TZG PARTNERSHIP

5256

Basement Impact Assessment

35 Chester Terrace, London

8th October 2014

Prepared by Etelka Szabo MSc
Checked by Marek Glowinski BSc MIStructE MConsE

Table of Contents

1. Brief

1.1. AW Architecture is preparing a planning application for a new basement alteration. This report should be read in conjunction with all relevant architects' drawings.

1.2. This report is prepared in accordance with Camden SPD guidance on Subterranean Development.

2. Description

2.1. The existing building is a five storey house of conventional construction. External walls are of solid masonry with upper floors and internal partitions of timber. There are significant distortions and cracks to the whole building.

2.2. It is connected to a (handed) identical property from both sides and is in a road of similar buildings.

2.3. The property is located at approximately 37m AOD on a negligible slope of less than 1:100.

2.4. The back garden is lower than the front garden by approximately 1.5m thus the current lower garden floor is half a storey below road level and ground floor half a storey above.

2.5. The entirety of Chester terrace is listed Grade I and is additionally surrounded by a number of other listed buildings and the Grade I listed Regent's Park.

2.6. Geology and Flood Risk

i. The local geology is Made Ground over London Clay. The basement walls are Category 2 (CIRIA C580) and thus boreholes are proposed in order to finalise the structural design. The boreholes will not be carried out prior to submitting the planning application. However, TZG Partnership have designed numerous basements in the vicinity and our experience suggests the local geology is very constant.

ii. The property is not within a Flood Plain according to Environment Agency published information. There are no known subterranean water courses (the River Fleet is within a culvert).

iii. From knowledge gained from other basements in the area dealt with by TZG, groundwater flow is not expected to be adversely affected by the proposed construction. Water flow is minimal through London Clay other than occasional perched water – these trapped "lenses" can flow into excavations but can be dealt with by pumping. Ground water may flow over the top of the London Clay but such flows are minimal and any obstruction provided by this basement is considered to be negligible especially as the topography is so flat.

3. Proposed Structure

3.1. It is proposed that the existing external vaulted basement area at the front of the property be deepened by approximately 1000 mm.

3.2. Existing internal vault walls will be removed and steel beams installed to support the masonry arches above.

3.3. The new basement slab will form a reinforced concrete raft foundation. Due to the removal of soil there is a nett reduction in loading on the London Clay at formation level, thus no piles are required to transfer loads.

3.4. The new retaining walls will be formed by underpinning the existing main walls; at certain locations below the street the existing masonry wall will be replaced by the new RC structure at full height.

4. Construction methodology

4.1. Underpinning of existing walls:

4.1.1 Excavate pits beneath the flank and front walls. These are to be in a sequence based on the CADBE mnemonic (or any other accepted sequence). Pits will be no more than 1m wide and maybe less if ground or wall conditions dictate. At full replacement of rear walls horizontal props are to be installed.

4.1.2 Cast a reinforced concrete base and kicker. Cast a vertical retaining wall/underpin dry-pack against the existing brick structure and leave propped against the base.

4.1.3 Continue with the CADBE sequence until the front and flank walls have been underpinned and propped.

4.2. Installation of new steel beams

4.2.1 Install needles in the internal walls supported by props.

4.2.2 Remove walls.

4.2.3 Install steel beams.

4.3. Installation of basement raft

4.4. The above methodologies have been successfully utilised and fine tuned over the past 20 years since the start of the proliferation of basement extensions and building alterations.

5. Damage prediction to adjacent properties

5.1. We have carried out calculations based on “Embedded Retaining Walls – guidance for economic design. CIRIA C580. London 2003”. These calculations show that predicted movement showed result in negligible damage (category 0). (See Appendix III)

5.2. Preliminary calculations have been carried out to assess the effect of loads onto the London Clay. Based on these calculations the size of the foundation was chosen so that the bearing stresses under the new foundation do not exceed that of the original foundations.(See Appendix IV)

6. Slope Stability

6.1. There are no slopes within the zone which may be considered to be affected by this basement construction.

7. Summary

7.1. The proposed basement is relatively small scale in relation to the overall geology, hydrology and topography of the area. Ground conditions are such that on a macro scale there will be no significant impact on soils, land use, water quality and hydrology. Any impact in the immediate vicinity will be temporary only and the scale will be negligible.

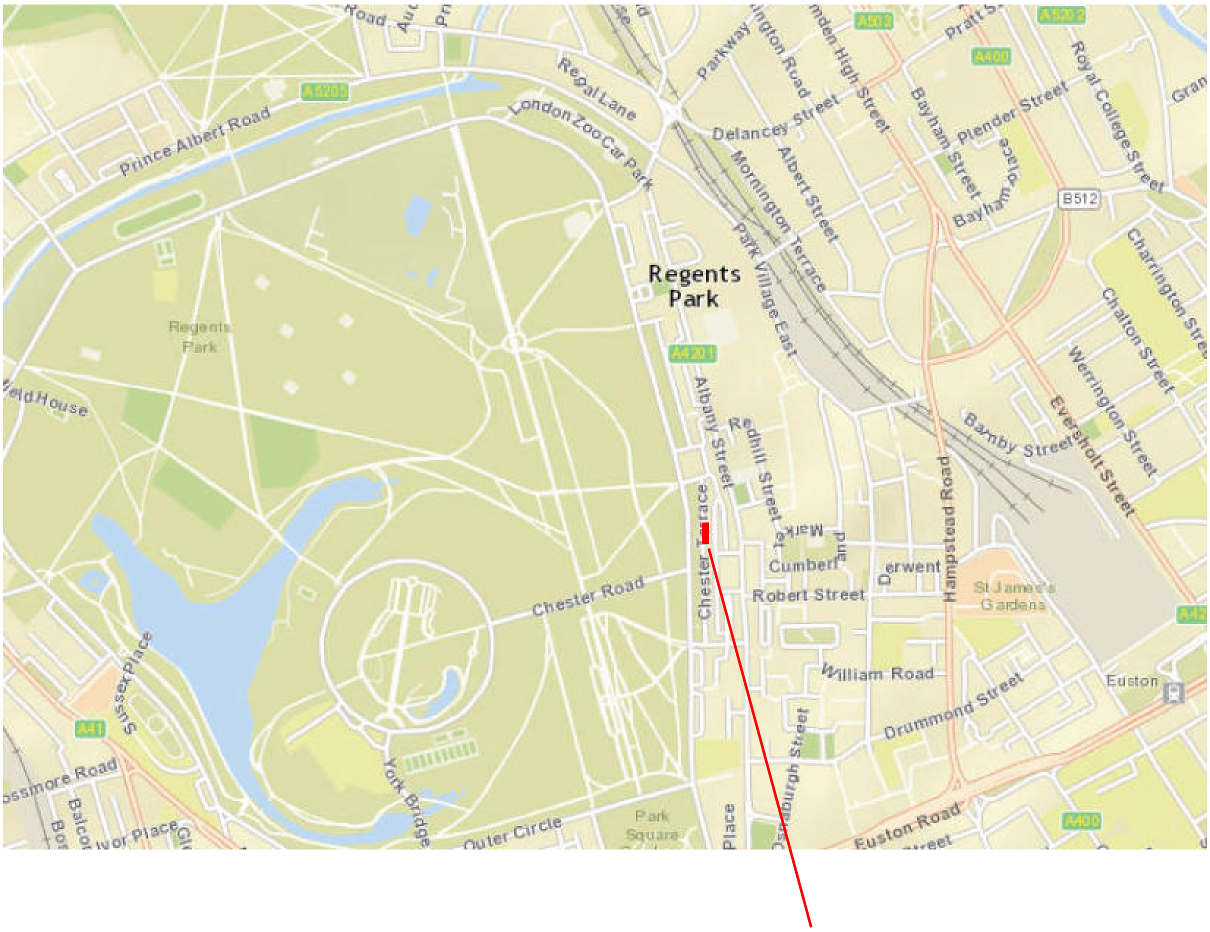
Etelka Szabo M.Sc.

APPENDIX I

Location Plan

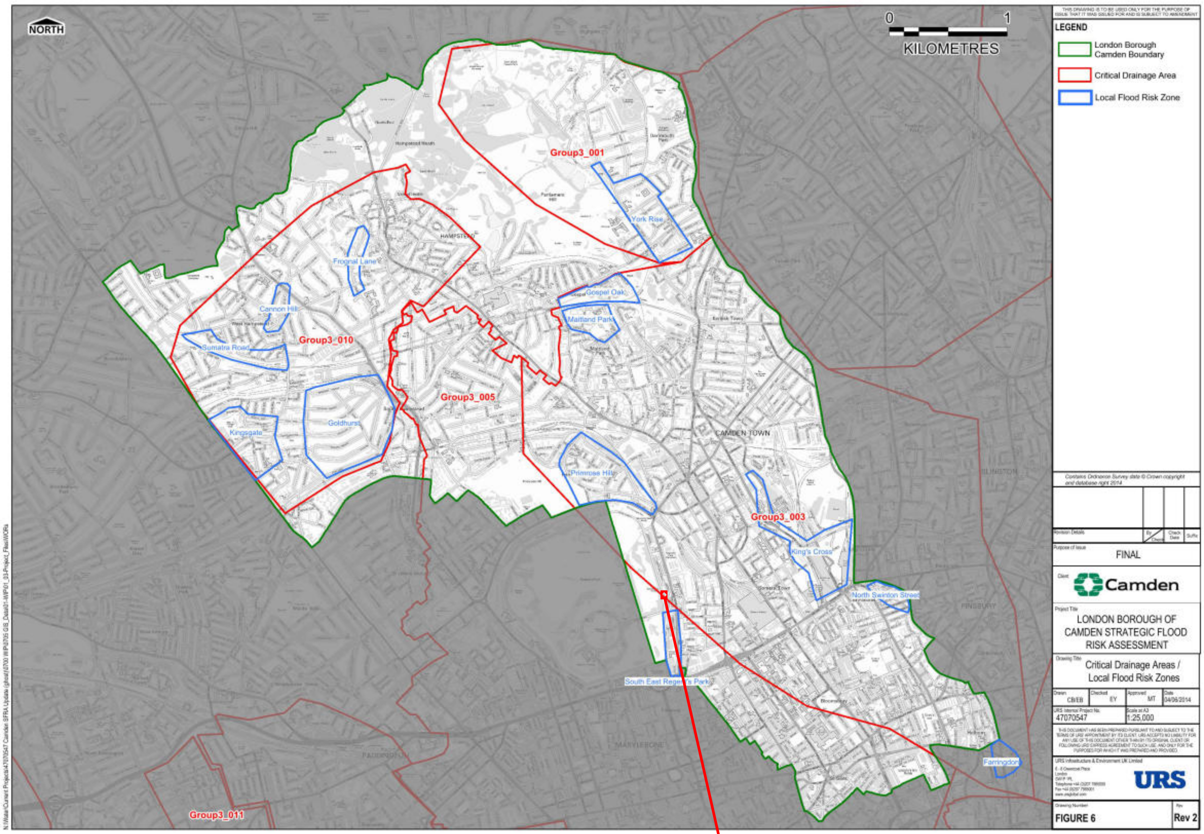
Critical Drainage Areas / Local Flood Risk Zones

SITE LOCATION PLAN



35 CHESTER TERRACE

Critical Drainage Areas / Local Flood Risk Zones



35 CHESTER TERRACE

APPENDIX II

Construction Sequence TS001

APPENDIX III

Damage Prediction Calculations DA.01-DA.02

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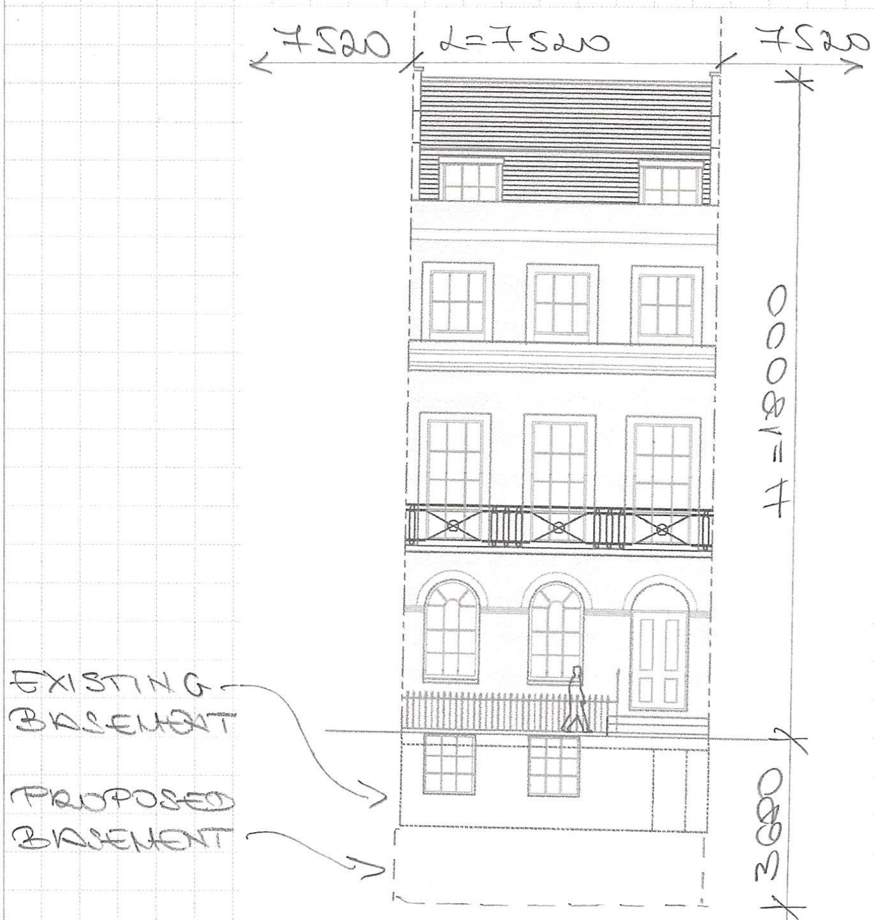
PAGE No.: DA.01.
CONTRACT No.: 5256
DATE: 10.2014
BY: E.S.

DAMAGE ASSESSMENT CALCULATIONS

CIRIA REF.



$L/H = \frac{7520}{18000} = 0.418$

TABLE 2.2. • POTENTIAL MOVEMENT DUE TO WALL INSTALLATION

- HORIZONTAL SURFACE MOVEMENT = 0.05%

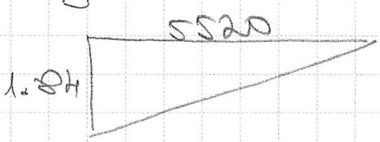
$\Delta H = 0.05 \times 3680/100 = 1.84$ mm

- VERTICAL SURFACE MOVEMENT = 0.05%

$\Delta V = 0.05 \times 3680/100 = 1.84$ mm

- DISTANCE BEHIND WALL TO NEGLIGIBLE MOVEMENT:

$l_0 = 3680 \times 1.5 = 5520$ mm



$\Rightarrow 0.33$ mm/m

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TABLE 2.4. • POTENTIAL MOVEMENT DUE TO EXCAVATION

- HORIZONTAL SURFACE MOVEMENT = 0,15 %

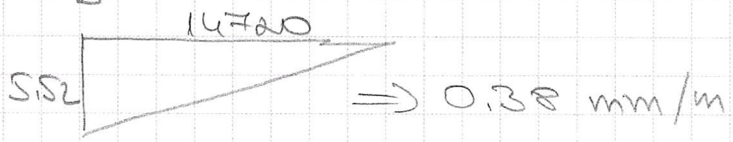
$\Delta H = 0.15 \times 3680 / 100 = 5.521$ mm

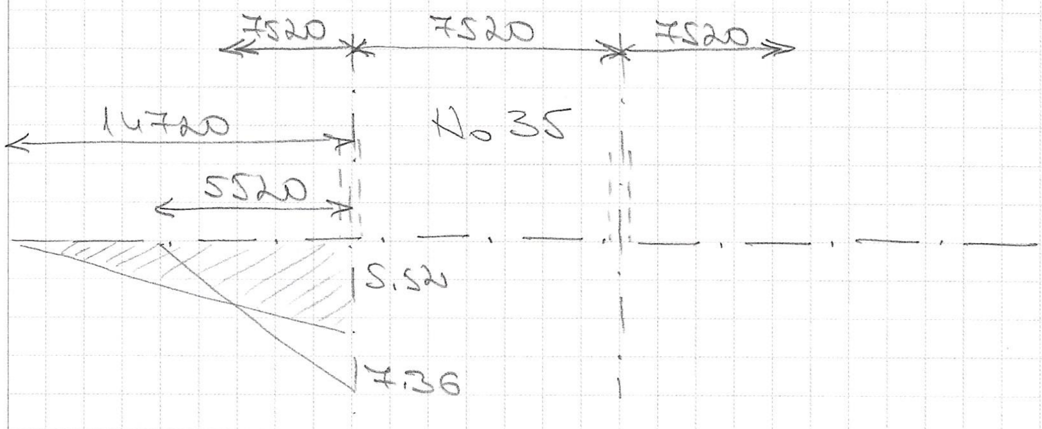
- VERTICAL SURFACE MOVEMENT = 0,10 %

$\Delta V = 0,10 \times 3680 / 100 = 3,68$ mm

- DISTANCE BEHIND WALL TO NEGLIGIBLE MOVEMENT

$l_\Delta = 3680 \times 4.0 = 14\,720$ mm





• DETERMINE HORIZONTAL MOVEMENT

$\delta_h = 7.36$ mm @ PARTY WALL

BOX 2.5 $\varepsilon_h = \delta_h / L = 7.36 \times 100 / 14720 = 0.05\%$

LIMITING TENSILE STRAIN FOR CATEGORY 0 (NEGLIGIBLE) IS 0.05 %

ANTICIPATED DAMAGE MAY BE CATEGORIZED AS "NEGLIGIBLE" TO "VERY SLIGHT"

APPENDIX IV

Basement Structures

BS.01-BS.09

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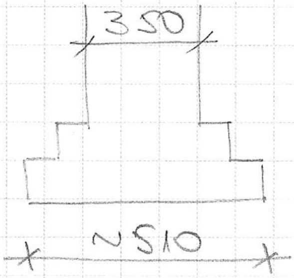
FOUNDATION STRESSES

- EXISTING FOUNDATION STRESS (BELOW INTERNAL WALLS)

LOADS:

	DL	LL
- DEAD LOAD FROM MASONRY ARCH AND STREET 0.9 × 22 × 2.6	51.5	
- LIVE LOAD FROM TRAFFIC 5.0 × 2.6		13.0
- WALL 0,35 × 20 × 1.0	7.0	
	58.5	13.0

EXISTING FOUNDATION WIDTH:



$q = 58.5 + 13.0 = 71.5\ kN/m$

$\sigma = 71.5 / 0.51 = 140\ kN/m^2$

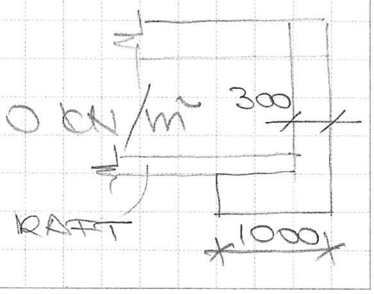
- NEW FOUNDATION STRESS (BELOW NEW RC WALL)

LOADS:

	DL	LL
- DEAD - FROM STEEL BEAM 0.9 × 22 × 4.5/2	44.6	
- LIVE - FROM STEEL BEAM 5.0 × 4.5/2		11.3
- WALL 0,30 × 25 × (2.60 + 1.0)	27.0	
	71.6	11.3

$q = 71.6 + 11.3 = 82.9\ kN/m$

$\sigma = 82.9 / 1,00 = 82.9\ kN/m^2 < 140\ kN/m^2$



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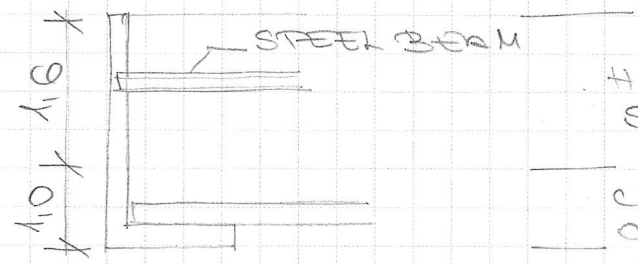
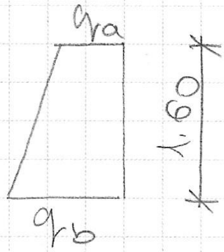
RETAINING WALL - REAR



HORIZONTAL SIMPLY SUPPORTED

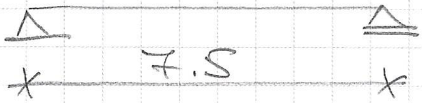
CANTILEVERED OF BASE SLAB



$K_a = \frac{1-\sin 20^\circ}{1+\sin 20^\circ} = 0.49$ LONDON CLAY

$q_a = 1.5 \times 0.49 \times 5.0 = 3.68$ kN/m

$q_b = 3.68 + 1.35 \times 0.49 \times 20 \times 1.6 = 24.85$ kN/m



C 30/37

$h = 300$ mm $d = 300 - 20 - 16/2 = 272$ mm

$M_{Ed} = 24.85 \times 7.5^2/8 = 174.7$ kNm

$$\xi_c = 1 - \sqrt{1 - 2 \times \frac{M_{Ed}}{f_{cd} \times b \times d^2}}$$

$$= 1 - \sqrt{1 - 2 \times \frac{174.7 \times 10^6}{20 \times 1000 \times 272^2}} = 0.126$$

$x_c = \xi_c \times d = 0.126 \times 272 = 34.27$ mm

$$A_s = \frac{M_{Ed}}{(d - x_c/2) \times f_{yd}} = \frac{174.7 \times 10^6}{(272 - 34.27/2) \times 435} = 1576 \text{ mm}^2$$

H16 - 125 $A_s = 1608$ mm^2

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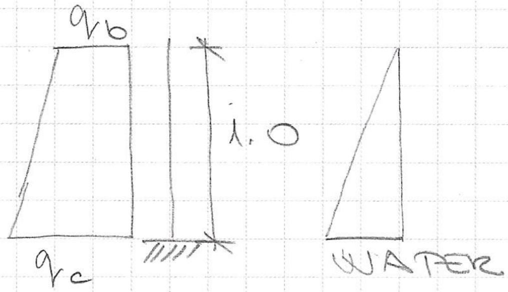
RETAINING WALL - UNDER PINNING



$q_b = 24.85$ kN/m

$q_c = q_b + 1.35 \times (20-10) \times 0.49 \times 1.0 + 1.0 \times 10$

$= q_b + 16.62 = 41.47$ kN/m

$M_{Ed} = 24.85 \times 1.0^2/2 + 16.62 \times \frac{1}{2} \times \frac{1}{3}$

$= 15.20$ kNm

$h = 300$ mm $\quad d = 300 - 75 - 16/2 = 217$ mm

C30/37

$\xi_c = 1 - \sqrt{1 - 2 \times \frac{15.20 \times 10^6}{20 \times 1000 \times 217^2}} = 0.021$

$x_c = 1.1 \times \xi_c \times d = 1.1 \times 0.021 \times 217 = 5.02$ mm

↑ DUE TO AXIAL LOADING

$A_s = \frac{15.20 \times 10^6}{(217 - 5.02/2) \times 435} = 208$ mm²

H12 - 200 $\quad A_s = 565$ mm²

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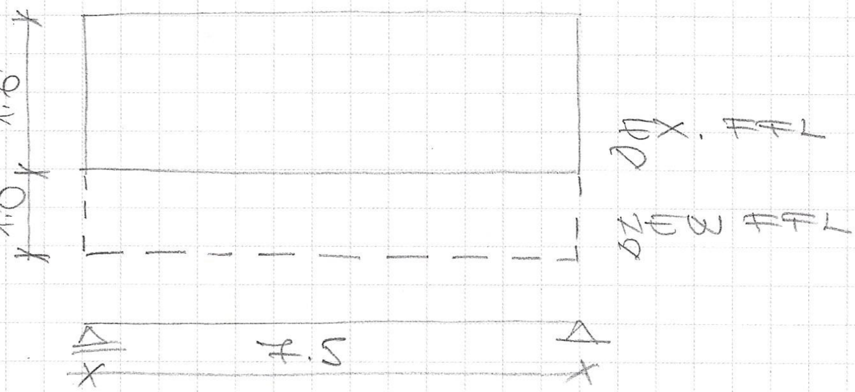
RAFT



ACCORDING TO OUR INFORMATION NO FLOOD WAS IN THE BASEMENT.
AS A SAFETY MEASURE FOR THE DESIGN OF THE BASE SLAB WATER TABLE LEVEL AT THE ORIGINAL BASEMENT FFL IS ASSUMED

$q = 0.9 \times 0.20 \times 25 - 1.0 \times 10 \times 1.0 = -5.5\ kN/m$

$M_{Ed} = 5.5 \times 7.5/8 = 38.67\ kNm$

$h = 200\ mm \qquad d = 200 - 20 - 12/2 = 174\ mm$

$$\xi_c = 1 - \sqrt{1 - 2 \times \frac{M_{Ed}}{f_{cd} \times b \times d^2}}$$

$$= 1 - \sqrt{1 - 2 \times \frac{38.67 \times 10^6}{20 \times 1000 \times 174^2}} = 0.066$$

$x_c = \xi_c \times d = 0.066 \times 174 = 11.49\ mm$

$$A_s = \frac{M_{Ed}}{(d - x_c/2) \times f_{yd}} = \frac{38.67 \times 10^6}{(174 - 11.49/2) \times 435} = 528\ mm^2$$

H12-150 $\qquad A_s = 754\ mm^2$

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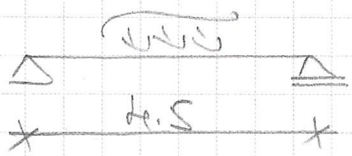
STEEL BEAMS

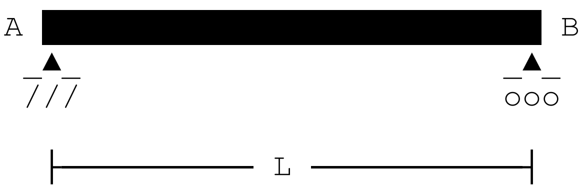


LOADS:

	DL	LL
- DEAD LOAD FROM MASONRY ARCH AND STREET 0.9×22×2.6	51.5	
- LIVE LOAD FROM TRAFFIC 5.0×2.6		13.0
- STEEL BEAM SELF W. 1.0	1.0	
	52.5	13.0

254×254×132 UKC

Location: STEEL BEAM



Simply supported steel beam

Calculations in accordance with BS EN 1993-1-1:2005.

Beam span L=4.5 m

Steel section properties

254 x 254 x 132 UKC
Dimensions (mm): h=276.3 b=261.3 tw=15.3 tf=25.3 r=12.7
Properties (cm): Iy=22500 Iz=7530 Wply=1870 Wplz=878 It=319
A=168 iy=11.573 iz=6.6949

Strength of steel - Table 3.1 (amended by N.A.)

The material thickness is 25.3 mm and steel grade is S 275.

Yield strength	fy=265 N/mm^2
Ultimate strength	fu=410 N/mm^2
Young's modulus	E=210000 N/mm^2
Shear modulus	G=81000 N/mm^2

Loading (unfactored)

Permanent UDL (including S.W)	wd=52.5 kN/m
Variable UDL	wi=13 kN/m

Factored loads

Distributed load	w'=wd*gamG+wi*gamQ=52.5*1.35+13*1.5 =90.375 kN/m

Factored shear force

At end B	Vb=w'*L/2=90.375*4.5/2=203.34 kN
At end A	Va=w'*L-Vb=90.375*4.5-203.34 =203.34 kN
Max shear is same at both ends	Ve=Va=203.34 kN

Factored moment

Maximum bending moment at centre	M=w'*L^2/8=90.375*4.5^2/8 =228.76 kNm
Corresponding shear force	V=0 kN
Maximum moment	MyEd=M=228.76 kNm
Maximum shear force	VzEd=Vb=203.34 kN

Deflection

UDL for deflection calculation   wu=wd+wi=52.5+13=65.5 kN/m
Central UDL deflection   DEL=5*wu*L^4/(384*E*Iy)*10^8
=5*65.5*4.5^4/(384*210000*22500)
*10^8
=7.4016 mm
Deflection to span ratio   1: 608
Limiting deflection (brittle)   DELlim=L*1000/360=4.5*1000/360
=12.5 mm

As DEL ≤ DELlim (7.4016 mm ≤ 12.5 mm), the deflection is within the limiting value.

Section classification

Classify outstand element of compression flange:
Parameter (Table 5.2)   e=(235/fy)^0.5=(235/265)^0.5
=0.9417
Outstand   c=(b-tw-2*r)/2=(261.3-15.3-2*12.7)/2
=110.3 mm
Ratio   c't=c/tf=110.3/25.3=4.3597

As c/tf ≤ 9e (4.3597 ≤ 8.4753), outstand element of compression flange is classified as Class 1 plastic.

Classify web element of section:
Depth between fillets   C=h-2*(tf+r)=276.3-2*(25.3+12.7)
=200.3 mm
Ratio   C't=C/tw=200.3/15.3=13.092

As C/tw ≤ 72e (13.092 ≤ 67.802), web element in bending is classified as Class 1 plastic.

Hence, the overall section classification is Class 1.

Moment resistance - Clause 6.2.5

Moment resistance   McRd=Wply*fy/10^3=1870*265/10^3
=495.55 kNm
Unity factor   unity=MyEd/McRd=228.76/495.55
=0.46163

Section chosen is considered suitable.

Shear plastic resistance - Clause 6.2.6

In the absence of torsion the shear plastic resistance depends on:
Shear area   Avz=A*100-2*b*tf+(tw+2*r)*tf
=168*100-2*261.3*25.3+(15.3+2
*12.7)*25.3
=4607.9 mm^2
Shear plastic resistance   VplRd=Avz*fy/SQR(3)/1000
=4607.9*265/SQR(3)/1000
=705 kN
Unity factor   Unity=VzEd/VplRd=203.34/705
=0.28843

Section chosen is considered suitable.

Note: No M-V interaction has to be considered as since the maximum moment occurs near the mid-span and the maximum shear force is obtained at the supports.

Shear buckling - Clause 6.2.6(6)

```
Depth between the flanges         hw=h-2*tf=276.3-2*25.3=225.7 mm
Buckling ratio                    hw't=hw/tw=225.7/15.3=14.752
As hw/tw ≤ 72e ( 67.802 ), no check for shear buckling is required.
```

Coefficient C1

```
Eff.length between restraints     LT=6.8 m
Coefficient C1                    C1=1.0 (conservative)
Hence, a revised ψ factor psi=1.0 will be adopted as C1=1.0.
```

Lateral torsional buckling

```
Warping constant                  Iw=Iz/4*((h-tf)/10)^2
                                    =7530/4*((276.3-25.3)/10)^2
                                    =1.186E6 cm6
Terms for Critical moment Mcr:
Euler term                        Et=PI^2*E*Iz/(LT^2*100)
                                    =3.1416^2*210000*7530/(6.8^2*100)
                                    =3.3752E6 N
Load to shear centre distance     zg=h/2=276.3/2=138.15 mm
Shear modulus term                Gt=LT^2*G*It/(PI^2*E*Iz)*10^6
                                    =6.8^2*81000*319/(3.1416^2*210000
                                     *7530)*10^6
                                    =76556 mm2
Square root term                  Sr=(Iw*100/Iz+Gt)^0.5
                                    =(1.186E6*100/7530+76556)^0.5
                                    =303.82 mm
Critical moment                   Mcr=C1*Et*Sr/10^6
                                     =1*3.3752E6*303.82/10^6
                                     =1025.4 kNm
Allowing for the effect of destabilizing load
Non-dimensional slenderness       lamLT=1.2*(Wply*fy/(Mcr*10^3))^0.5
                                       =1.2*(1870*265/(1025.4*10^3))^0.5
                                       =0.8342
Limiting slenderness value        lamLT0=0.4
Ratio                             h'b=h/b=276.3/261.3=1.0574
As h/b ≤ 2, imperfection value    aLT=0.34 (curve b)
compute                           comp1=aLT*(lamLT-lamLT0)
                                       =0.34*(0.8342-0.4)
                                       =0.14763
compute                           comp2=0.75*lamLT^2=0.75*0.8342^2
                                       =0.52191
Factor                            phiLT=0.5*(1+comp1+comp2)
                                       =0.5*(1+0.14763+0.52191)
                                       =0.83477
Modification factor    chiLT=1/(phiLT+(phiLT^2-0.75*lamLT^2)^0.5)
                            =1/(0.83477+(0.83477^2-0.75*0.8342^2)^0.5)
                            =0.79808
Factor                            kc=1/(C1)^0.5=1/(1)^0.5=1
Moment distribution factor        f=1-0.5*(1-kc)*(1-2*(lamLT-0.8)^2)
                                   =1-0.5*(1-1)*(1-2*(0.8342-0.8)^2)
                                   =1
```

Modified chiLT factor	ChiLT=chiLT/f=0.79808/1=0.79808
Design buckling resistance moment	MbRd=ChiLT*Wply*fy/10^3 =0.79808*1870*265/10^3 =395.49 kNm
Unity factor	unitb=MyEd/MbRd=228.76/395.49 =0.57843

Section chosen is suitable.

UNIVERSAL COLUMN DESIGN SUMMARY — 254 x 254 x 132 UC Grade S 275

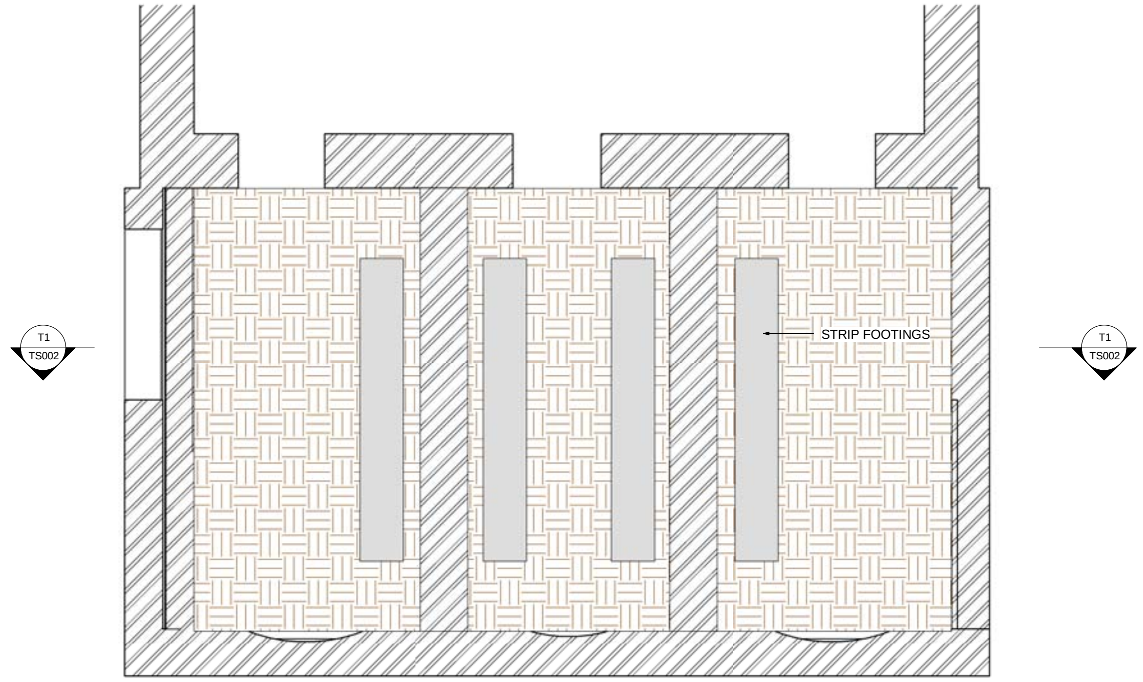
Maximum shear force	203.34 kN
Shear plastic resist.	705 kN
Design moment	228.76 kNm
Moment resistance	495.55 kNm
Buckling resistance	395.49 kNm
Central deflection	7.4016 mm
Limiting deflection	12.5 mm

Factored end shears:

Factored shear at A	203.34 kN
Factored shear at B	203.34 kN

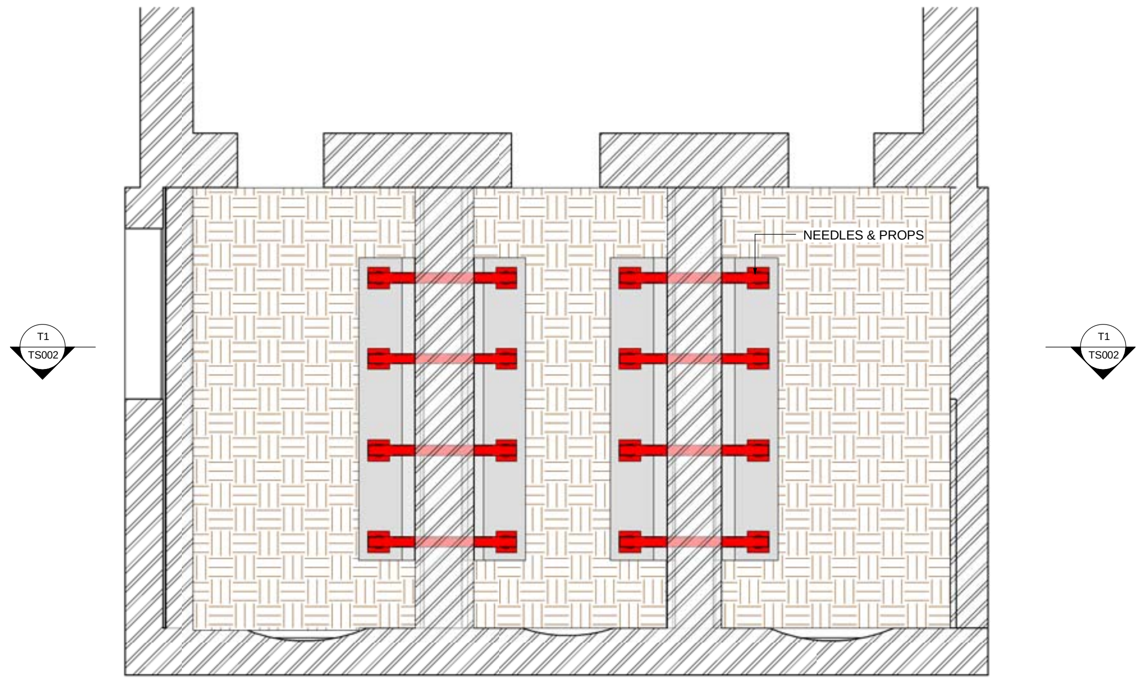
NOTES

1. IT IS RECOMMENDED THAT NO WORK IS CARRIED OUT UNTIL BUILDING REGULATIONS APPROVAL HAS BEEN OBTAINED.
2. IT IS ESSENTIAL THAT TZG ARE NOTIFIED OF ANY DISCREPANCIES OR SUBSEQUENT CHANGES PRIOR TO THEM BEING IMPLEMENTED.
3. DO NOT SCALE FROM THIS DRAWING.
4. THIS DRG IS TO BE READ IN CONJUNCTION WITH THE SPECIFICATION AND ARCHITECTS DRAWINGS.
5. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.
6. A CONTRACTOR USED TO WORKING WITH THE MATERIALS SHOWN ON THIS DRAWING SHOULD FIND NO UNEXPECTED HAZARDS. ANY ADDITIONAL RISKS ARE NOTED ON THE DRAWING.



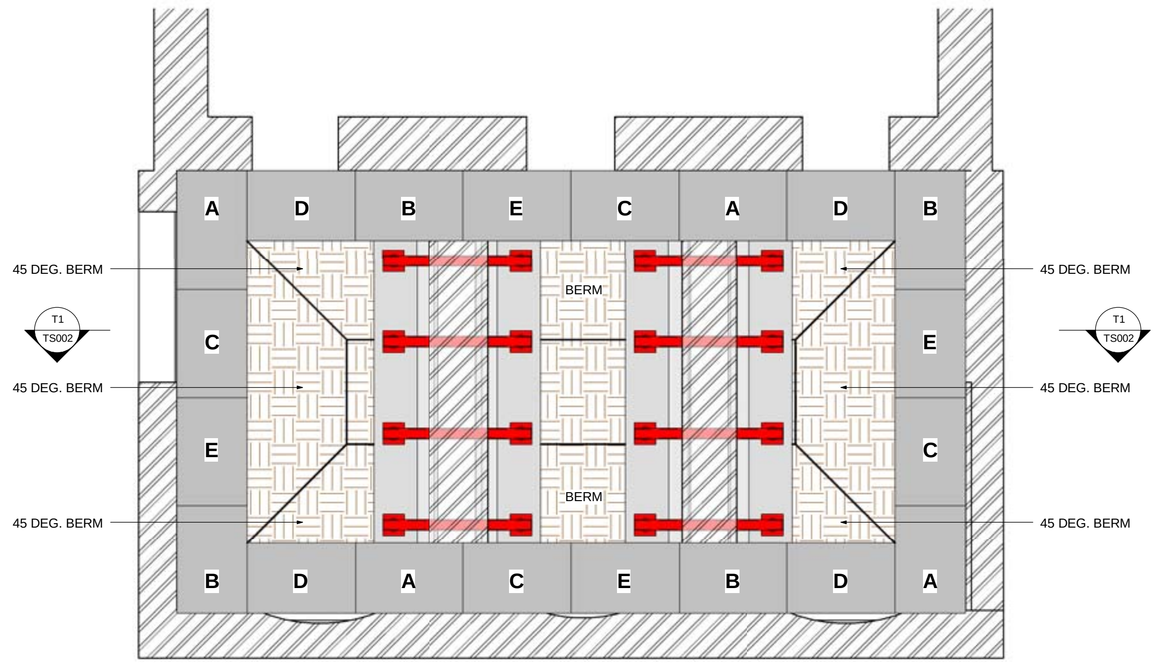
STAGE 1

1. REMOVE EXISTING SLAB
2. CAST STRIP FOOTING AT PROPOSED SLAB LEVEL FOR PROP SUPPORT



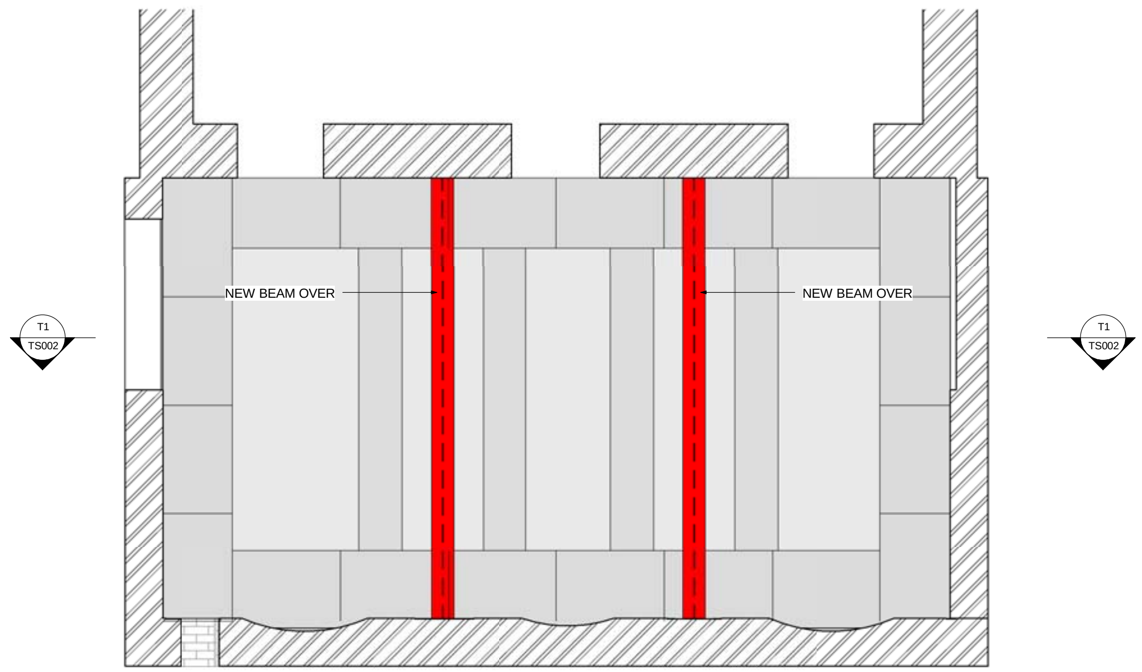
STAGE 2

1. INSTALL NEEDLES THROUGH EXISTING WALLS TO BE REMOVED
2. INSTALL PROPS



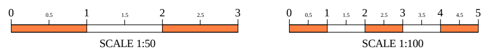
STAGE 3

1. EXCAVATE TO BASEMENT LEVEL WITH 45 DEG. BERMS ALL ROUND
2. UNDERPIN EXISTING WALLS AND CAST TOES IN 1m SECTIONS FOLLOWING C,A,D,B,E SEQUENCE AS SHOWN



STAGE 4

1. INSTALL PERMANENT STEEL BEAMS & COLUMNS
2. REMOVE PROPS
3. CAST REMAINING SLAB CONNECTING TO TOES AND STRIP FOOTINGS



PRELIMINARY

REV.	DATE	DESCRIPTION

CLIENT

CONTRACT: 35 CHESTER PLACE

TITLE: TEMPORARY WORKS STAGES

TZG PARTNERSHIP
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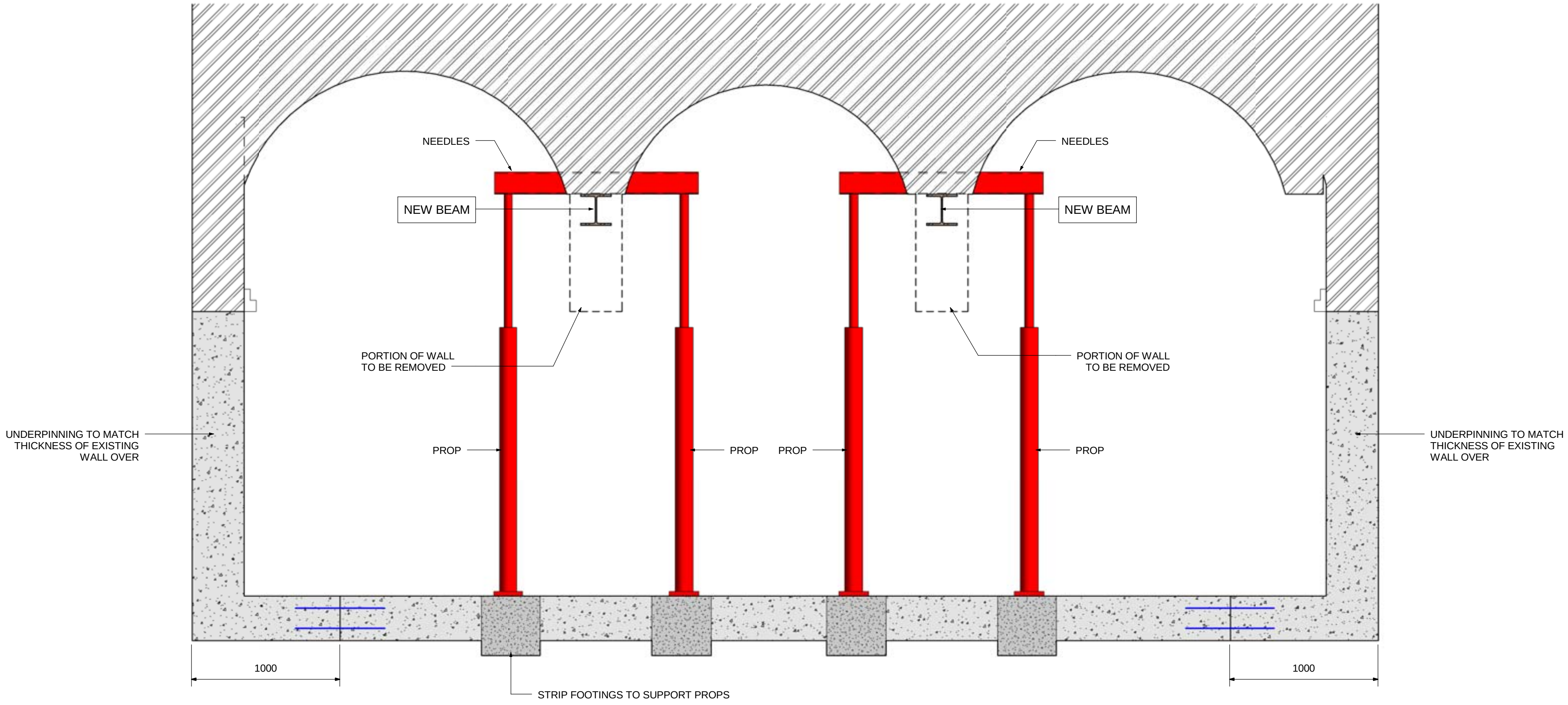
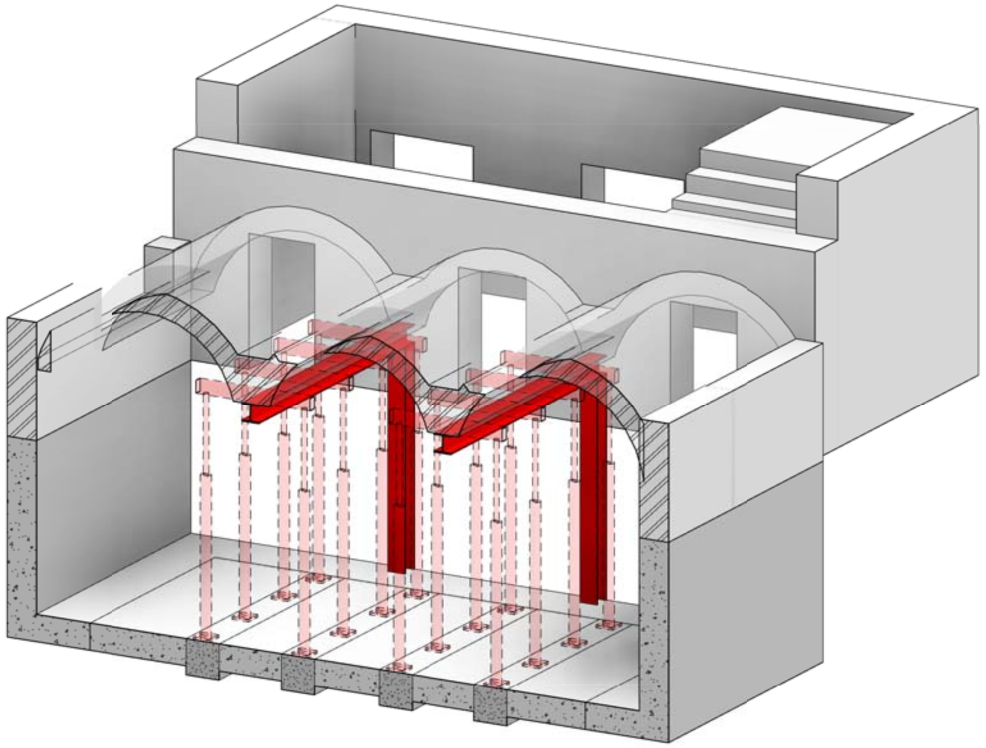
Original size A1	SCALE AS SHOWN	DRAWN SGA	DATE 12/28/11
	CONTRACT No. 5256	DRG. No. TS001	REVISION



T1 SECTION T1
1 : 20



NOTES

1. IT IS RECOMMENDED THAT NO WORK IS CARRIED OUT UNTIL BUILDING REGULATIONS APPROVAL HAS BEEN OBTAINED.
2. IT IS ESSENTIAL THAT TZG ARE NOTIFIED OF ANY DISCREPANCIES OR SUBSEQUENT CHANGES PRIOR TO THEM BEING IMPLEMENTED.
3. DO NOT SCALE FROM THIS DRAWING.
4. THIS DRG IS TO BE READ IN CONJUNCTION WITH THE SPECIFICATION AND ARCHITECTS DRAWINGS.
5. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.
6. A CONTRACTOR USED TO WORKING WITH THE MATERIALS SHOWN ON THIS DRAWING SHOULD FIND NO UNEXPECTED HAZARDS. ANY ADDITIONAL RISKS ARE NOTED ON THE DRAWING.

REV.	DATE	DESCRIPTION

CLIENT

CONTRACT
35 CHESTER PLACE

TITLE
TEMPORARY SECTION & 3D VIEW

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PRELIMINARY

SCALE AS SHOWN	DRAWN SGA	DATE 10/09/14
CONTRACT No. 5256	DRG. No. TS002	REVISION

Original size A1