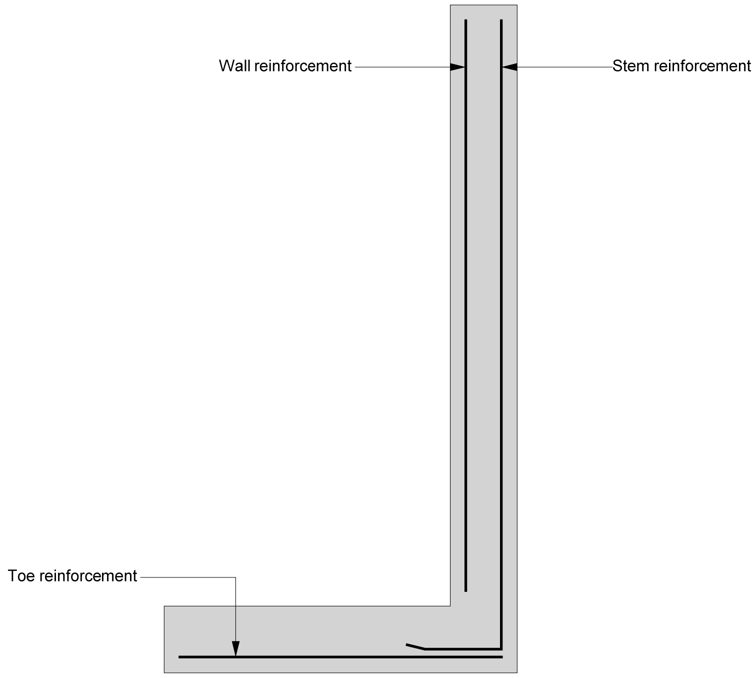
Compression reinforcement is not required

Reinforcement provided **12 mm dia.bars @ 100 mm centres**

Area required $A_{s\_wall\_req}$ = **455.0** mm^2/m Area provided $A_{s\_wall\_prov}$ = **1131** mm^2/m

PASS - Reinforcement provided to the retaining wall at mid height is adequate

Indicative retaining wall reinforcement diagram

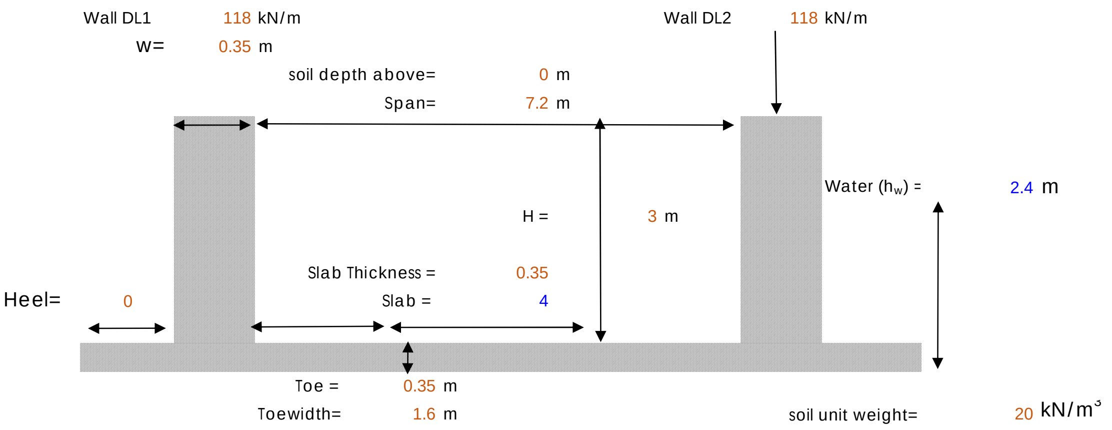


Toe bars - 16 mm dia.@ 75 mm centres - (2681 mm^2/m)
Wall bars - 12 mm dia.@ 100 mm centres - (1131 mm^2/m)
Stem bars - 16 mm dia.@ 75 mm centres - (2681 mm^2/m)

BASEMENT SLAB CALCULATIONS

Ref

Slab Uplift



Slab Uplift

Slab = 8.8 kN/m

Uplift $= h_w \times 10kN/m^3 =$ 23.6 kN/m

Service Moment = (net uplift)*(span)^2 / 8 -96.2 kNm/m

Factored Design moment= -117.2 kNm/m

Factored Design shear = -65.1 kN/m

[At Detailed Design stage, the slab should be designed to resist these forces]

Appendix B: Construction Programme

<u>The Contractor is responsible for the final construction programme</u>

Outline Construction Programme

(For planning purposes only)

	Months															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Planning approval																
Detailed Design																
Tender																
Party Wall Approval																
Monitoring of Adjacent structures																
Enabling works																
Basement Construction																
Superstructure construction																

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Appendix C: Construction Method

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Basement Construction Method Statement for 31 St Marks Crescent

1. Basement Formation Suggested Method Statement

1.1. This method statement provides an approach that will allow the basement design to be correctly considered during design, temporary design and construction. This statement is for planning purposes only. Once Planning and Building Control applications have been completed, the responsibility for the temporary works will transfer to the Contractor during works on site**.**

1.2. This sequence has been written by a Chartered Engineer. The sequencing has been developed using guidance from ASUC (Association of Specialist Underpinning Contractors).

1.3. This method has been produced to demonstrate the feasibility of the works at planning and for inclusion in the Basement Impact Assessment at Planning for Camden.

2. Enabling Works

2.1. The site is to be hoarded to prevent unauthorised public access.

2.2. Licences for skips and conveyors should be posted on the hoarding.

2.3. Dewater: It is possible that water may be encountered on site during the works.

2.3.1. Localised removal of water may be required to deal with rain from perched water or localised water. This is to be dealt with by localised pumping. Typically achieved by a small sump pump in a bucket.

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

Temporary props will be provided along the head of the pin in the temporary condition. Before the base is cast cross props are needed. The base/ground slab provides propping in the final condition. 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 soil mass is to be removed in portions (thirds but no greater than 8m) and cross propping subsequently added as the central soil ass is removed

The general approach Croft would recommend is to locally insert strategic pins/footings to carry the load over from a steel grillage and then to construct new basement to the building. Refer to drawing TW-10 for diagrams to support the sequence below

3.1. Phase 1 – Strategic Foundations

Refer to Phase 1 of the outline construction sequence on drawing TW-10.

3.1.1. Pit excavations to be propped with Acow props as selected in Section 4.
3.1.2. Prop back to central soil mound

3.2. Phase 2 – Needling and propping of existing walls

Refer to Phase 2 of the outline construction sequence on drawing TW-10.

3.3. Phase 3 – Insertion of steel grillage

Refer to Phase 3 of the outline construction sequence on drawing TW-10.

3.3.1. Erect internal columns where required before installing Lower Ground floor level steel beams

3.4. Phase 4 – Perimeter underpinning

Refer to Phase 4 of the outline construction sequence on drawing TW-10.

3.4.1. Pit excavations to be propped with Acow props as selected in Section 4.
3.4.2. Prop back to central soil mound

3.5. Phase 5 – Excavate central soil mound

Refer to Phase 5 of the outline construction sequence on drawing TW-10.

3.5.1. Remove upper half of central soil mound
3.5.2. Install full width cross props 600mm below ground level
3.5.3. Remove central soil mound to slab level
3.5.4. Install full width cross props at 600mm above basement level
3.5.5. Remove remainder of soil between underpin toes

3.6. Phase 6 –Cast slab

Refer to Phase 6 of the outline construction sequence on drawing TW-10.

3.6.1. After installing below slab level drainage and clayboard, place reinforcement and cast central portion of slab
3.6.2. Construct Lower Ground Floor level slab
3.6.3. One the Lower Ground Floor structure is completed and basement slab is constructed, remove temporary cross props.

4. Basement Temporary Works Design: Lateral Propping

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 be pumped out.

Trench sheets should be placed at regular centres to deal with the ground. It is expected that the soil between the trench sheeting will arch. Looser soil will require tighter centres. It is typical for underpins to be placed at 1000c/c in this condition the highest load on a trench sheet is when 2 No.s 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 c_u (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:

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Trench Sheet Design

Soil Depth	Dsoil = 3000mm
Surcharge	sur = 10kN/m^2
Soil Density	γ = 20kN/m^3
Angle of Friction	ϕ = 25°

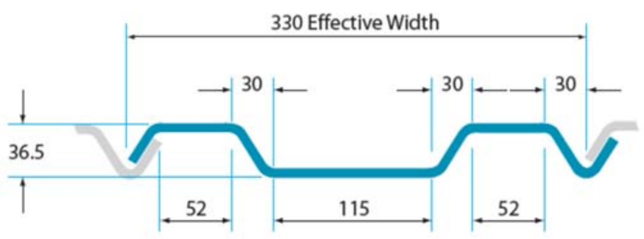
$k_a = (1 - \sin(\phi)) / (1 + \sin(\phi))$ = **0.406**

$k_p = 1 / k_a$ = **2.464**

Soil pressure bottom	soil = $k_a * \gamma *$ Dsoil	= **21.916**kN/m^2
Surcharge pressure	surcharge = sur * k_a	= **4.059** kN/m^2

STANDARD LAP

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



Technical Information

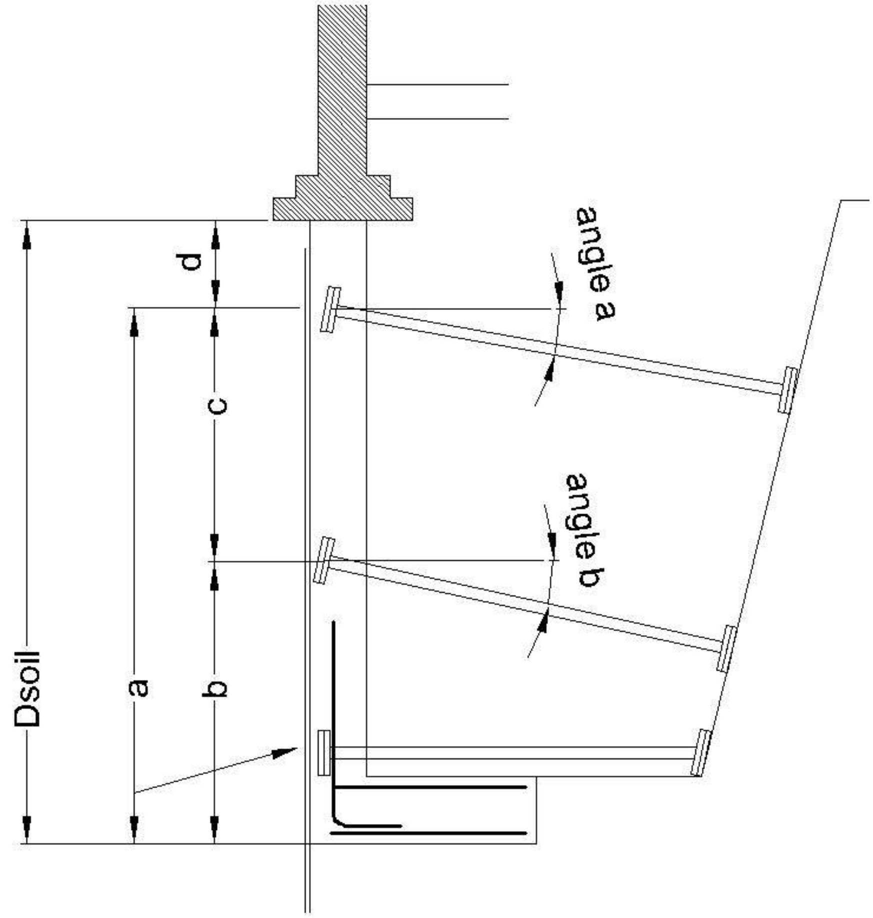
Effective width per sheet (mm)	330
Thickness (mm)	3.4
Depth (mm)	35
Weight per linear metre (kg/m)	10.8
Weight per m² (kg)	32.9
Section modulus per metre width (cm³)	48.3
Section modulus per sheet (cm³)	15.9
I value per metre width (cm⁴)	81.7
I value per sheet (cm⁴)	26.9
Total rolled metres per tonne	92.1

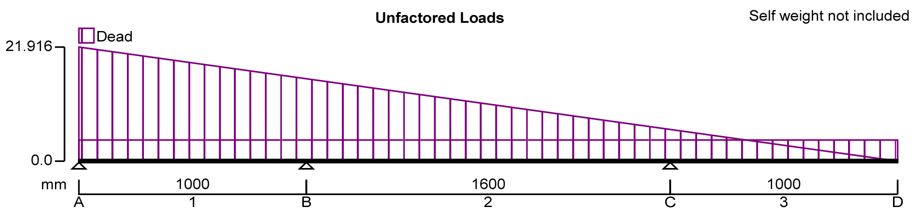
$Sxx = 15.9\ cm^3$

$py = 275 N/mm^2$

$Ixx = 26.9 cm^4$

$A = (1m * 32.9 kg/m^2) / (7750 kg/m^3)$ = **4245.161**mm^2





CONTINUOUS BEAM ANALYSIS - INPUT

BEAM DETAILS

Number of spans = **3**

Material Properties:

Modulus of elasticity = **205** kN/mm^2 Material density = **7860** 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 = **1000** mm	Cross-sectional area = **4245** mm^2	Moment of inertia = **269.×10^3** mm^4
Span 2	Length = **1600** mm	Cross-sectional area = **4245** mm^2	Moment of inertia = **269.×10^3** mm^4
Span 3	Length = **1000** mm	Cross-sectional area = **4245** mm^2	Moment of inertia = **269.×10^3** mm^4

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 1.4×Dead

Span 2 1.4×Dead

Span 3 1.4×Dead

CONTINUOUS BEAM ANALYSIS - RESULTS

Support Reactions - Combination Summary

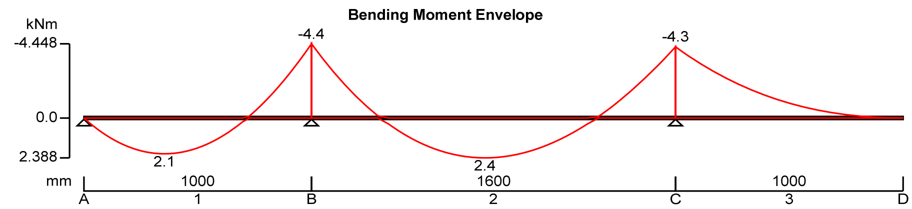
Support A	Max react = **-12.3** kN	Min react = **-12.3** kN	Max mom = **0.0** kNm	Min mom = **0.0** kNm
Support B	Max react = **-38.5** kN	Min react = **-38.5** kN	Max mom = **0.0** kNm	Min mom = **0.0** kNm
Support C	Max react = **-24.8** kN	Min react = **-24.8** kN	Max mom = **0.0** kNm	Min mom = **0.0** kNm
Support D	Max react = **0.0** kN	Min react = **0.0** kN	Max mom = **0.0** kNm	Min mom = **0.0** kNm

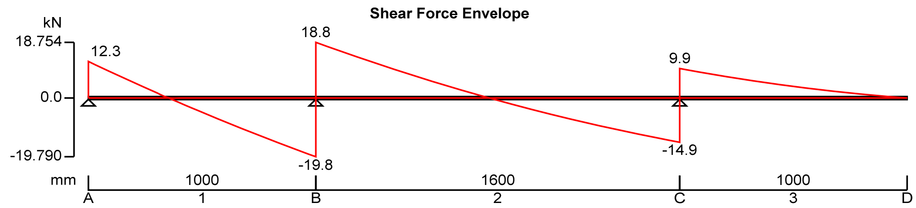
Beam Max/Min results - Combination Summary

Maximum shear = **18.8** kN — Minimum shearF_{min} = **-19.8** kN

Maximum moment = **2.4** kNm — Minimum moment = **-4.4** kNm

Maximum deflection = **17.1** mm — Minimum deflection = **-0.1** mm





Number of sheets Nos = 3

Moment M_allowable = Sxx * py * Nos = **13.118**kNm

Deflection D = / Nos = **5.699**mm

Acro Load Acro = R_{max_B} / 2 = -19.272kN

Safe working loads for Acrow Props — loads given in kN

For normal purposes 1 kilo Newton (kN) = 100 kg	Height	m / ft	2.0 / 6.6	2.25 / 7.4	2.5 / 8.2	2.75 / 9.0	3.0 / 9.8	3.[illegible] / 10
TABLE A Props loaded concentrically and erected vertically	Prop size 1 or 2		35	35	35	34	27	23
	Prop size 3					34	27	23
	Prop size 4							32
TABLE B Props loaded concentrically and erected 1½° max. out of vertical	Prop size 1 or 2 or 3		35	32	26	23	19	17
	Prop size 4							24
TABLE C Props loaded 25 mm eccentricity and erected 1½° max. out of vertical	Prop size 1 or 2 or 3		17	17	17	17	15	13
	Prop size 4							17
TABLE D Props loaded concentrically and erected 1½° out of vertical and laced with scaffold tubes and fittings	Prop size 3					35	33	32
	Prop size 4							35

Acrow Props A or B are acceptable placed 0.5m from top, middle and 1m from bottom

Cross Props

Surcharge sur = $10kN/m^2$

Soil Density $\gamma = 20kN/m^3$

Angle of Friction $\phi = 25°$

Soil Depth Dsoil = 3000mm

$k_a = (1 - \sin(\phi)) / (1 + \sin(\phi))$ = **0.406**

$k_p = 1 / k_a$ = **2.464**

$1 - \sin(\phi)$ = **0.577**

Soil force bottomsoilforce = $k_a * \gamma *$ Dsoil * Dsoil / 2 = **36.527**kN/m

Surcharge Force Surchargeforce = k_a * sur * Dsoil = **12.176**kN/m

Place Props every other pin spacing = 2m

Propforce Propforce = spacing * (soilforce + Surchargeforce) = **97.406**kN

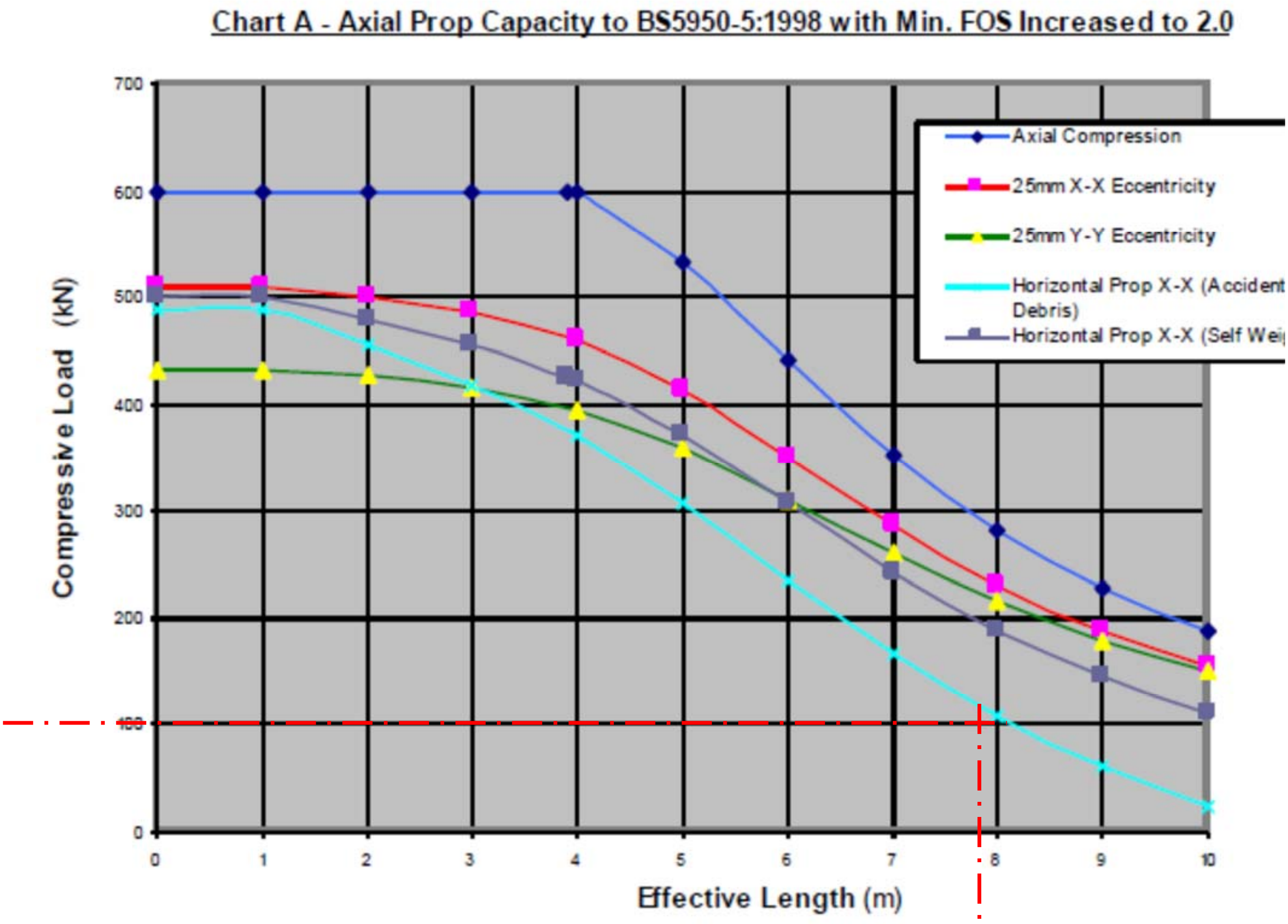


Figure 1 Mabey Mass 50 Load Chart

Provide Mabey Mass 50 at 2m centres

<u>Outline construction sequence</u>

Phase 1. Break away floor Lower Ground Floor slab, excavate and cast pins that will support ends of new steel beams (pins 1-9 on drawing SL-10); follow the methodology in Section 4 of the Method Statement

Phase 2. Needle and prop front, rear and internal load-bearing walls from lower ground floor level

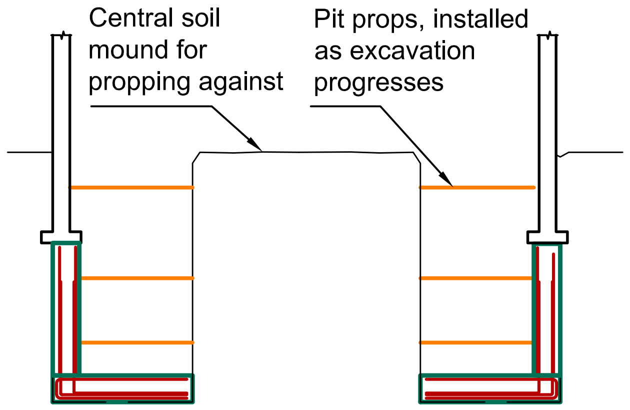
Phase 3. Locally demolish lower ground floor slab to allow steel beams to be inserted below load-bearing walls, insert steel and drypack to load-bearing walls

Phase 4. Continue to excavate basement perimeter walls in 1m wide hit and miss segments following the numbering sequence indicated on plan, leaving in place the central soil mound for propping against (see section diagram)

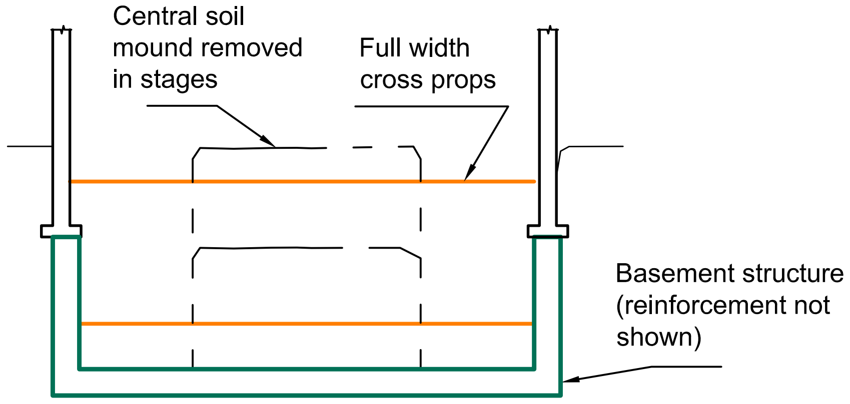
Phase 5. Excavate central soil mound, demolishing remainder of Lower Ground Floor slab, installing full width cross props as excavation progresses (see section diagram).

Phase 6. Cast basement slab (see section diagram). Props may be remove after basement structure and new Lower Ground Floor slab is complete.

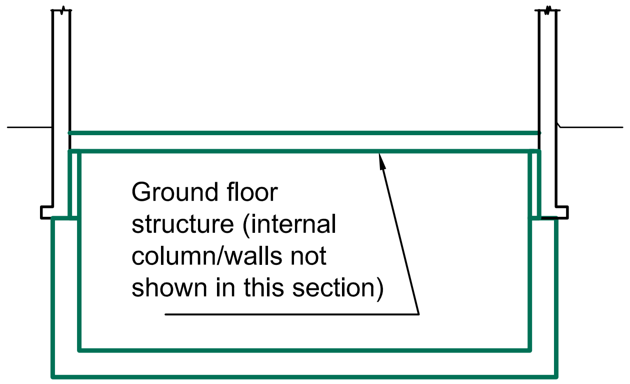
Phase 4



Phase 5



Phase 6



- PLANNING ISSUE - NOT FOR CONSTRUCTION

Rev	Date	Amendments
-	15.03.2017	First issue for comment

Job No. 161202	Drawn GW / Chk'd -	Scale As shown @ A3
Dwg No. TW-10	Rev. -	Date Jan 2017

Croft Structural Engineers
Clockshop Mews, r/o 60 Saxon Rd, London, SE25 5EH.
020 8684 4744
www.croftse.co.uk

Client: Basement Design Studio

Project: 31 St Marks Crescent

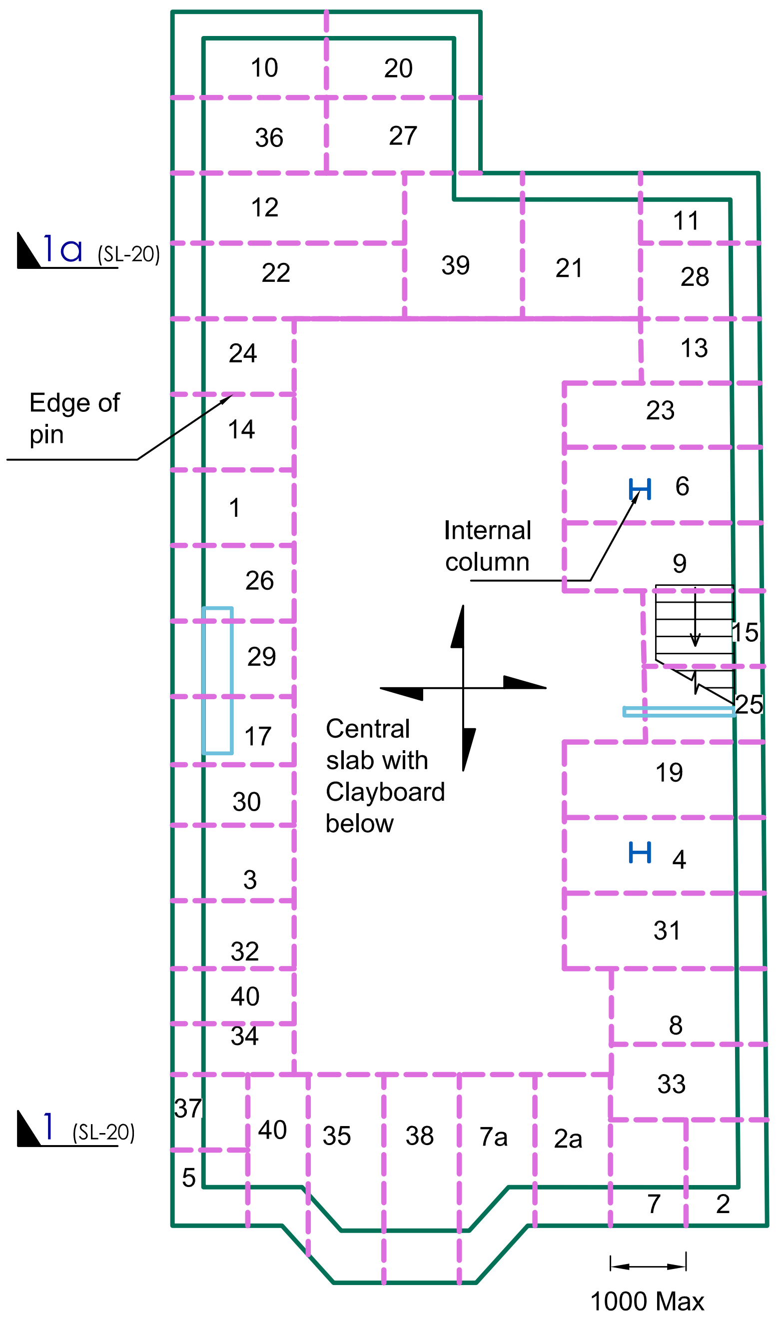
Title : Temporary Works Scheme Design

USE IN CONJUNCTION WITH BASEMENT CONSTRUCTION METHOD STATEMENT

<u>Typical section through building showing construction sequence</u>

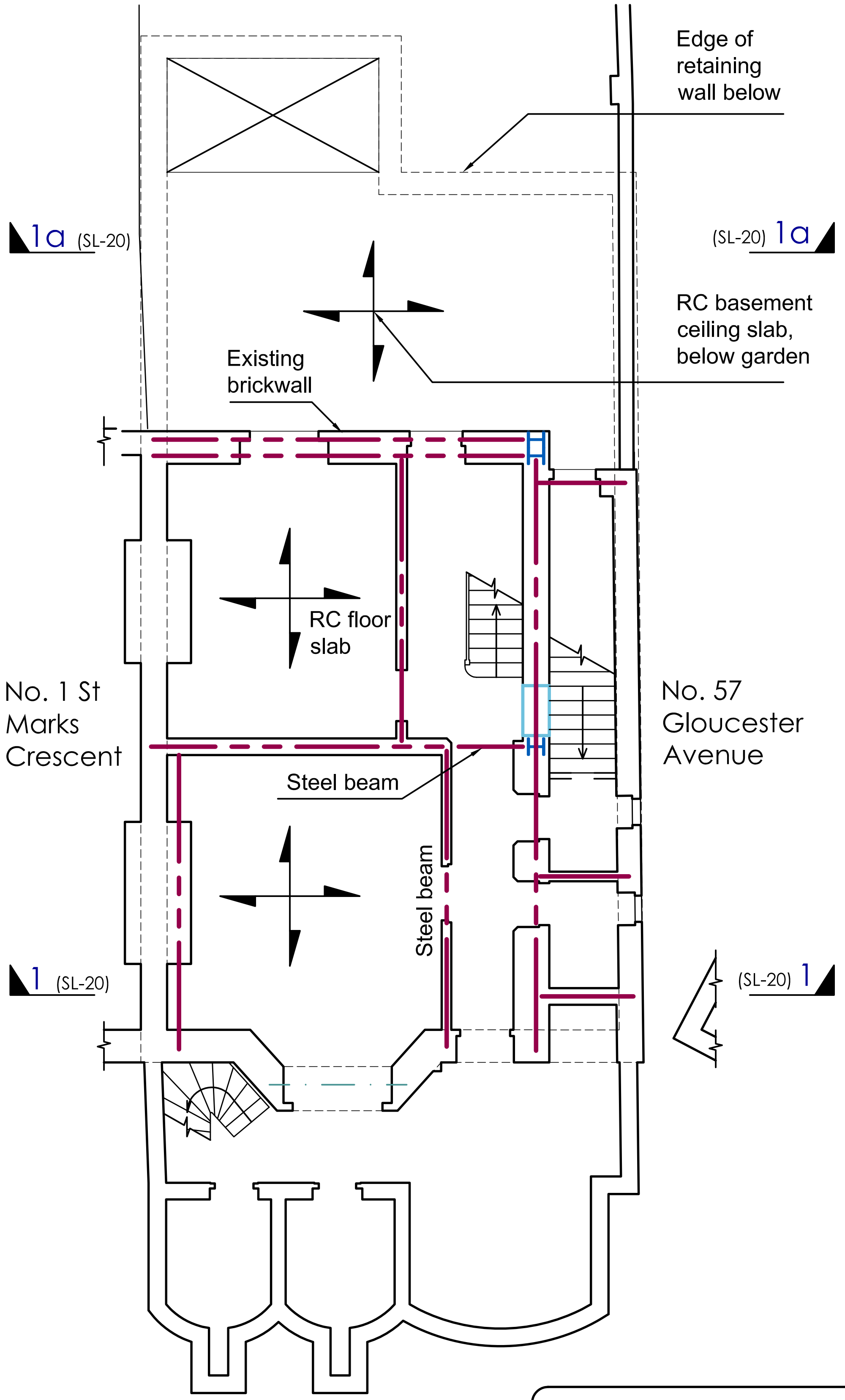
(1:100)

Appendix D: Structural Drawings



Basement Floor Plan

(Scale 1:100)

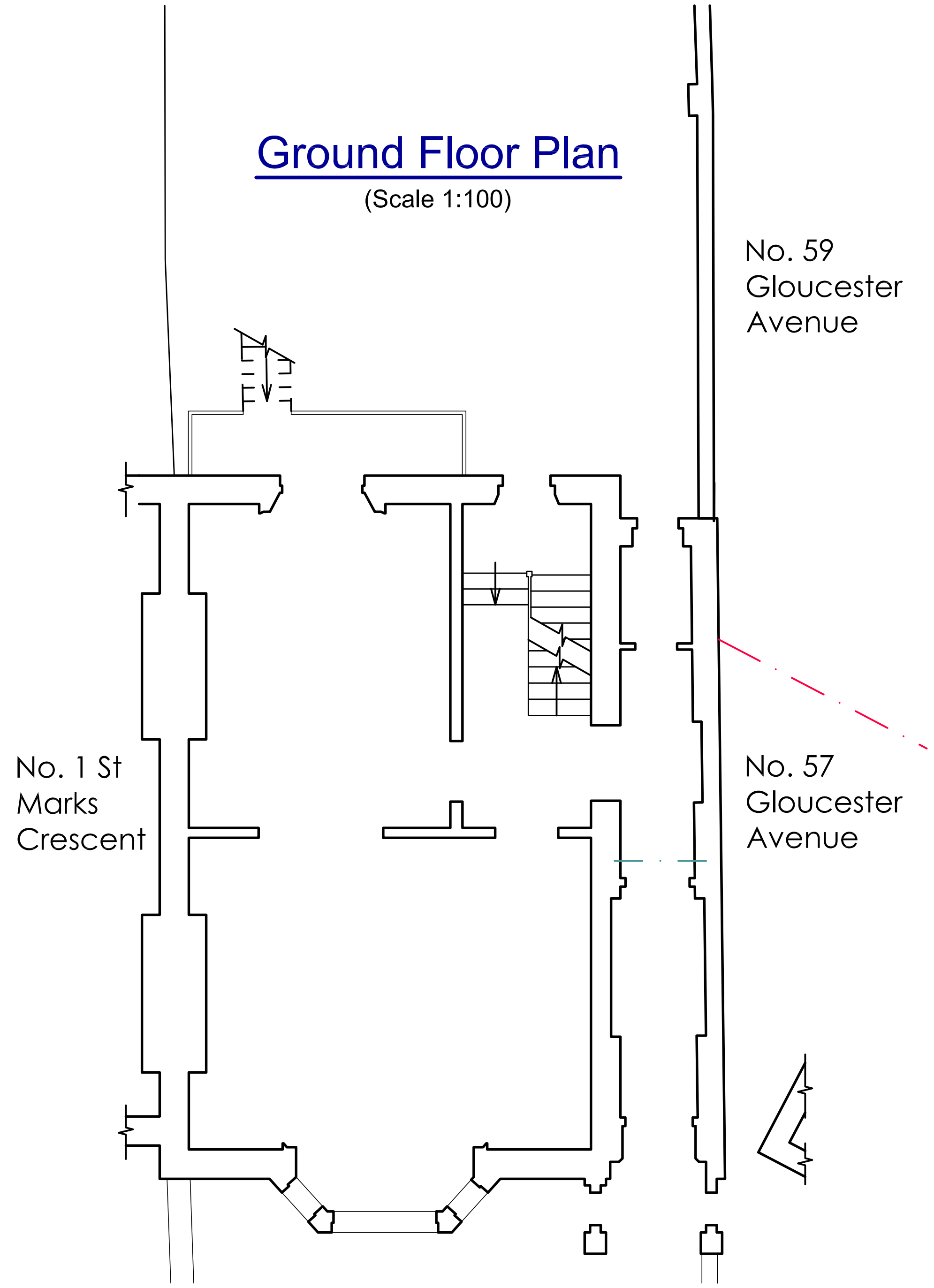


Lower Ground Floor Plan

(Scale 1:100)

Ground Floor Plan

(Scale 1:100)



- PLANNING ISSUE - NOT FOR CONSTRUCTION

Rev	Date	Amendments
-	15.03.2017	First issue for comment

Croft Structural Engineers
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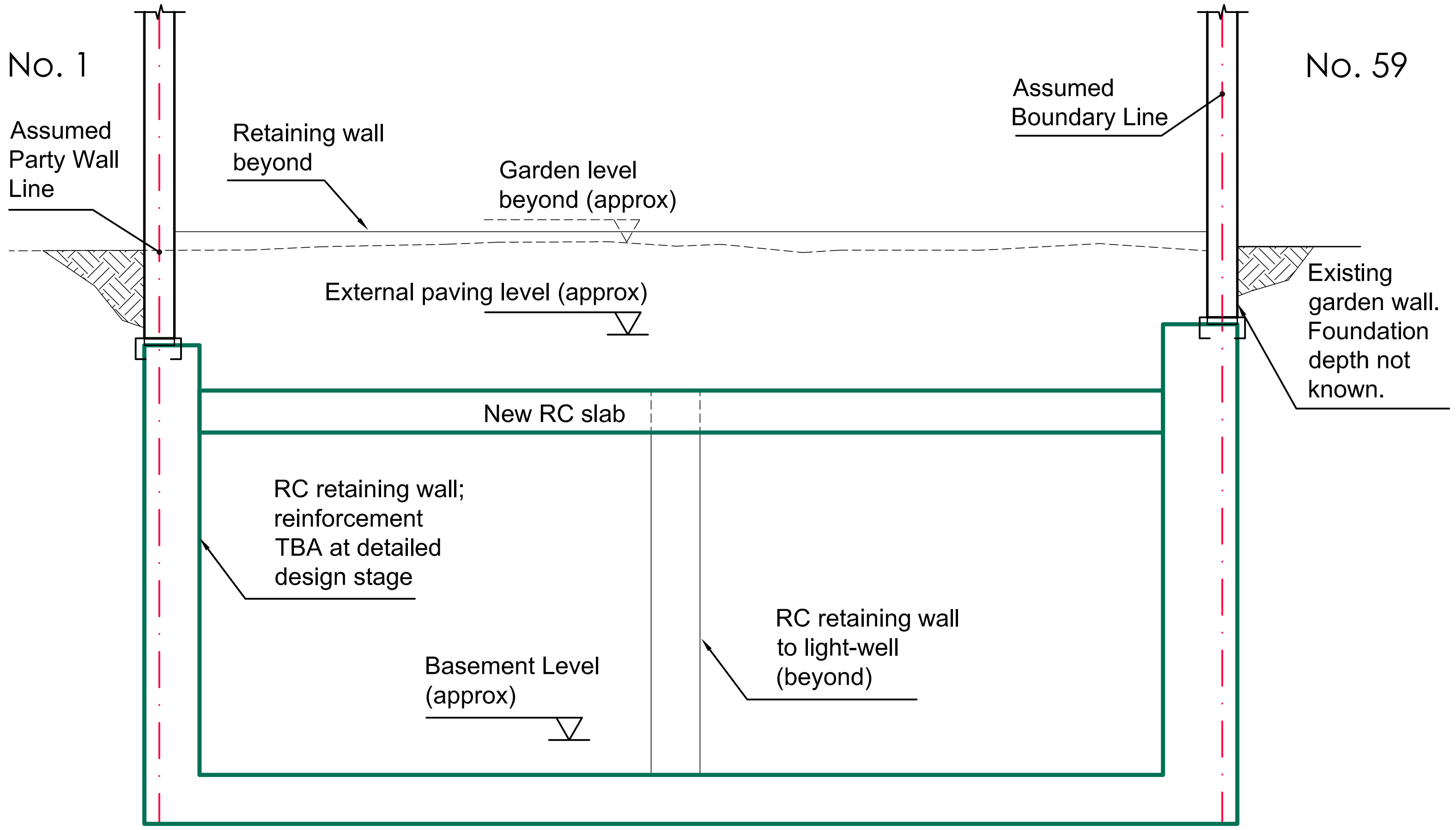
Job No.	Drawn	Scale
161202	GW	As shown @ A3
	Chk'd: -	
Dwg No.	**Rev.**	**Date**
SL-10	-	Jan 2017

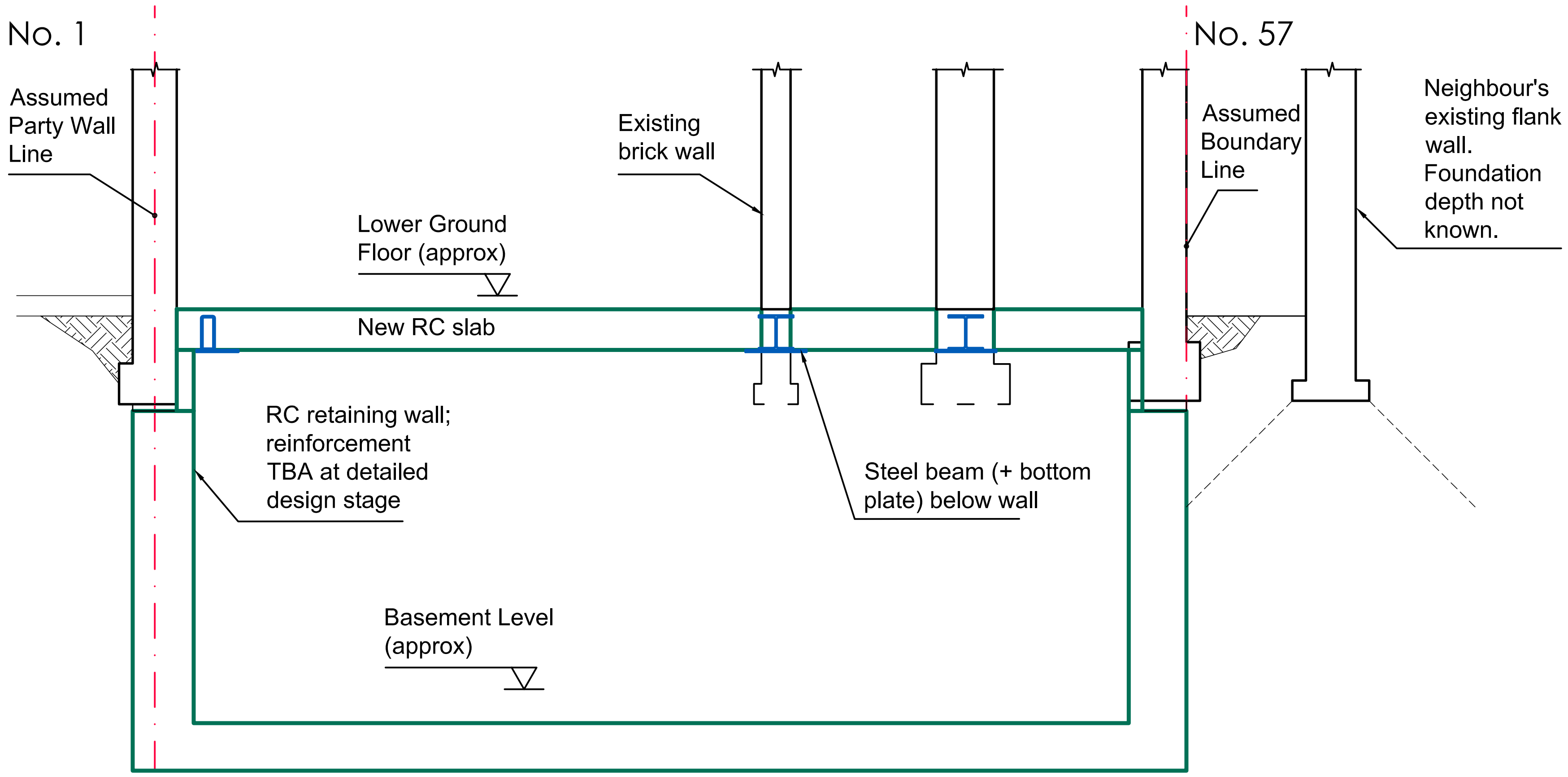
Client: Basement Design Studio

Project: 31 St Marks Crescent

Title : Structural Scheme Design - Floor Plans



Section 1a-1a
(1:50)



Section 1-1
(1:50)

- PLANNING ISSUE -
NOT FOR CONSTRUCTION

Rev	Date	Amendments
-	15.03.2017	First issue for comment

Job No. 161202	Drawn GW / Chk'd -	Scale As shown @ A3
Dwg No. SL-20	Rev. -	Date Jan 2017

Croft Structural Engineers
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020 8684 4744
www.croftse.co.uk

Client: Basement Design Studio

Project: 31 St Marks Crescent

Title : Structural Scheme Design - Sections

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Appendix E: Proposed Monitoring Statement

Job Number: 161202

CROFT STRUCTURAL ENGINEERS

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Clock Shop Mews
Rear of 60 Saxon Road
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Structural Monitoring Statement

Property:

31 St Marks Crescent
Camden
NW1 7TT

Client:

Basement Design Studio

Revision	Date	Comment
-	15.03.2017	First Issue

CROFT STRUCTURAL ENGINEERS

Contents

1. Introduction

Basement works are intended to 31 St Marks Crescent. The structural works for this require Party Wall Awards. This statement describes the procedures for the Principal Contractor to follow to observe any movement that may occur to the existing properties, and also describes mitigation measures to apply if necessary.

2. Risk Assessment

The purpose of this risk assessment is to consider the impact of the proposed works and how they impact the party wall. There are varying levels of inspection that can be undertaken and not all works, soil conditions and properties require the same level of protection.

Monitoring Level Proposed	Type of Works.
Monitoring 1 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works.	Loft conversions, cross wall removals, insertion of padstones Survey of LUL and Network Rail tunnels. Mass concrete, reinforced and piled foundations to new build properties

Monitoring 2 Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate.	Removal of lateral stability and insertion of new stability fames Removal of main masonry load bearing walls. Underpinning works less than 1.2m deep
Monitoring 3 Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical monitoring movement by standard optical equipment	Lowering of existing basement and cellars more than 2.5m Underpinning works less than 3.0m deep in clays Basements up to 2.5m deep in clays
Monitoring 4 Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical monitoring movement by standard optical equipment Lateral movement between walls by laser measurements	New basements greater than 2.5m and shallower than 4m Deep in gravels Basements up to 4.5m deep in clays Underpinning works to Grade I listed building
Monitoring 5 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical & lateral monitoring movement by theodolite at specific times during the projects.	Underpinning works to Grade I listed buildings Basements to Listed building Basements deeper than 4m in gravels Basements deeper than 4.5m in clays Underpinning, basements to buildings that are expressing defects.
Monitoring 6	

Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical & lateral monitoring movement by electronic means with live data gathering. Weekly interpretation	Double storey basements supported by piled retaining walls in gravels and soft sands. (N<12)
Monitoring 7 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical & lateral monitoring movement by electronic means with live data gathering with data transfer.	Larger multi-storey basements on particular projects.

3. Scheme Details

This document has been prepared by Croft Structural Engineers Ltd. It covers the proposed construction of a new basement underneath the existing structure.

Scope of Works

The works comprise:

- Visual Monitoring of the party wall
- Attachment of Tell tales or Demec Studs to accurately record movement of significant cracks.
- Attachment of levelling targets to monitor settlement.
- The monitoring of the above instrumentation is in accordance with Appendix A. The number and precise locations of instrumentation may change during the works; this shall be subject to agreement with the Principal Contractor (PC).
- All instruments are to be adequately protected against any damage from construction plant or private vehicles using clearly visible markings and suitable head protection e.g. manhole rings or similar. Any damaged instruments are to be immediately replaced or repaired at the contractors own cost.
- Reporting of all data in a manner easily understood by all interested parties.
- Co-ordination of these monitoring works with other site operations to ensure that all instruments can be read and can be reviewed against specified trigger values both during and post construction.
- Regular site meetings by the Principal Contractor (PC) and the Monitoring Surveyor (MS) to review the data and their implications.
- Review of data by Croft Structural Engineers

In addition, the PC will have responsibility for the following:

- Review of methods of working/operations to limit movements, and
- Implementation of any emergency remedial measures if deemed necessary by the results of the monitoring.

The Monitoring Surveyor shall allow for settlement and crack monitoring measures to be installed and monitored on various parts of the structure described in Table 1 as directed by the PC and Party Wall Surveyor (PWS) for the Client.

Item	Instrumentation Type
Party Wall Brickwork	
Settlement monitoring	Levelling equipment & targets
Crack monitoring	Visual inspection of cracking, Demec studs where necessary

Table 1: Instrumentation

General

The site excavations and substructure works up to finished ground slab stage have the potential to cause vibration and ground movements in the vicinity of the site due to the following:

a) Removal of any existing redundant foundations / obstructions;
b) Installation of reinforced concrete retaining walls under the existing footings;
c) Excavations within the site

The purpose of the monitoring is a check to confirm building movements are not excessive.

This specification is aimed at providing a strategy for monitoring of potential ground and building movements at the site.

This specification is intended to define a background level of monitoring. The PC may choose to carry out additional monitoring during critical operations. Monitoring that should be carried out is as follows:

a) Visual inspection of the party wall and any pre-existing cracking
b) Settlement of the party wall

All instruments are to be protected from interference and damage as part of these works.

Access to all instrumentation or monitoring points for reading shall be the responsibility of the Monitoring Surveyor (MS). The MS shall be in sole charge for ensuring that all instruments or monitoring points can be read at each visit and for reporting of the data in a form to be agreed with the PWS. He shall inform the PC if access is not available to certain instruments and the PC will, wherever possible, arrange for access. He shall immediately report to the PC any damage. The Monitoring Surveyor and the Principal Contractor will be responsible for ensuring that all the instruments that fall under their respective remits as specified are fully operational at all times and any defective or damaged instruments are immediately identified and replaced.

The PC shall be fully responsible for reviewing the monitoring data with the MS - before passing it on to Croft Structural Engineers - determining its accuracy and assessing whether immediate action is to be taken by him and/or other contractors on site to prevent damage to instrumentation or to ensure safety of the site and personnel. All work shall comply with the relevant legislation, regulations and manufacturer's instructions for installation and monitoring of instrumentation.

Applicable Standards and References

The following British Standards and civil engineering industry references are applicable to the monitoring of ground movements related to activities on construction works sites:

1. BS 5228: Part 1: 1997 - Noise and Vibration Control on Construction and Open Sites -Part 1.Code of practice for basic information and procedures for noise and vibration control, Second Edition, BSI 1999.
2. BS 5228: Part 2: 1997 - Noise and Vibration Control on Construction and Open Sites -Part 2.Guide to noise and vibration control legislation for construction and demolition including road construction and maintenance, Second Edition, BSI 1997.
3. BS 7385-1: 1990 (ISO 4866:1990) - Evaluation and measurement for vibration in buildings - Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings, First Edition, BSI 1990.
4. BS 7385-2: 1993 - Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from ground-borne vibration, First Edition, BSI 1999.
5. CIRIA SP 201 - Response of buildings to excavation-induced ground movements, CIRIA 2001.

SPECIFICATION FOR INSTRUMENTATION

General

The Monitoring Contractor is required to monitor, protect and reinstall instruments as described. The readings are to be recorded and reported. The following instruments are defined:

a) Automatic level and targets: A device which allows the measurement of settlement in the vertical axis. To be installed by the MS.

b) Tell-tales and 3 stud sets: A device which allows measurement of movement to be made in two axes perpendicular to each other. To be installed by the MS.

Monitoring of existing cracks

The locations of tell-tales or Demec studs to monitor existing cracks shall be agreed with Croft Structural Engineers.

Instrument Installation Records and Reports

Where instrumentation is to be installed or reinstalled, the Monitoring Surveyor, or the Principal Contractor, as applicable, shall make a complete record of the work. This should include the position and level of each instrument. The records shall include base readings and measurements taken during each monitoring visit. Both tables and graphical outputs of these measurements shall be presented in a format to be agreed with the CM. The report shall include photographs of each type of instrumentation installed and clear scaled sections and plans of each instrument installed. This report shall also include the supplier's technical fact sheet on the type of instrument used and instructions on monitoring.

Two signed copies of the report shall be supplied to the PWS within one week of completion of site measurements for approval.

Installation

All instruments shall be installed to the satisfaction of the PC. No loosening or disturbance of the instrument with use or time shall be acceptable. All instruments are to be clearly marked to avoid damage.

All setting out shall be undertaken by the Monitoring Surveyor or the Principal Contractor as may be applicable. The precise locations will be agreed by the PC prior to installation of the instrument.

The installations are to be managed and supervised by the Instrumentation Engineer or the Measurement Surveyor as may be applicable.

Monitoring

The frequencies of monitoring for each Section of the Works are given in Appendix A.

The following accuracies/ tolerances shall be achieved:

Party Wall settlement	±1.5mm
Crack monitoring	±0.75mm

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REPORT OF RESULTS AND TRIGGER LEVELS

General

Within 24 hours of taking the readings, the Monitoring Surveyor will submit a single page summary of the recorded movements. All readings shall be immediately reviewed by Croft Structural Engineers prior to reporting to the PWS.

Within one working day of taking the readings the Monitoring Contractor shall produce a full report (see below).

The following system of control shall be employed by the PC and appropriate contractors for each section of the works. The Trigger value, at which the appropriate action shall be taken, for each section, is given in Table 2, below.

The method of construction by use of sequential underpins limits the deflections in the party wall.

Between the trigger points, which are no greater than 2 m apart, there should be no more than:

Allowable movement to BS5950 for brittle finishes:

Vertical = Span / 360 = 4000mm / 360 = 11.1mm

Croft proposes a tighter recommendation of 3mm

Above Monitoring level 3 lateral movement is required to be measured and the figures should be:

Horizontal = Height / 500 = 4500mm / 500 = 9mm

Croft proposes a tighter recommendation of 4mm

During works measurements are taken, these are compared with the limits set out below:

MOVEMENT		CATEGORY	ACTION
Vertical	Horizontal		
0mm-3mm	0-4mm	Green	No action required
3mm-5mm	4-6mm	AMBER	Detailed review of Monitoring: Check studs are OK and have not moved. Ensure site staff have not moved studs. If studs have moved reposition. Relevel to ensure results are correct and tolerance is not a concern. Inform Party Wall surveyors of amber readings. Double the monitoring for 2 further readings. If stable revert back. Carry out a local structural review and inspection. Preparation for the implementation of remedial measures should be required. Double number of lateral props
5mm-8mm	6-9mm		Implement remedial measures review method of working and ground conditions
>8mm	>9mm	RED	Implement structural support as required; Cease works with the exception of necessary works for the safety and stability of the structure and personnel; Review monitoring data and implement revised method of works

Table 2 – Movement limits between adjacent sets of Tell-tales or stud sets

Any movements which exceed the individual amber trigger levels for a monitoring measure given in Table 2 shall be immediately reported to the PWS, and a review of all of the current monitoring data for all monitoring measures must be implemented to determine the possible causes of the trigger level being exceeded. Monitoring of the affected location must be increased and the actions described above implemented. Assessment of exceeded trigger levels must not be carried out in isolation from an assessment of the entire monitoring regime as the monitoring measures are inter-related. Where required, measures may be implemented or prepared as determined by the specific situation and combination of observed monitoring measurement data.

Standard Reporting

1 No. electronic copy of the report in PDF format shall be submitted to the PWS.

The Monitoring Surveyor shall report whether the movements are within (or otherwise) the Trigger Levels indicated in Table 2. A summary of the extent of completion of any of the elements of works and any other significant events shall be given. These works shall be shown in the form of annotated plans (and sections) for each survey visit both local to the instrumentation and over a wider area. The associated changes to readings at each survey or monitoring point shall be then regulated to the construction activity so that the cause of any change, if it occurs, can be determined.

The Monitoring Surveyor shall also give details of any events on site which in his opinion could affect the validity of the results of any of the surveys.

The report shall contain as a minimum, for each survey visit the following information:

a) The date and time of each reading:
b) The weather on the day:
c) The name of the person recording the data on site and the person analysing the readings together with their company affiliations;
d) Any damage to the instrumentation or difficulties in reading;
e) Tables comparing the latest reading with the last reading and the base reading and the changes between these recorded data;
f) Graphs showing variations in crack width with time for the crack measuring gauges; and
g) Construction activity as described. It is very important that each set of readings is associated with the extent of excavation and construction at that time. Readings shall be accompanied by information describing the extent of works at the time of readings. This shall be agreed with the PC.

Spread-sheet columns of numbers should be clearly labelled together with units. Numbers should not be reported to a greater accuracy than is appropriate. Graph axis should be linear and clearly labelled together with units. The axis scales are to be agreed with the PC before the start of monitoring and are to remain constant for the duration of the job unless agreed otherwise. The specified trigger values are also to be plotted on all graphs.

The reports are to include progress photographs of the works both general to the area of each instrument and globally to the main Works. In particular, these are to supplement annotated plans/sections described above. Wherever possible the global photographs are to be taken from approximately the same spot on each occasion. The locations of these points on site should be proposed by the structural engineer at detailed design stage.

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Erroneous Data

All data shall be checked for errors by the Monitoring Surveyor prior to submission. If a reading that appears to be erroneous (i.e. it shows a trend which is not supported by the surrounding instrumentation), he shall notify the PC immediately, resurvey the point in question and the neighbouring points and if the error is repeated, he shall attempt to identify the cause of the error. Both sets of readings shall be processed and submitted, together with the reasons for the errors and details of remedial works. If the error persists at subsequent survey visits, the Monitoring Surveyor shall agree with the PC how the data should be corrected. Correction could be achieved by correcting the readings subsequent to the error first being identified to a new base reading.

The Monitoring Surveyor shall rectify any faults found in or damage caused to the instrumentation system for the duration of the specified monitoring period, irrespective of cause, at his own cost.

Trigger Values

Trigger values for maximum movements as listed in Table 2. If the movement exceeds these values then action may be required to limit further movement. The PC should be immediately advised of the movements in order to implement the necessary works.

It is important that all neighbouring points (not necessarily a single survey point) should be used in assessing the impact of any movements which exceed the trigger values, and that rechecks are carried out to ensure the data is not erroneous. A detailed record of all activities in the area of the survey point will also be required as specified elsewhere.

Responsibility for Instrumentation

The Monitoring Surveyor shall be responsible for: managing the installation of the instruments or measuring points, reporting of the results in a format which is user friendly to all parties; and immediately reporting to all parties any damage. The Monitoring Surveyor shall be responsible for informing the PC of any movements which exceed the specified trigger values listed in Table 2 so that the PC can implement appropriate procedures. He shall immediately inform the PWS of any decisions taken.

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APPENDIX A
MONITORING FREQUENCY

INSTRUMENT	FREQUENCY OF READING
Settlement monitoring and Monitoring existing cracks	**<u>Pre-construction</u>** Monitored once. **<u>During construction</u>** Monitored after every pin is cast for first 4 no. pins to gauge effect of underpinning. If all is well, monitor after every other pin. **<u>Post construction works</u>** Monitored once.

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APPENDIX B

An Analysis on allowable settlements of structures (Skempton and MacDonald (1956))

The most comprehensive studies linking self-weight settlements of buildings to structural damage were carried out in the 1950's by Skempton and MacDonald (1956) and Polshin and Tokar. These studies show that damage is most often caused by differential settlements rather than absolute settlements. More recently, similar empirical studies by Boscardin and Cording (1989) and Boone (1996) have linked structural damage to ground movements induced by excavations and tunnelling activities.

In 1955 Skempton and MacDonald identified the parameter δρ/L as the fundamental element on which to judge maximum admissible settlements for structures. This criterion was later confirmed in the works of GRANT *et al.* [1975] and WALSH [1981]. Another important approach to the problem was that of BURLAND and WROTH [1974], based on the criterion of maximum tensile strains.

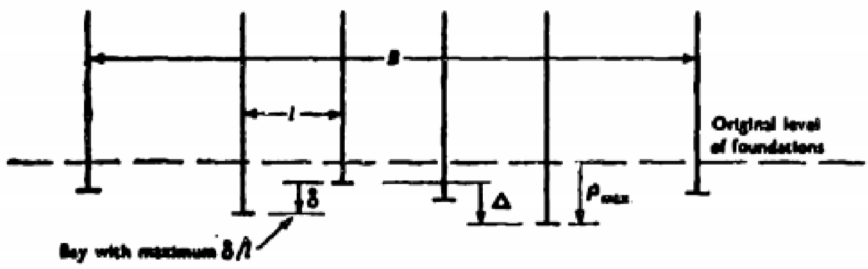

Figure 2.1 – Diagram illustrating the definitions of maximum angular distortion, δ/l, maximum settlement, ρ_{max}, and greatest differential settlement, Δ, for a building with no tilt (Skempton and MacDonald, 1956).

Figure 1: Diagram illustrating the definitions of maximum angular distortion, δ/l, maximum settlement, p_{max}, and greatest differential settlement ,Δ , for a building with no tilt (Skempton and MacDonald, 1956)

The differential settlement is defined as the greatest vertical distance between two points on the foundation of a structure that has settled, while the angular distortion, is the difference in elevation between two points, divided by the distance between those points.

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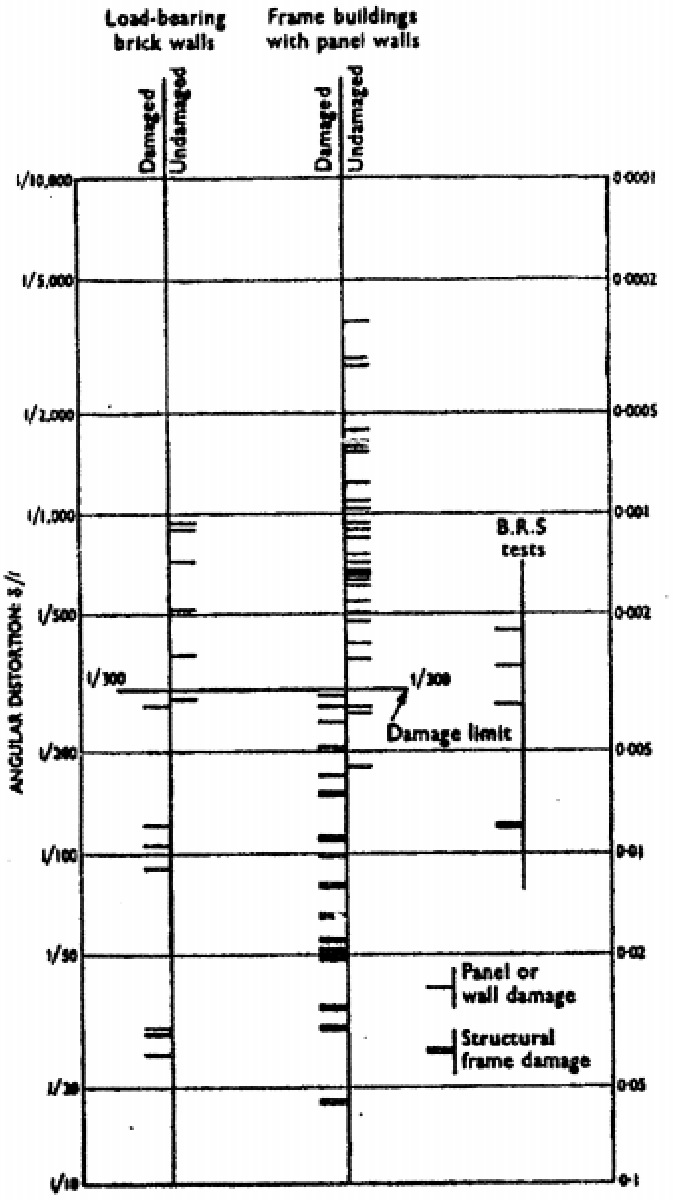
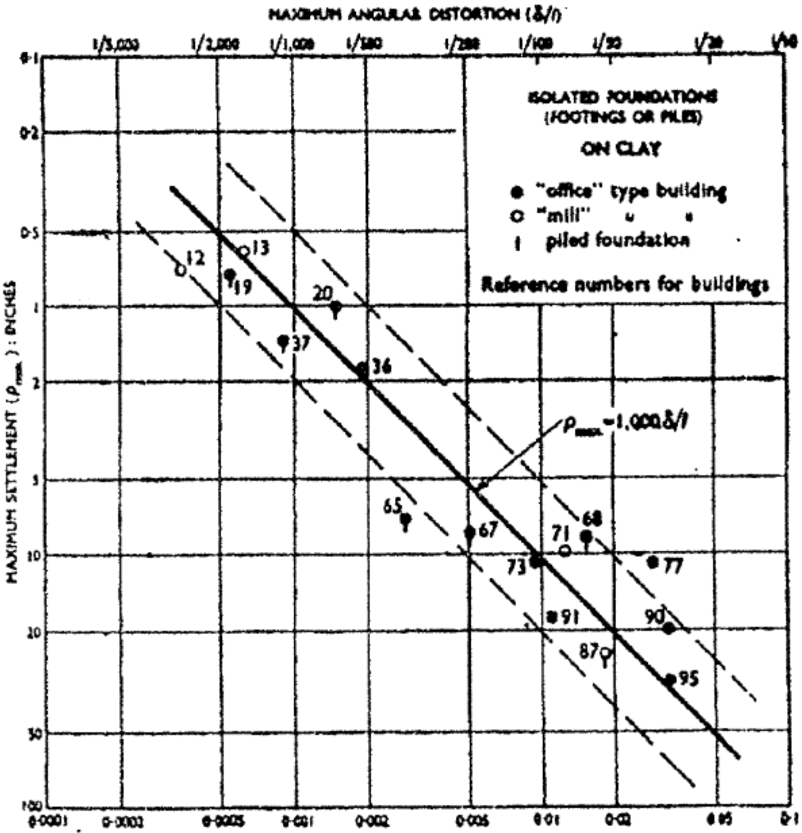
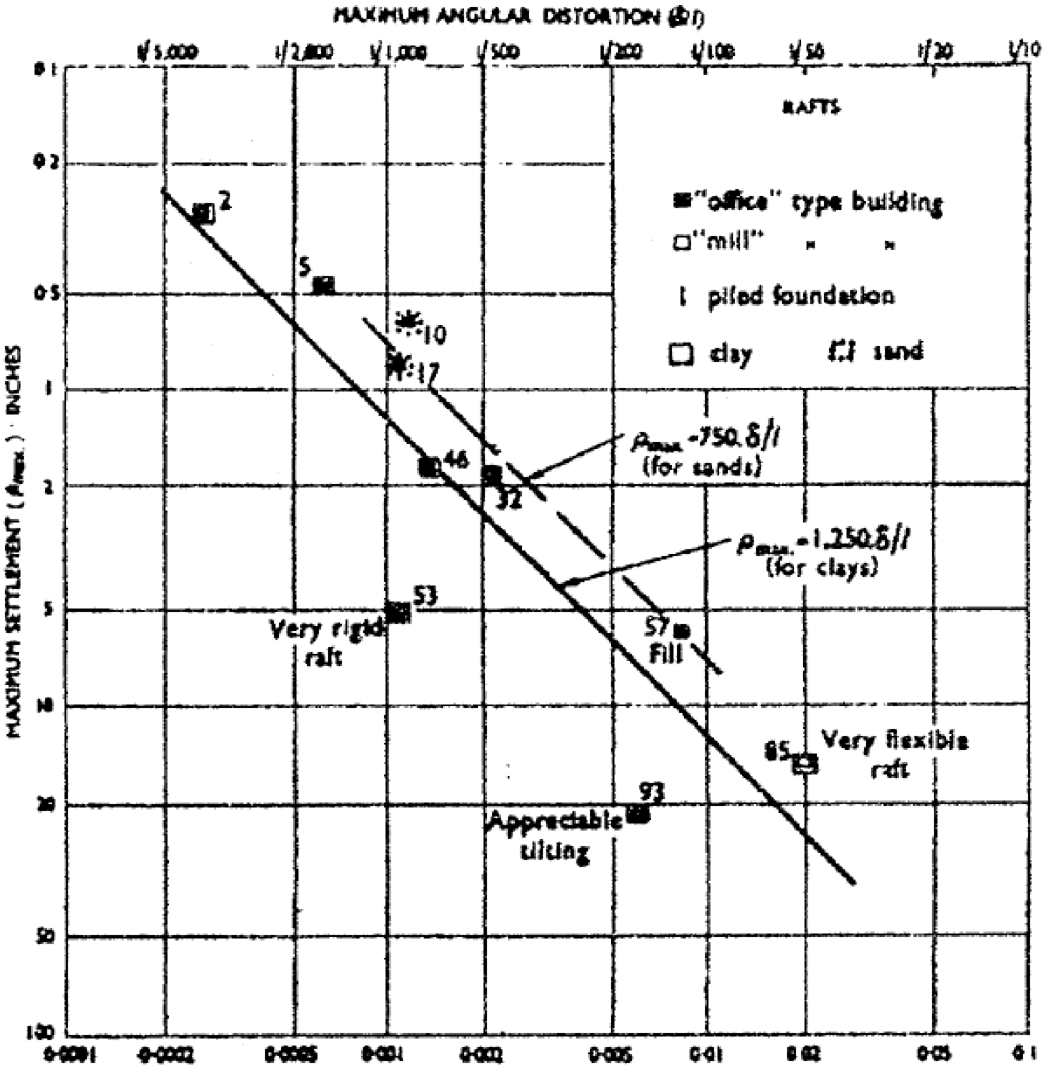


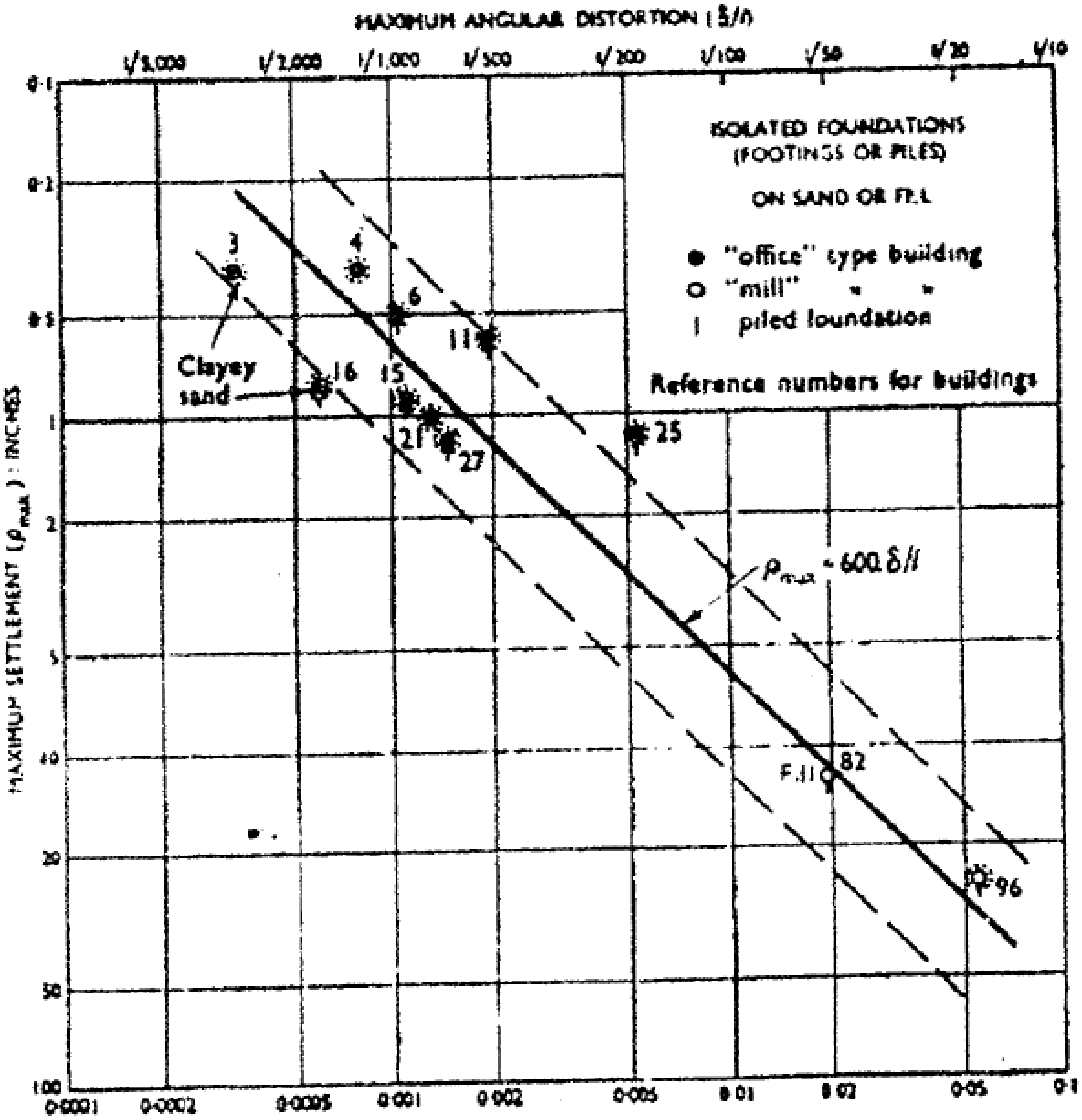
Figure 2: Skempton and MacDonald's analysis of field evidence of damage on traditional frame buildings and loadbearing brick walls

Data from Skempton and MacDonald's work suggest that the limiting value of angular distortion is 1/300. Angular distortion, greater than 1/300 produced visible cracking in the majority of buildings studied, regardless of whether it was a load bearing or a frame structure. As shown in the figure 2.

Other key findings by Skempton and MacDonald include limiting values of δ/l for structure, and a relationship between maximum settlement, ρ_{max} and δ/l for structures founded on sands and clays. The charts below show these relations for raft foundations and isolated footings.






MAXIMUM ANGULAR DISTORTION (δ/l)
1/5,000
1/2,000
1/1,000
1/500
1/200
1/100
1/50
1/20
1/10
ISOLATED FOUNDATIONS
(FOOTINGS OR PILES)
ON SAND OR FILL
● "office" type building
○ "mill" " "
| piled foundation
Reference numbers for buildings
Clayey sand
3
4
6
11
16
15
21
27
25
82
F.11
96
ρmax = 600 δ/l
MAXIMUM SETTLEMENT (ρmax) : INCHES
0·1
0·2
0·5
1
2
5
10
20
50
100
0·0001
0·0002
0·0005
0·001
0·002
0·005
0·01
0·02
0·05
0·1

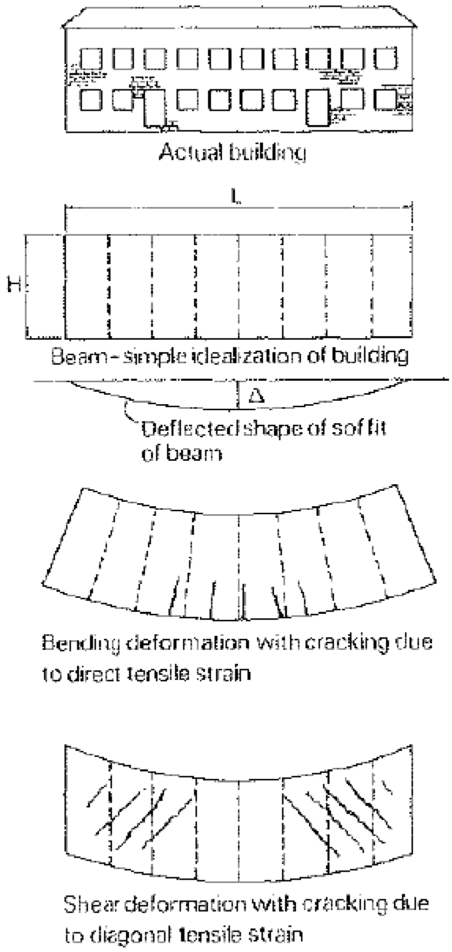


TABLE I

Angular distorsion	Characteristic situation
1/300	Cracking of the panels in frame buildings of the traditional type, or of the walls in load-bearing wall buildings;
1/150	Structural damage to the stanchions and beams;
1/500	Design limit to avoid cracking;
1/1000	Design limit to avoid any settlement damage.

CROFT STRUCTURAL ENGINEERS

Appendix F: Communication with Canal & River Trust

Geoff Watson

From: Paul schaaf <paul@basementdesignstudio.co.uk>
Sent: 28 February 2017 18:49
To: Geoff Watson
Subject: Fwd: St Marks Crescent - Works Affecting Canals
Attachments: Application Procedure August 16.docx; Untitled attachment 00033.htm; Final Check List.docx; Untitled attachment 00036.htm; Form 1.doc; Untitled attachment 00039.htm; Form 2 - Cost Undertaking 2016.docx; Untitled attachment 00042.htm

Hi Geoff,
Jake has asked me to forward this string to you regarding construction near canals, it may be something you need to address. I am not contactable in the morning until 1pm
Regards

Paul

Sent from my iPhone

Begin forwarded message:

> **From:** "Jake Puddy" <jake.puddy@londonbasement.co.uk>
> **To:** "mike@basementdesignstudio.co.uk" <mike@basementdesignstudio.co.uk>, "paul@basementdesignstudio.co.uk" <paul@basementdesignstudio.co.uk>
> **Cc:** "ben.holmes@londonbasement.co.uk" <ben.holmes@londonbasement.co.uk>
> **Subject: Fwd: St Marks Crescent - Works Affecting Canals**
>
> Hi Paul
>
> Can you pass this onto Croft please
> In particular the link to the codes of practice Part 2
>
> It mentions several areas that may need to be addressed by their report
>
> Thanks
>
> Jake Puddy
>
> London Basement
> Business Development
>
> **T**: 07738 252085
> **W:** www.londonbasement.co.uk
>
> Begin forwarded message:
>
>> **From:** "Customer Services" <Customer.Services@canalrivertrust.org.uk>
>> **To:** "jake.puddy@londonbasement.co.uk" <jake.puddy@londonbasement.co.uk>
>> **Cc:** "Enquiries TPWNorth" <Enquiries.TPWNorth@canalrivertrust.org.uk>, "Enquiries TPWSouth" <Enquiries.TPWSouth@canalrivertrust.org.uk>

Thank you for the recent enquiry.

All works that impact on the canal infrastructure will need to fulfil the requirements of the Code of Practice for Works Affecting the Canal and River Trust.

This link will gain you access to the code https://canalrivertrust.org.uk/business-and-trade/undertaking-works-on-our-property-and-our-code-of-practice.

We consider these works may have an impact and we have attached a summary of the application process together with the necessary application forms. We would advise you to read the whole of Part 1 and the relevant sections of Part 2.

In order to progress with your application, we require you to;

1. Complete and return the attached Form 1 & 2, along with the non-refundable payment for the initial application of £380 + VAT (£456 in total)
2. Provide as much detail as possible of the project with particular reference to the impact on the assets of the Trust.

Payment and contact details can be located in the application procedure document.

To ensure your application is processed as quickly as possible, we have enclosed a check list for you to complete and return. This will also help us to assess that all the documentation you have sent have been received. Once the initial details are received, an Engineer will be assigned to discuss and progress the project.

Should you require any further information or assistance please contact us on either Enquiries.TPWSouth@canalrivertrust.org.uk or Enquiries.TPWNorth@canalrivertrust.org.uk
Kind regards,

Infrastructure Services Team
Canal & River Trust

Customer Service Advisor

Canal & River Trust

https://canalrivertrust.org.uk/contact-us/ways-to-contact-us