TRIGRAM
PARTNERSHIP
CONSULTING STRUCTURAL ENGINEERS

36 Flask Walk,
London, NW3

Subterranean Construction Method Statement, and Structural Report in Support of Planning Application.

Consulting Engineers

Trigram Partnership
Harling House
47-51 Gt Suffolk Street
LONDON
SE1 OBS

Tel: 020 7401 8100
Fax: 020 7401 8845
Email: mail@trigrampartnership.com

Job No 4266/JF/June 2015

36 Flask Walk, London, NW6

Structural Report in Support of Planning Application

Contents

1. Introduction

This structural report has been prepared for the purpose of supporting the planning application for the construction of a single storey basement under no. 36 Flask Walk, NW3 1HE, and should not be used for any other purposes.

The extent of the proposed subterranean development covers the footprint of the existing building and front garden. A large open light well in the front garden allows natural light and ventilation to the new basement.

The report is limited in scope to that which is necessary to demonstrate a suitable construction method and sequence that will ensure the structural integrity of the building, the adjoining structures, public thoroughfares and buried structures.

2. Description of 36 Flask Walk and Adjoining Properties

No. 36 Flask Walk is a three storey mid-terrace property within the Hampstead Conservation area, and appears to have been built late 1970's together with Nos. 32 & 34.

The building is of semi-traditional construction, having masonry walls, timber stud partitions, timber joist floors to all levels and timber roof. The floor joists span between the Party Walls to no. 34 and no. 38 Flask Walk.

The second floor has a mansard roof clad with slates. The mansard roof has been set back from the main elevations to form inboard gutters, and there is one large dormer at the front and two smaller dormers at the rear.

The ground floor is elevated above street level and under the ground floor there is an approximately 0.8 m deep unobstructed crawl space which occupies the full footprint of the property.

The property has a small patio at the rear, below which there is a communal underground car parking area.

A visual inspection suggests that the property has not been altered from its original configuration. The property, and the adjoining properties, appears to be in sound condition, and no signs of noticeable historic movements are apparent.

The ground floor area of no. 34 provides the access and hall way to its first floor. The remaining ground floor area is the access ramp down to the basement car park behind nos. 32, 34 and 36.

Two trial pits were excavated in order to investigate the foundations to the party walls at their respective locations.

In the case of the foundation to the party wall 36/38 Flask Walk a traditional corbelled brick foundation resting on a concrete base was observed. The underside of the existing foundation is at level 101.40, i.e. approximately 2.6 m below the existing ground floor level, and protrudes 300 mm from the face of the masonry wall.

In the case of the foundation to the party wall 34/36 Flask Walk the underside was encountered at level 101.16, which is approximately 0.8 m below the finished floor level of the communal parking area behind 36 Flask Walk. This indicates that the foundation is generally set at a constant level.

The concrete foundation was measured to be 500 mm deep and protrude 800 mm from the face of the masonry wall, and despite the geometry suggesting otherwise the foundation appeared to be unreinforced.

3. Proposed Structural Works

It is proposed to construct a new basement under the existing building extending out to the boundary with the public footpath.

By extending the basement beyond the foot print of the existing building it becomes possible to include a cloakroom beneath the access steps and a good sized light well. The latter significantly improving the natural light and ventilation to the new basement.

The Structural Surface Level (SSL) for the new basement will be approximately 3.1 m below the Finished Floor Level (FFL) of the existing ground floor. Thus, the excavation for the new basement will entail a general lowering of the existing Ground Level (GL) within the crawl space of 36 Flask Walk by approximately 2.3 m.

The level of the oversite concrete under the building corresponds well to the level of the road surface in front of the property.

The basement slab will be designed in reinforced concrete to accommodate the heave forces associated with the removal of a overburden on the clay strata as well as pressures arising from the assumed ground water regime.

All reinforced concrete works will be specified as ‘water tight concrete construction’, but in addition there will be a drained cavity to achieve a grade 3 level of protection against water ingress.

The use of the property will be retained as ‘residential’ therefore the loadings on the suspended floors will remain as existing.

4. Ground Conditions

According to British Geological Survey, sheet 256, Solid and Drift edition, the underlying soils for locality comprise an up to 30 m thick layer of Claygate Beds overlaying London Clay.

A comprehensive site specific geotechnical investigation was undertaken by Chelmer Site Investigations. The investigation involved sinking 2 no. boreholes from within the property to a depth of 10.0 m below the ground floor level. Their Factual Report, Geo-environmental Report and Basement Impact Assessment are submitted with this report.

Based on the data from their investigation the stratigraphy under 36 Flask Walk is summarised as follows:

0.0 m - 0.8 m	BGL	Made Ground
0.8 m - 4.3 m	BGL	Re-worked Ground (Sandy Clay)
4.3 m - 5.7 m	BGL	Weathered Claygate (Silty Clay)
5.7 m - 8.8 m +	BGL	Claygate/London Clay

Thus, similar to the existing foundations the new foundations will all be located within the Re-worked Ground strata.

The geology was determined to have good loadbearing characteristics, and a safe bearing pressure of 160 kN/m^2 was reported to be applicable at the underside of the new foundations.

The concrete and the cover to any reinforcement will be specified in accordance with the aggressive chemical environment reported for this site.

5. Hydrogeology

The records taken from the installed standpipes showed the presence of groundwater at relatively high levels. The highest of which almost coincided with the level of the underside of the new Party Wall foundations.

However, the hydrogeological investigation suggests that the water encountered is water perched in localised silt pockets within the Re-worked Ground strata, and there is no evidence of significant water flow across the site. Thus, it is anticipated that any adverse impact on the groundwater flow from the construction of the basement will be minimal.

In accordance with the recommendations by the geotechnical specialists the new structure will (as a precaution) be designed in the short-term condition for a groundwater level equal to the ground level, and in the long-term condition for a water level standing 0.5 m below ground.

There are no known water courses in close proximity to the site.

6. Ground Stability

There are no steep areas and the proposed basement excavation raise no concern in relation to the overall stability of the 4.5 degree slope across the site.

Owing to the re-worked nature of the ground, full ground support will be installed as the excavations for the proposed basement are progressed.

In general normal precautions in supporting the ground around the basement should be taken, though when undercutting for the spreader footings in the Re-worked Ground special provisions need to be put in place to ensure the stability of the roof of these excavations at all time.

7. Basement Construction

The structural form of the proposed basement will comprise reinforced concrete underpins to the party walls. The width of the new footings to will match the width of the existing footings.

We expect the excavation to remain dry during construction, though minor pumping may be required during construction in the event a pocket of groundwater were encountered.

The necessary provisions for supporting the footpath and the road will be put in place by means of shoring designed for appropriate surcharges.

Temporary works will be required during underpinning and construction of retaining RC walls, and will be maintained until the necessary permanent supports have been established.

8. Underpinning

A 1-in-5 underpin sequence will be adopted to minimise the risk of induced settlement.

Some cracking may nevertheless occur, but should be category 0 – 1 (BRE categories), so would be cosmetic and repairable using normal decorating techniques. Such repairs would be the responsibility of the Building Owner, and be covered by a Party Wall Award.

9. Trees

According to the guidelines by NHBC the new basement will be located within the zone of influence of the nearest trees. The nearest larger tree is located on the opposite side of Flask Walk at a distance of approximately 9 m.

The new foundations will all be founded within soils characterised as having medium volume change potential and will be sufficiently deep so as not to be affected by the trees and seasonal moisture movements.

10. Buried Services and Tunnels

Tunnels for the Northern Line are known to pass close to the west of the site, though at a considerable depth. London Underground will have to confirm that the proposed basement is outside any of their exclusion zones prior to commencing construction.

No detailed information is available regarding existing and buried services, such as drainage runs, gas and electricity services, and a survey will have to be carried out prior to commencing construction.

As noted above, services in the public footpath and highway will be protected from ground movements. Those serving this property will be modified as part of these works.

11. Monitoring

It is proposed that reflective targets are affixed to the front elevations of no. 34 and no. 38 Flask Walk prior to work starting on site.

Potential building movements will be closely monitored during execution of the works, and continue until all underpinning works within the existing basement have completed, the new basement walls are constructed and restrained and that all new permanent steel works supporting the front elevation have been installed.

12. Indicative Construction Sequence for the Works

A proposed sequence for the construction of the works is appended.

The Main Contractor will be responsible for defining the detailed construction sequence, and for the design of all temporary works. The design and method statements will be vetted by the Design Team prior to implementation.

13. Conclusion

By adopting these measures, the proposed basement extension can be constructed with no detrimental effect to the structural integrity or stability of the house or the existing structures adjoining or adjacent to the house.

TRIGRAM
PARTNERSHIP
CONSULTING STRUCTURAL ENGINEERS

This Report was prepared by:

Dr Jesper Friis, BSc, MSc, PhD

Bruce Huxtable, CEng, MIStructE, MICE, MSt, BSc (Hons)

June 2015

Appendix A - Indicative Construction Sequence

- Install monitoring targets in accordance with the requirements of the Party Wall Award.
- Install waling beams and props to replace the restraining effect of the timber floor during construction.
- Remove the existing ground floor joists to facilitate excavation for new basement. Install props across the site.
- Install Temporary Works piles on either side of front façade, carry out integrity tests and construct pile caps.
- Position two no. primary beams on top of the pile caps parallel with the existing wall.
- Needle through the existing wall. Needles supported on primary beams, and dry pack.
- Transfer weight of façade to Temporary Works, allowing the existing foundations to the front elevation to be removed in due course.
- General level reduction. Check integrity and 'plumbness' of exposed piles. Excavate to underside of existing footing (platform level)
- Working from platform level excavate to form 1 in 5 of the underpins. Install full support, trench shoring, as the excavation progress.
- Construct bases of underpins.
- Fix reinforcement, erect shutters and concrete stems of underpins.
- Strike shutters when concrete has gained sufficient strength, and dry pack.
- Excavate trench between pins of opposite wall, fix reinforcement and cast strip of basement slab. Props across the site will be in place and adjusted during the excavation of the trench.
- Install temporary lateral propping at front construct retaining walls.
- Complete all underpins, infill slabs and construct front retaining walls.
- Install steel box frame to support front façade.
- Remove Temporary Works needles, break down and remove pile caps and piles.

Appendix B - Designer's Risk Assessment Summary

General

The works involve excavations below an existing building.

Particular Residual Risks

Full ground support will be necessary during the excavation of the underpins, and all other excavations in the reworked soils.

The basement excavation will extend beyond the front façade. The façade will be supported on temporary works propping, using RC piles as columns. Therefore, these piles must be designed to provide vertical support and lateral stability. The piles integrity is to be confirmed during the excavation phase. The piles/columns are to be designed as if out of plumb, but within the specified 1 in 75 tolerances.

Appendix C - Underpinning Specification

The general specification will be in accordance with the Standard Detail D80, overleaf.

The main contractor will produce a layout drawing defining the bays and sequence, to take account of the particular site features. This will be reviewed in principle by the design team.

TRIGRAM PARTNERSHIP
CONSULTING STRUCTURAL ENGINEERS

HARLING HOUSE
47–51 GREAT SUFFOLK ST
TEL: 0171 401 8100
FAX: 0171 401 8845

Job No	Sheet No	Rev
	D 80	

STANDARD DETAIL

TYPICAL UNDERPINNING DETAILS.

GENERAL NOTES.

(REF. CIRIA REPORT 111: STRUCTURAL RENOVATION OF TRADITIONAL BUILDINGS).

A. THE CONTRACTOR IS TO SUBMIT FOR APPROVAL THEIR LAYOUT PLAN SHOWING THE PROPOSED PIN LAYOUT AND SEQUENCE.

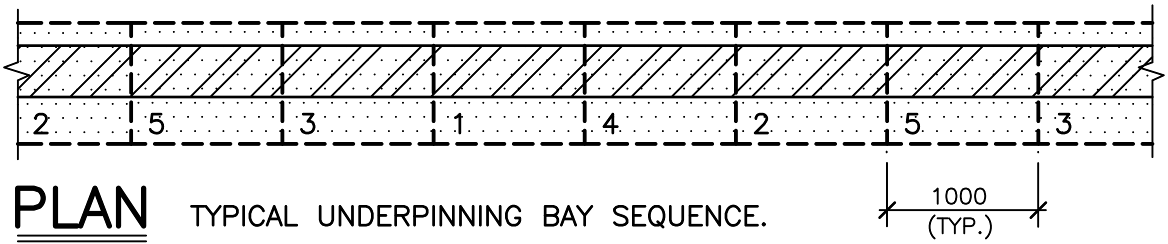
B. HEALTH AND SAFETY FILE / RECORD DRAWINGS: COLLATE AND SUBMIT A FULL SET OF RECORDS FOR INCLUSION IN HEALTH AND SAFETY FILE.
CONTENT FOR EACH UNDERPINNING BLOCK RECORD: DATE OF CASTING; DEPTH OF BASE BELOW DATUM; LENGTH; WIDTH EITHER SIDE OF WALL; DETAILS OF DRAINS AND SERVICES BUILT INTO BLOCK AND DIAMETER OF SLEEVING. (LATEST DAY FOR SUBMISSION: 14 DAYS AFTER COMPLETION.)

C. UNDERPINNING (EXCAVATION, CONCRETING & DRY PACKING) IS TO BE CARRIED OUT IN THE NUMERICAL SEQUENCE SHOWN i.e. BAY(S) 1 FOLLOWED BY BAY(S) 2 etc.

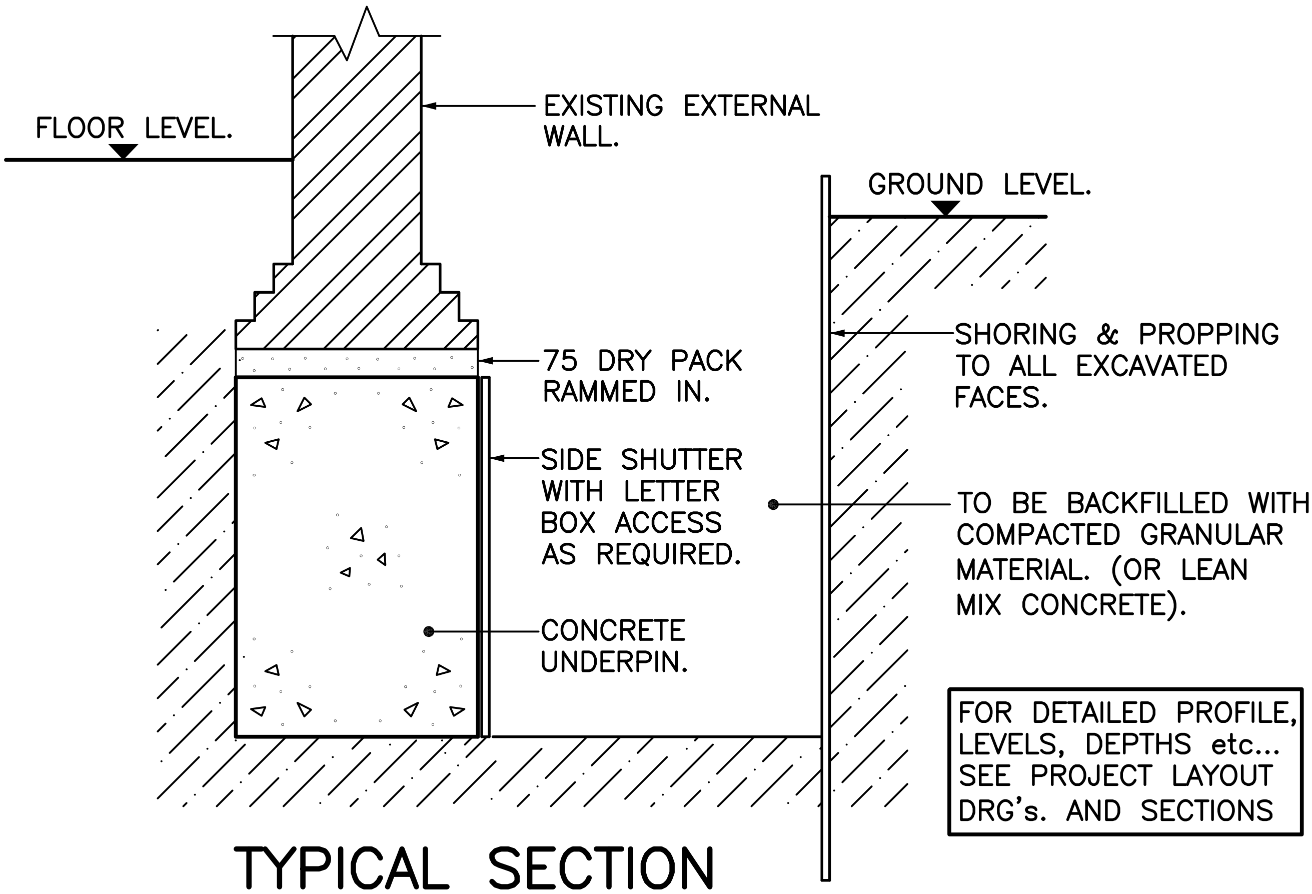
D. NO UNDERPINNING BAY(S) IS TO BE STARTED UNTIL THE PREVIOUS BAY IN THE NUMERICAL SEQUENCE HAS BEEN COMPLETED.

CONSTRUCTION SEQUENCE.

1. EXCAVATE TO UNDERSIDE OF PROPOSED UNDERPINNING BAY INSTALLING APPROPRIATE SHORING AS NECESSARY TO FORM BAY PROFILE WHILE KEEPING THE WORKS FREE FROM GROUND WATER.
2. SET UP SIDE FORMWORK AS REQUIRED.
3. CAST CONCRETE FOR BAY UP TO 75mm BELOW UNDERSIDE OF EXISTING FOUNDATION. (CONCRETE GRADE FND2 DESIGNATED MIX TO B.S.8500.)
4. ALLOW 2 DAYS FOR CONCRETE TO SET.
5. INSERT DRY PACK BETWEEN NEW CONCRETE AND EXISTING FOUNDATION. (DRY PACK MIX PROPORTIONS BY WEIGHT – 1:3 CEMENT/SAND MIXED TO DRY CONSISTENCY)
6. ALLOW ONE DAY FOR DRY PACK TO SET.
7. CARRY OUT STEPS 1 to 6 inc. ABOVE FOR ALL OTHER NUMBERED BAYS (IN NUMERICAL SEQUENCE) UNTIL FULL LENGTH OF WALL IS UNDERPINNED.
8. REMOVE SIDE SHUTTER.
9. BACKFILL AND REMOVE SHORING AS REQUIRED.



PLAN TYPICAL UNDERPINNING BAY SEQUENCE.



TYPICAL SECTION

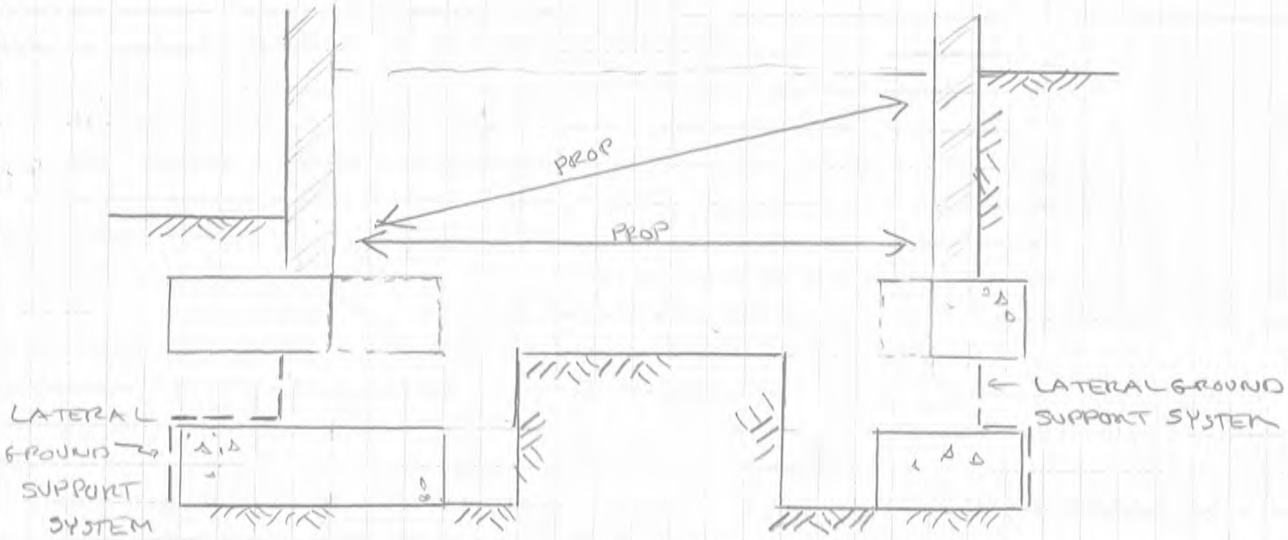
TRIGRAM
PARTNERSHIP LLP
CONSULTING STRUCTURAL ENGINEERS

Job No	Sheet No.	Rev
4266		
Made By	**Dates**	**Chkd**
	03/06/15	

36 FLASK WALK

Underpinning sequence

STAGE 1: EXCAVATE TO UNDERSIDE OF EXISTING FOOTINGS.
INSTALL PROPS ACROSS SITE



STAGE 2: CUT BACK EXISTING FOOTING
EXCAVATE TO FORM UNDERPIN AND CAST NEW MC FOOTING

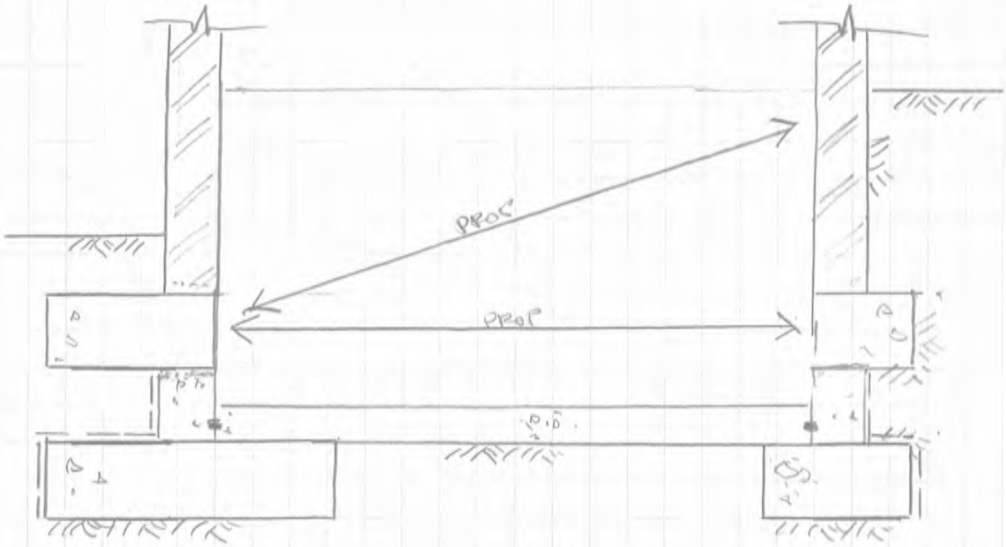
TRIGRAM PARTNERSHIP LLP

CONSULTING STRUCTURAL ENGINEERS

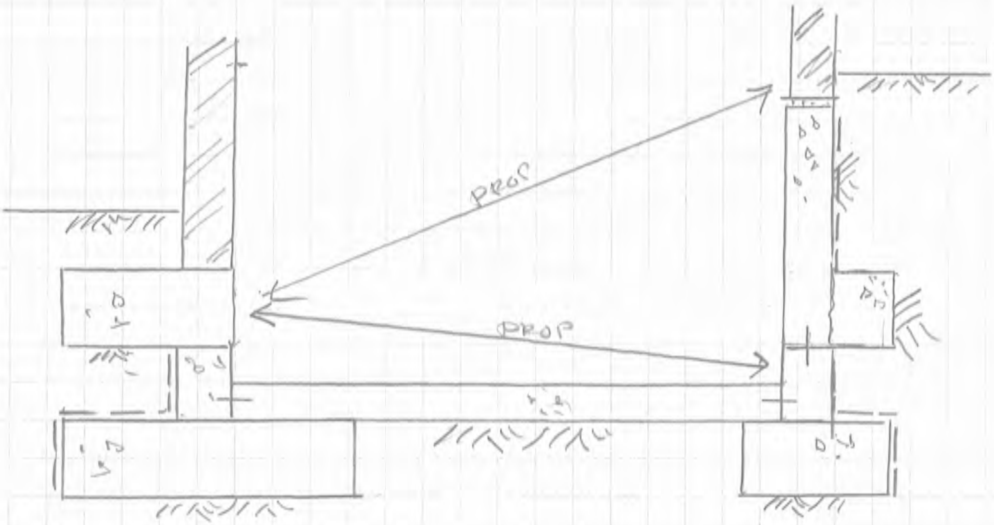
Job No	Sheet No.	Rev
4266		

Made By	Dates	Chkd
JF	02/06/15	

36 FLASK WALK



STAGE 3: SHUTTER, FIX REINFORCEMENT AND CAST WALL STUBS
STRIKE SHUTTER AND DRY PACK.
EXCAVATE TRENCH, FIX REINFORCEMENT AND CAST BASEMENT SLAB



STAGE 4: PART DEMOLISH MASONRY WALL TO # 38 FLASK WALK.
INSTALL LATERAL GROUND SUPPORT SYSTEM.
FIX REINFORCEMENT, SHUTTER AND CAST RC WALL EXTENSION.
STRIKE SHUTTER AND DRYPACK.

Appendix D - Temporary Works Specification

The main contractor will be responsible for the design of all temporary works supports for vertical loads; lateral soil pressures; and for the overall stability of the various structures.

The proposed methodology and sequence of works will be vetted by the design team. The proposed loadings will be agreed with Trigram Partnership LLP.

Appendix E - Concept Drawings

As Proposed - Sections SK.01 & SK.02

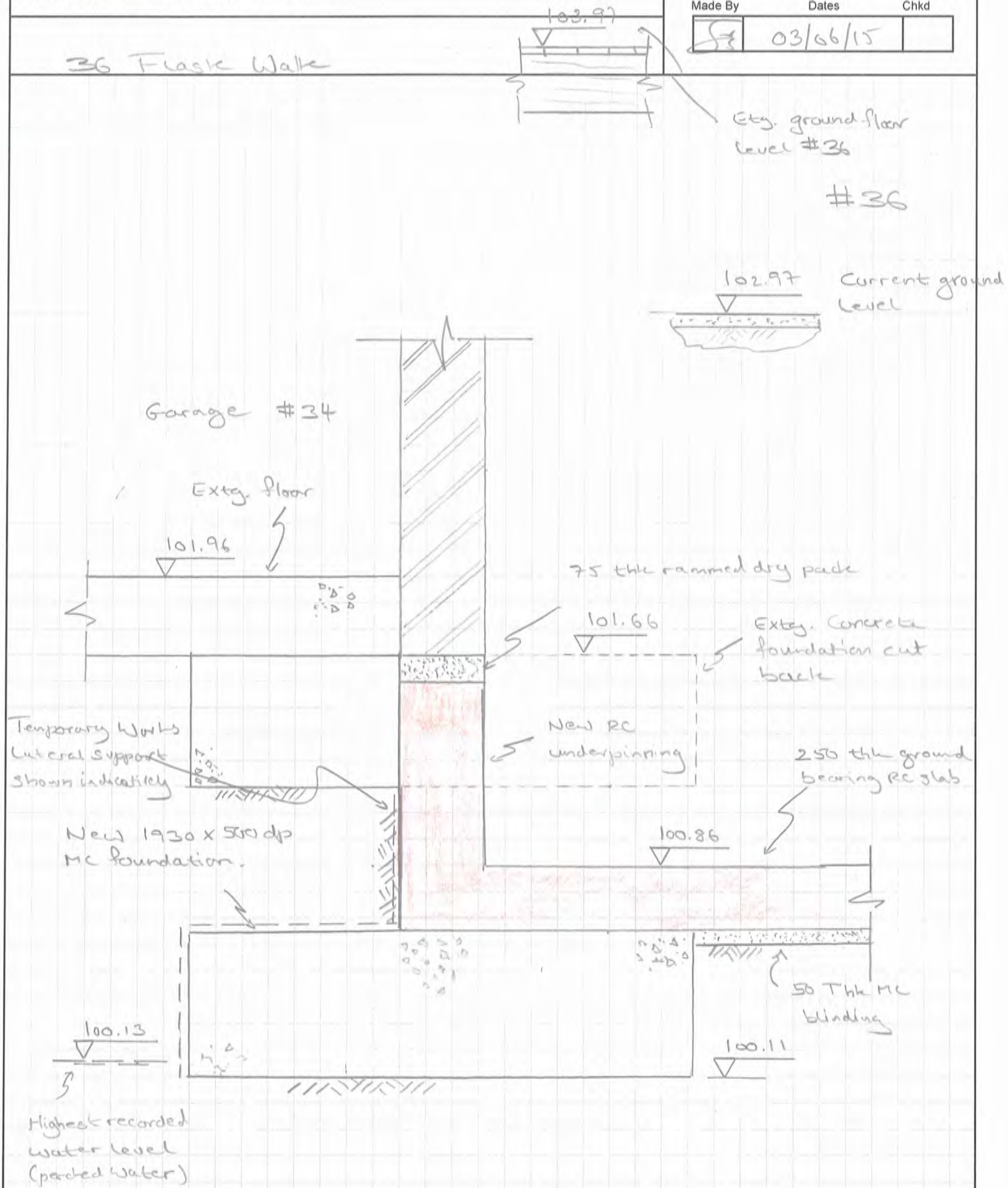
TRIGRAM PARTNERSHIP LLP

CONSULTING STRUCTURAL ENGINEERS

Job No	Sheet No.	Rev
4266	SK.01	

Made By	Dates	Chkd
[illegible]	03/06/15	

36 Flask Walk



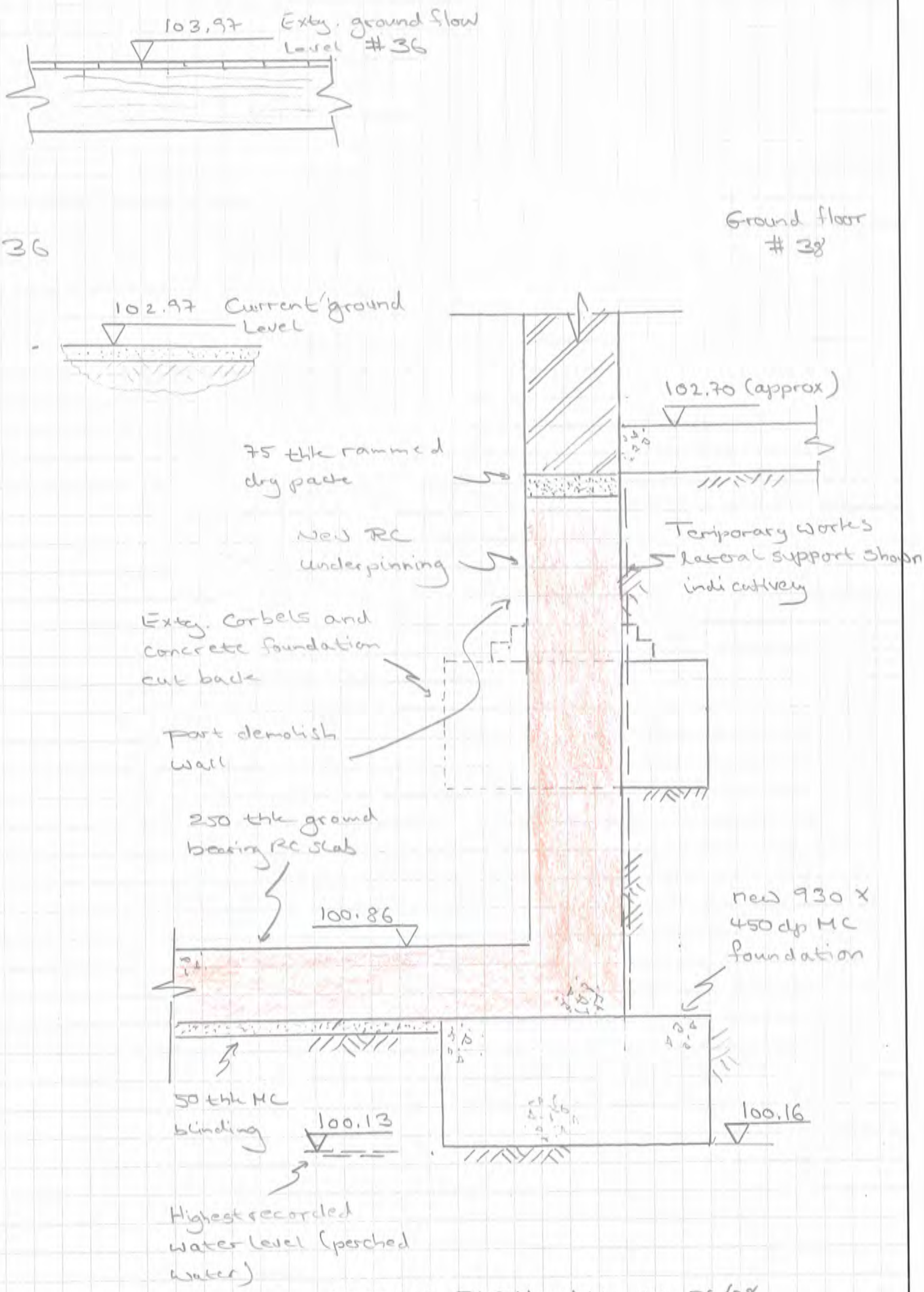
SECTION PARTY WALL NOS. 34/36

TRIGRAM
PARTNERSHIP LLP
CONSULTING STRUCTURAL ENGINEERS

Job No	Sheet No.	Rev
4266	SK.02	

Made By	Dates	Chkd
JS	03/06/15	

36 Flask Walk

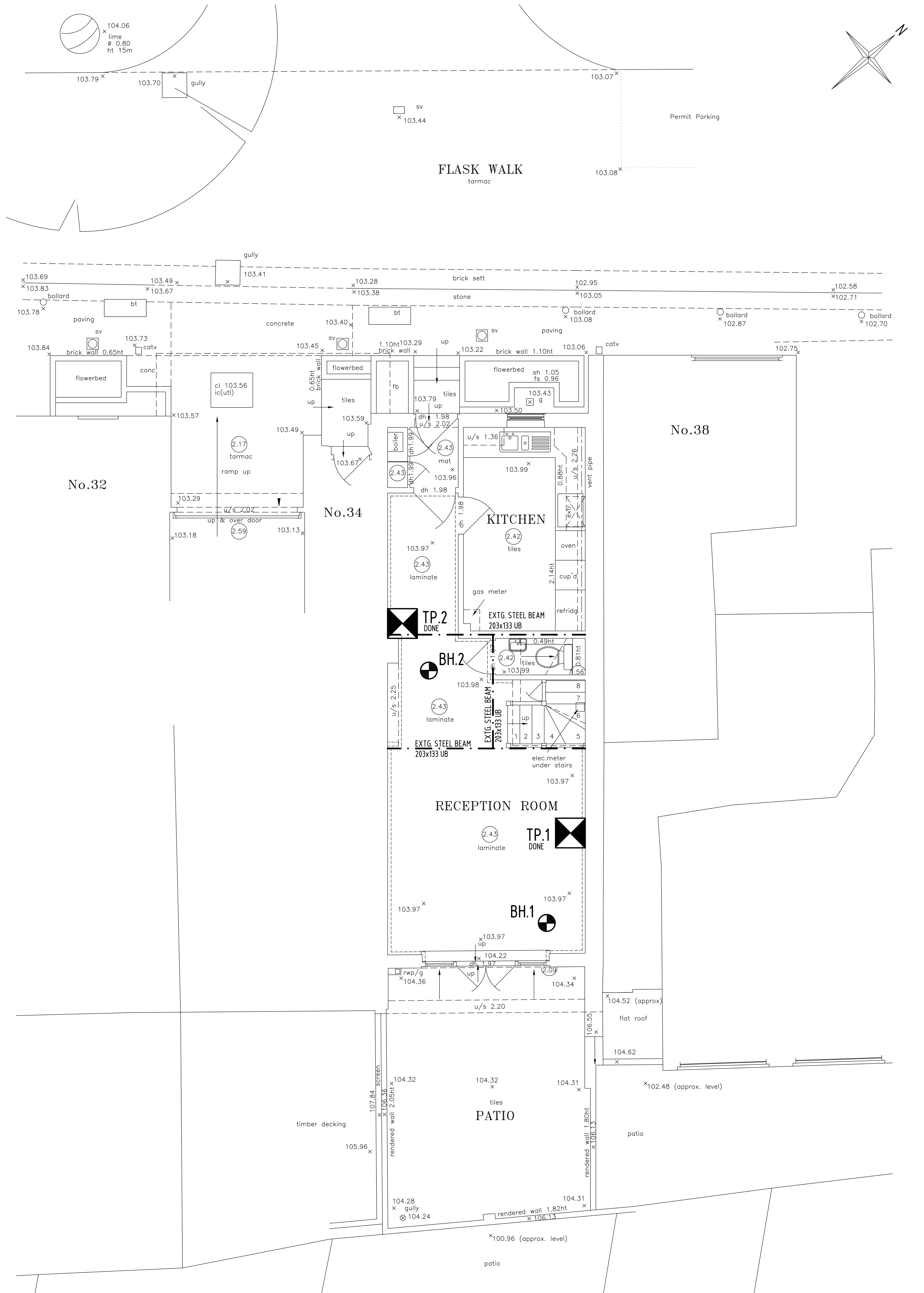


SECTION PARTY WALL NOS. 36/38

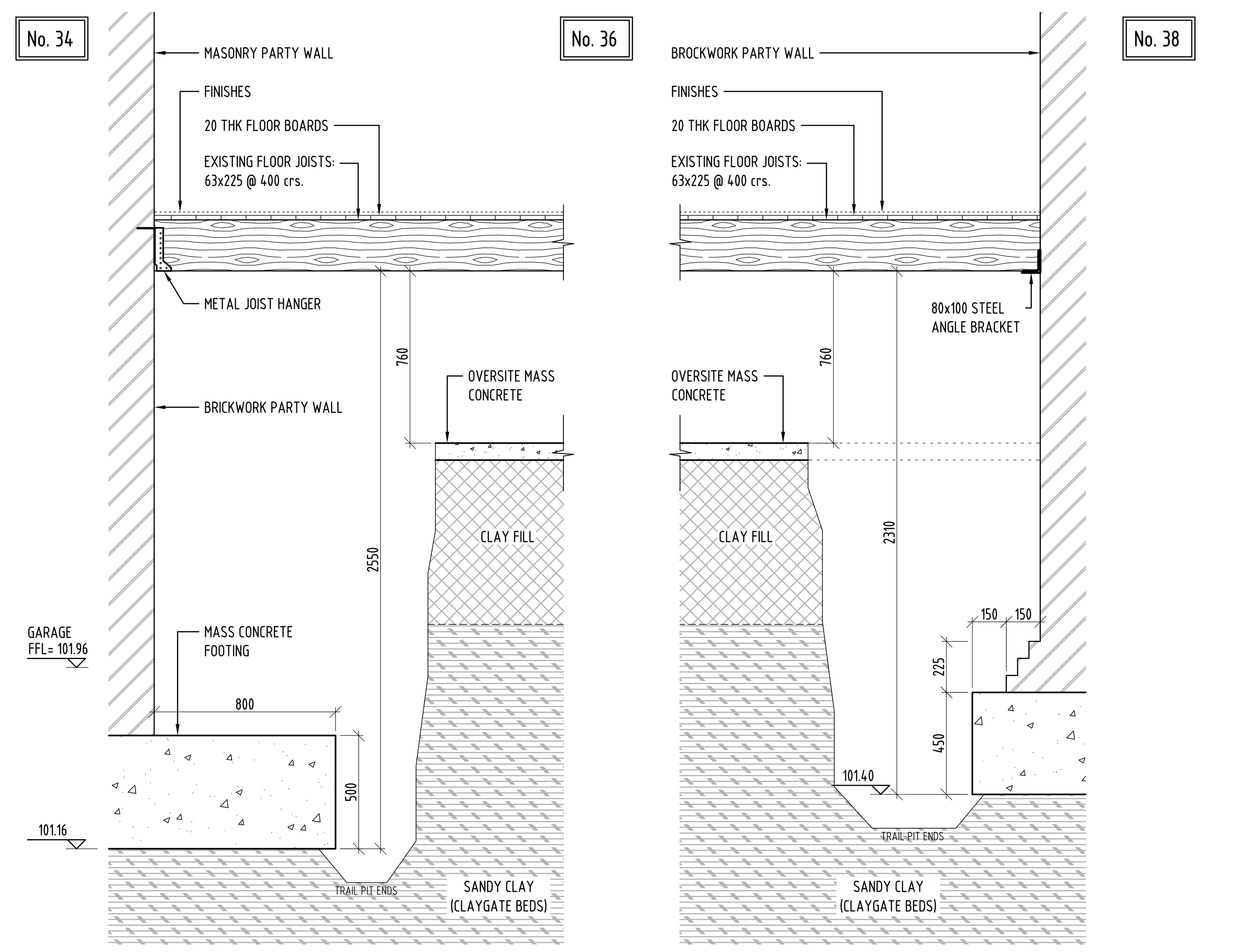
TRIGRAM PARTNERSHIP
CONSULTING STRUCTURAL ENGINEERS

Appendix F - Structural Exposures, Trial Pits

Site Investigation Plan and Sections - SI.01



EXISTING GROUND FLOOR PLAN
SCALE 1:50



TRIAL PIT 2
SCALE 1:20

TRIAL PIT 1
SCALE 1:20

NOTES

1. GENERAL:
1.1 NO DIMENSIONS ARE TO BE SCALED FROM THIS DRAWING, ALL DIMENSIONS ARE TO BE ESTABLISHED ON SITE.
1.2 THIS DRAWING IS TO BE READ WITH ALL RELEVANT ARCHITECTS AND SERVICES ENGINEERS DRAWINGS AND SPECIFICATIONS FOR CONSTRUCTION DETAIL, PLUMBING, DRAINAGE, ELECTRICAL WORK, HEATING WORK, INSULATION, DAMP PROOF DETAILS, VENTILATION, FINISHES, JOINERY ETC.
1.3 THE CONTRACTOR IS TO NOTIFY THE CONTRACT ADMINISTRATION (C.A.) OF ANY DISCREPANCIES BETWEEN THIS DRAWING AND SITE CONDITIONS BEFORE IMPLEMENTING THE WORK.
1.4 ANY TEMPORARY WORKS NECESSARY SHALL BE THE SOLE RESPONSIBILITY OF THE CONTRACTOR.

KEY

TP - DENOTES TRIAL PIT REQUIRED FOR SITE INVESTIGATION;
1. TRIAL PIT TO BE APPROX. 1.0x1.0m min., DUG TO THE UNDERSIDE OF EXISTING FOUNDATIONS AND NO DEEPER UNLESS INSTRUCTED BY THE ENGINEER. RECORDS SHOULD INCLUDE FOUNDATION CROSS SECTION WHERE APPLICABLE.
2. CONTRACTOR TO BACKFILL TRIAL PIT WITH COMPACTED EXCAVATED MATERIAL. EXCESS SPOIL TO BE REMOVED FROM SITE. PITS ARE TO BE REINSTATED TO ORIGINAL CONDITION.

BH - 150ø BORE HOLE TO 10.0m DEPTH

REV	DATE	DESCRIPTION	BY
B	16/01/15	BORE HOLE LOCATIONS ADDED.	IP
A	03/12/14	TRAIL PIT SECTIONS ADDED.	IP

DRG STATUS: PRELIMINARY

ARCHITECT: XUL ARCHITECTURE

JOB TITLE: 36 FLASK WALK LONDON, NW3

DRG TITLE: SITE INVESTIGATIONS EXISTING GROUND FLOOR PLAN TRIAL PIT SECTIONS

TRIGRAM PARTNERSHIP
CONSULTING STRUCTURAL ENGINEERS
HARLING HOUSE
47-51 GREAT SUFFOLK ST.
LONDON SE1 OBS
TEL: 020-7401 8100
FAX: 020-7401 8845

JOB NO	DRG NO	REV	SCALE	
4266	SI.01	B	AS NOTED @ A1	
			DRN JF	DATE 11/2014

Appendix G - Structural Scheme Calculations

1. Load take down
2. Box Frame
3. Basement Slab
4. Retaining walls

TRIGRAM PARTNERSHIP LLP

CONSULTING STRUCTURAL ENGINEERS

Job No	Sheet No.	Rev
4266		

Made By	Dates	Chkd
JB		

36 Flask Walk

1. Load take down.

Front elevation:

NORTH-WEST ELEVATION (FLASK WALK)

A.O.D. 100.00m

TRIGRAM PARTNERSHIP LLP
CONSULTING STRUCTURAL ENGINEERS

Job No	Sheet No.	Rev
4266		
Made By	**Dates**	**Chkd**
JS		

36 Flask Walk

Rear elevation:

SOUTH-EAST ELEVATION (REAR)
A.O.D. 100.00m

TP01

Front elevation:

@ section A-A:

P_{tot} = (4.2 · 6.3 − 2.1.1 − 0.8 − 1.6) · 4.40 = 96.2

+ (4.2 · 3.0 − 1.9) · 1.00 = 10.7

106.9 kN

p_{avg} = 106.9 / 4.2 = 25.4 kN/m (SLS)

Rear elevation:

@ section A-A:

P_{tot} = (4.2 · 3.9 − 2 · 1.1) · 4.40 = 62.4

+ (4.2 · 3.0 − 2 · 0.8) · 1.00 = 11.0

73.4 kN

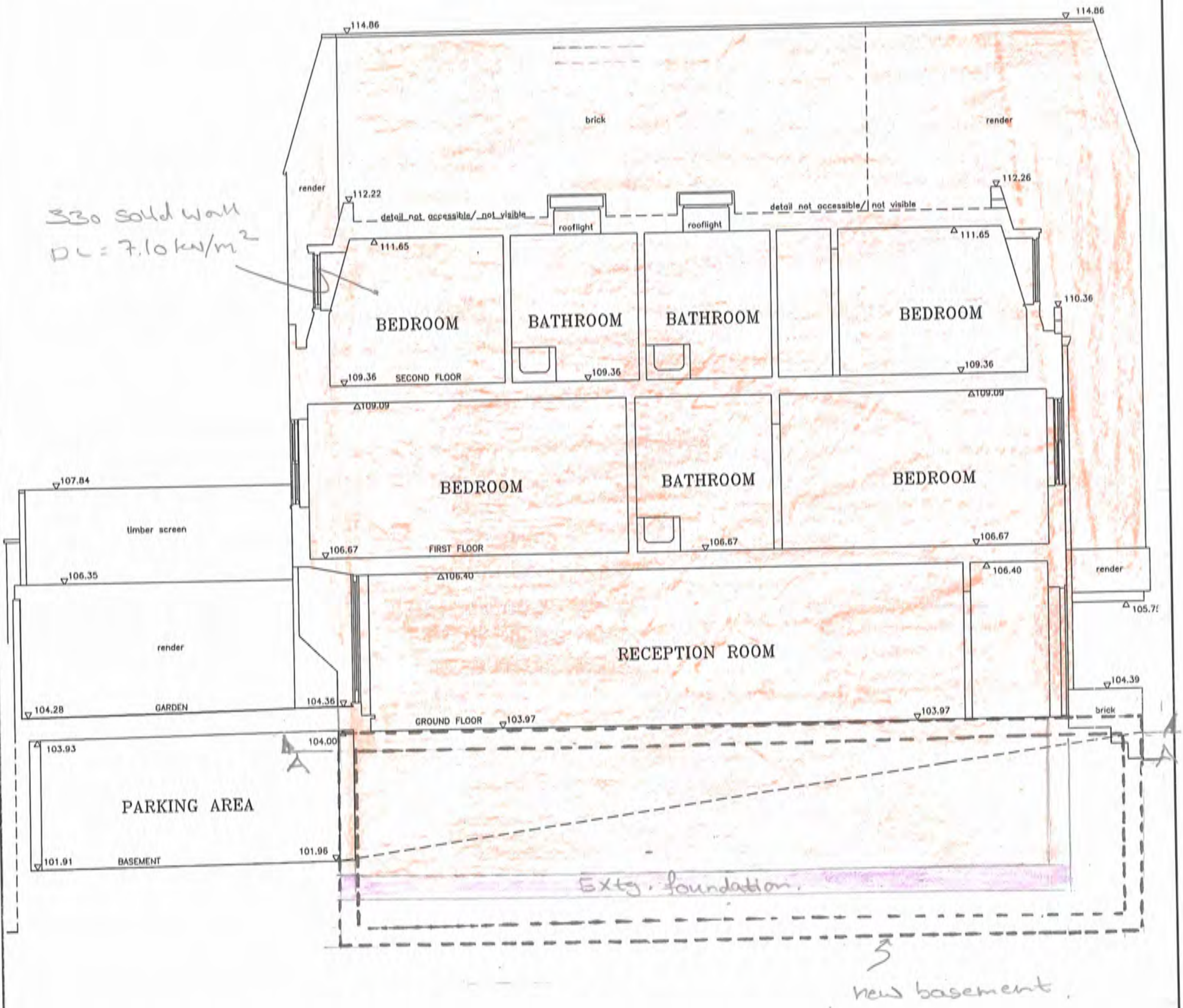
p_{avg} = 73.4 / 4.2 = 10.3 kN/m (SLS)

TRIGRAM
PARTNERSHIP LLP
CONSULTING STRUCTURAL ENGINEERS

Job No	Sheet No.	Rev
4266		

Made By	Dates	Chkd
JS		

Party Wall 34/36:

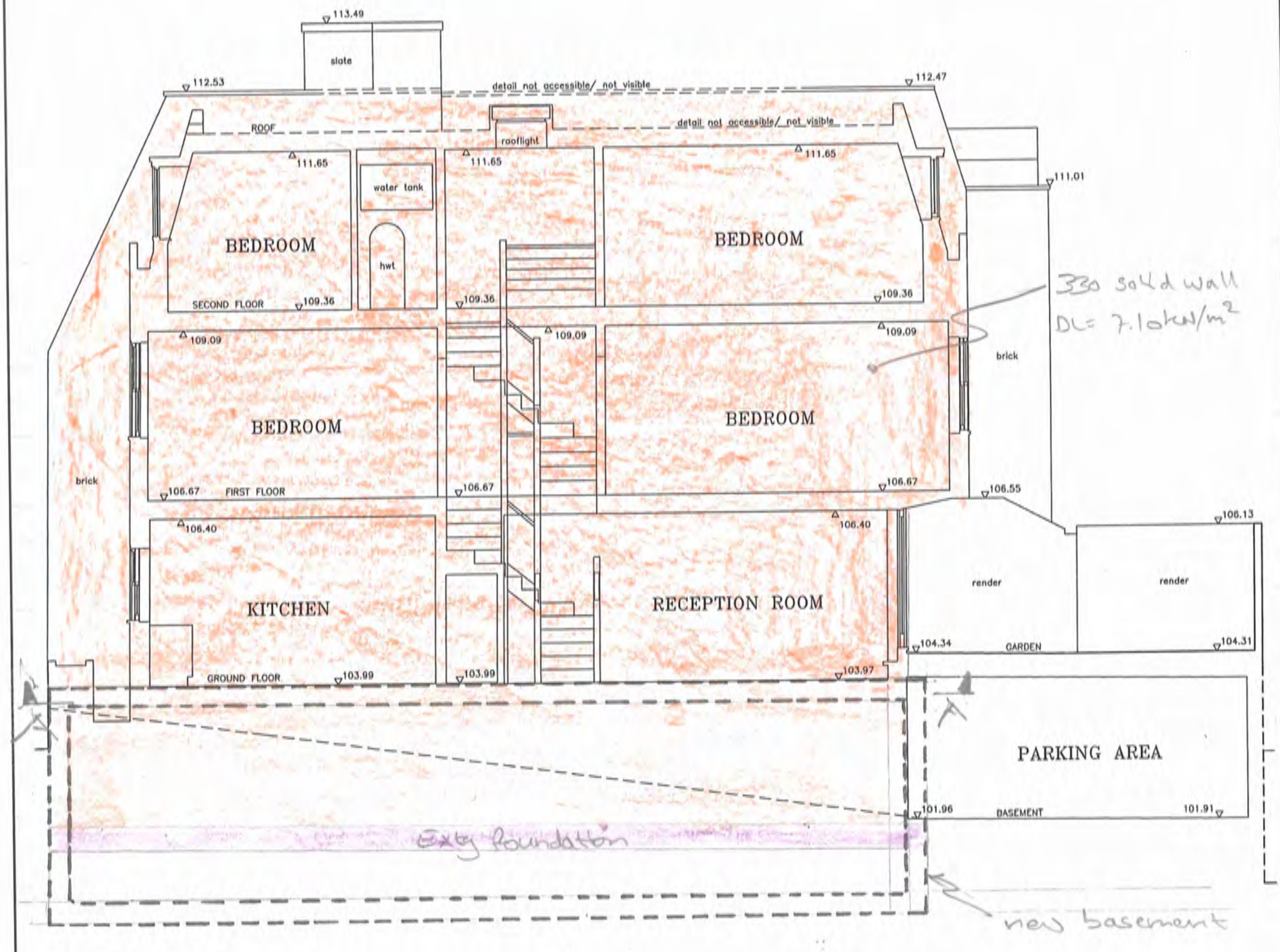


TRIGRAM PARTNERSHIP LLP
CONSULTING STRUCTURAL ENGINEERS

Job No	Sheet No.	Rev
4266		

Made By	Dates	Chkd
[illegible]		

party wall 36/38:



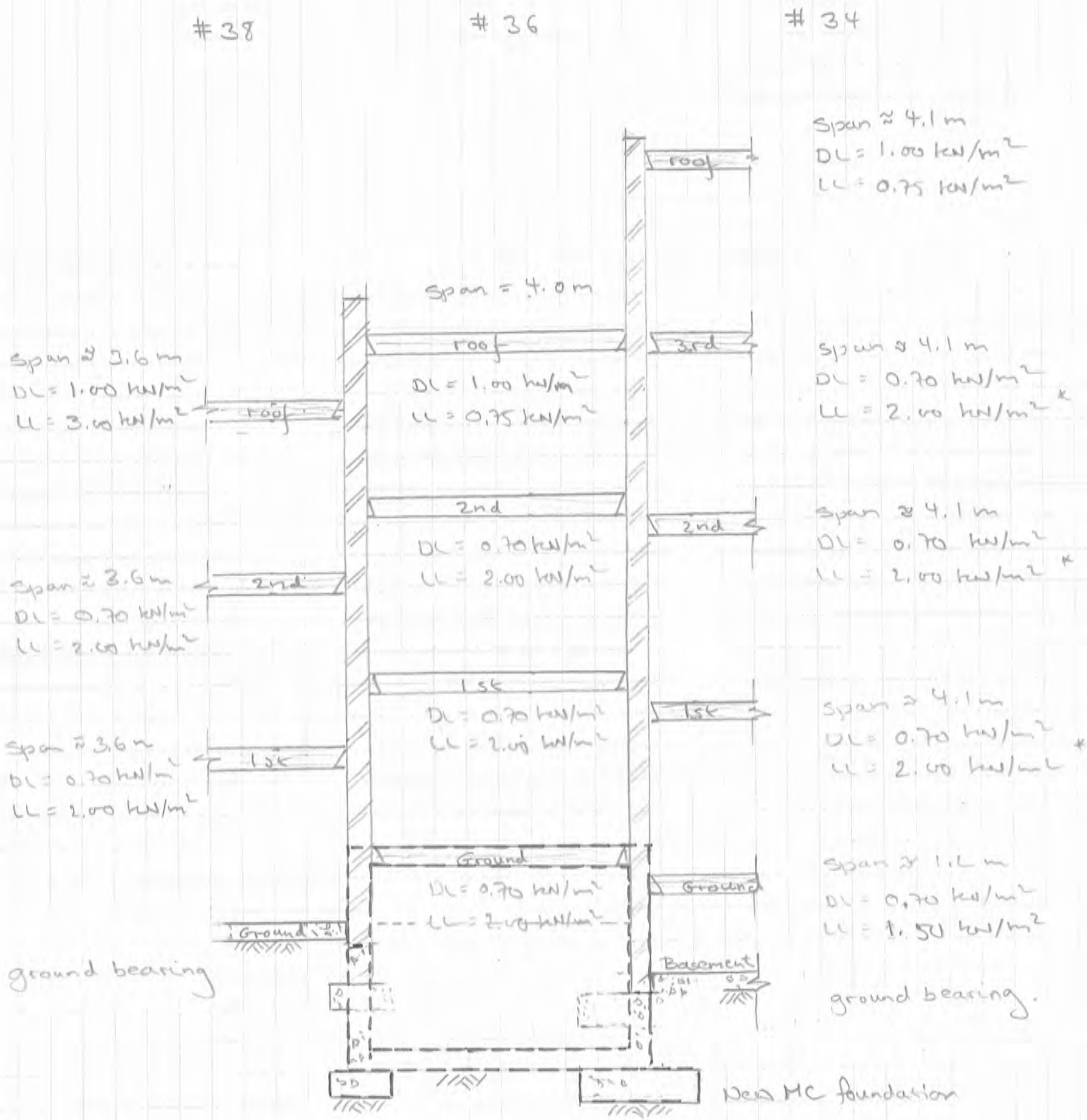
TP01

TRIGRAM
PARTNERSHIP LLP
CONSULTING STRUCTURAL ENGINEERS

Job No	Sheet No.	Rev
4266		
Made By	**Dates**	**Chkd**
JS		

36 Flask Walk

Indicative cross section:



* 0.50 kN/m² allowance for partitions

TP01

TRIGRAM PARTNERSHIP LLP
CONSULTING STRUCTURAL ENGINEERS

Job No	Sheet No.	Rev
4266		
Made By	**Dates**	**Chkd**
[initials]		

36 Flask Walk

party wall 34/36:

@ Section A-A.

P_{tot} = (12.9 · 10.9) · 7.10 = 998.3 , selfwt. party wall

+ 3 · 11.1 · ½ · 4.0 · (0.70 + 2.00) = 179.8 , #36 floors

+ 1 · 10.5 · ½ · 4.0 · (1.00 + 0.75) = 36.8 , #36 roof

+ 3 · 12.8 · ½ · 4.1 · (0.70 + 2.00) = 212.5 , #34 floors (1, 2 & 3)

+ 1 · 10.9 · ½ · 1.2 · (0.70 + 1.50) = 14.4 , #34 floor (Gr)

+ 1 · 12.0 · ½ · 4.1 · (1.00 + 0.75) = 43.1 , #34 roof

1484.9 kN

p_{avg} = 1484.9 / 11.5 = 129.1 kN/m

Party wall 36/38:

@ Section A-A

P_{tot} = (12.5 · 8.5) · 7.10 = 754.4 , selfwt. party wall

+ as above = 179.8 , #36 floors

+ as above = 36.8 , #36 roof

+ 2 · 12.5 · ½ · 3.6 · (0.70 + 2.00) = 121.5 , #38 floors

+ 1 · 12.5 · ½ · 3.6 · (1.00 + 3.00) = 90.0 , #38 roof

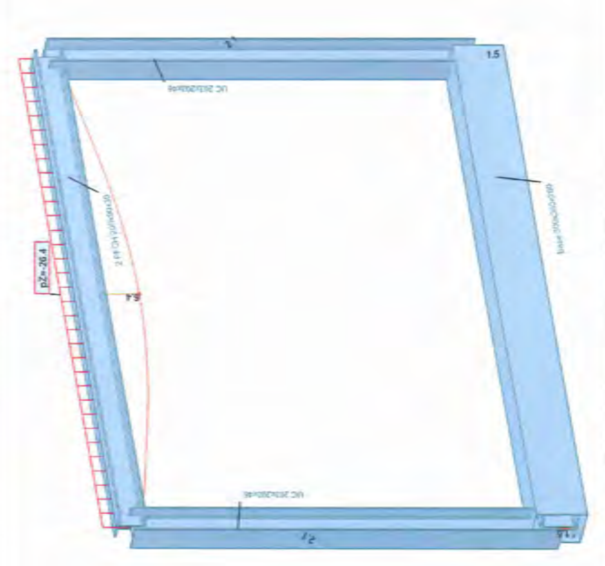
1182.5 kN

p_{avg} = 1182.5 / 12.4 = 95.4 kN/m

Autodesk Robot Structural Analysis Professional 2016
Author:
Address:
File: **Box frame.rtd**
Project: 36 Flask Walk

View - Exact deformation(s), Cases: 1 (Gravity) 2

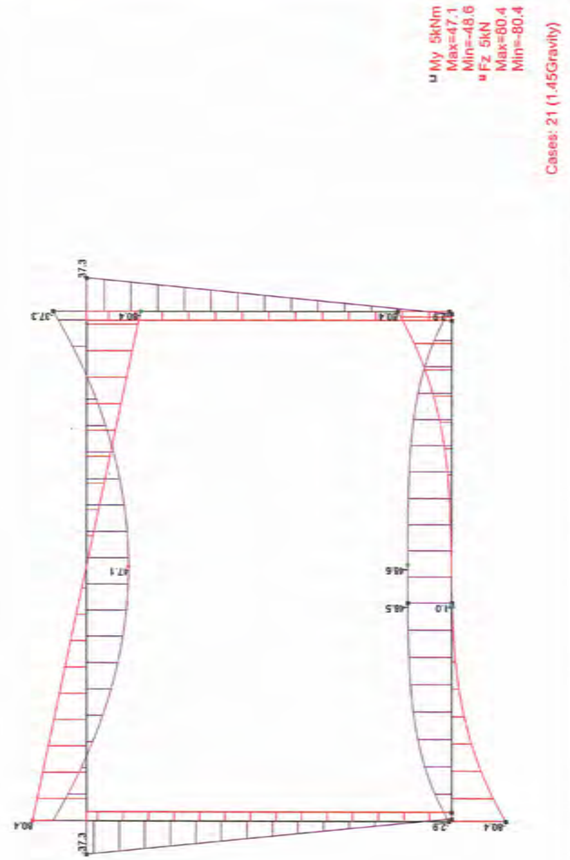
2. Box frame:



Date : 02/06/15
Page : 2

Autodesk Robot Structural Analysis Professional 2016
Author:
Address:
File: **Box frame.rtd**
Project: 36 Flask Walk

View - FZ,MY, Cases: 21 (1.45Gravity)



Date : 02/06/15
Page : 3

STEEL MEMBER DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

TEDDS calculation version 3.0.05

Section details

Section type — **UKPFC 200x90x30 (Corus Advance)**

Steel grade — **S275**

From table 9: Design strength p_y

Thickness of element — max(T, t) = **14.0** mm

Design strength — p_y = **275** N/mm²

Modulus of elasticity — E = **205000** N/mm²

Lateral restraint

Distance between major axis restraints — L_x = **4200** mm

Distance between minor axis restraints — L_y = **4200** mm

Effective length factors

Effective length factor in major axis — K_x = **1.00**

Effective length factor in minor axis — K_y = **1.00**

Effective length factor for lateral-torsional buckling — K_{LT} = **1.20**

Classification of cross sections - Section 3.5

ε = √[275 N/mm² / p_y] = **1.00**

Internal compression parts - Table 11

Depth of section — d = **148** mm

d / t = 21.1 × ε <= 80 × ε — Class 1 plastic

Outstand flanges - Table 11

Width of section — b = B = **90** mm

b / T = 6.4 × ε <= 9 × ε — Class 1 plastic

Section is class 1 plastic

Shear capacity - Section 4.2.3

Design shear force — F_{vy} = **40.2** kN

d / t < 70 × ε

Tedds Trigram Partnership Harling House 47-51 Great Suffolk Street London, SE1 0BS	Project: 36 Flask Walk				Job no: 4266	
	Calcs for: Box frame				Start page no./Revision: 2	
	Calcs by: JF	Calcs date: 02/06/2015	Checked by	Checked date	Approved by	Approved date

Web does not need to be checked for shear buckling

Shear area — $A_v = t \times D$ = **1400** mm²

Design shear resistance — $P_{vy} = 0.6 \times p_y \times A_v$ = **231** kN

PASS - Design shear resistance exceeds design shear force

Shear capacity - Section 4.2.3

Design shear force — F_{vx} = **0** kN

Moment capacity - Section 4.2.5

Design bending moment — M = **24** kNm

Moment capacity low shear - cl.4.2.5.2 — $M_c = \min(p_y \times S_{xx}, 1.2 \times p_y \times Z_{xx})$ = **80.1** kNm

Effective length for lateral-torsional buckling - Section 4.3.5

Effective length for lateral torsional buckling — $L_E = 1.2 \times L_y$ = **5040** mm

Slenderness ratio — $\lambda = L_E / r_{yy}$ = **175.051**

Equivalent slenderness - Section 4.3.6.7

Buckling parameter — u = **0.953**

Torsional index — x = **12.979**

Slenderness factor — $v = 1 / [1 + 0.05 \times (\lambda / x)^2]^{0.25}$ = **0.561**

Ratio - cl.4.3.6.9 — β_W = **1.000**

Equivalent slenderness - cl.4.3.6.7 — $\lambda_{LT} = u \times v \times \lambda \times \sqrt{[\beta_W]}$ = **93.578**

Limiting slenderness - Annex B.2.2 — $\lambda_{L0} = 0.4 \times (\pi^2 \times E / p_y)^{0.5}$ = **34.310**

$\lambda_{LT} > \lambda_{L0}$ - Allowance should be made for lateral-torsional buckling

Bending strength - Section 4.3.6.5

Robertson constant — α_{LT} = **7.0**

Perry factor — $\eta_{LT} = \max(\alpha_{LT} \times (\lambda_{LT} - \lambda_{L0}) / 1000, 0)$ = **0.415**

Euler stress — $p_E = \pi^2 \times E / \lambda_{LT}^2$ = **231.1** N/mm²

$\phi_{LT} = (p_y + (\eta_{LT} + 1) \times p_E) / 2$ = **301** N/mm²

Bending strength - Annex B.2.1 — $p_b = p_E \times p_y / (\phi_{LT} + (\phi_{LT}^2 - p_E \times p_y)^{0.5})$ = **136.5** N/mm²

Equivalent uniform moment factor - Section 4.3.6.6

Equivalent uniform moment factor for LTB — m_{LT} = **1.000**

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment — $M_b = p_b \times S_{xx}$ = **39.8** kNm

M_b / m_{LT} = **39.8** kNm

PASS - Buckling resistance moment exceeds design bending moment

STEEL MEMBER DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1

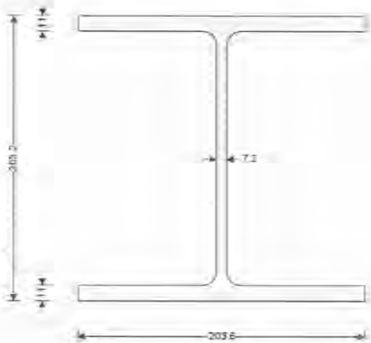
TEDDS calculation version 3.0.05

Section details

Section type	UC 203x203x46 (BS4-1)
Steel grade	S275

From table 9: Design strength p_y

Thickness of element	$max(T, t) = 11.0$ mm
Design strength	$p_y = 275$ N/mm²
Modulus of elasticity	$E = 205000$ N/mm²



Lateral restraint

Distance between major axis restraints	$L_x = 3000$ mm
Distance between minor axis restraints	$L_y = 600$ mm

Effective length factors

Effective length factor in major axis	$K_x = 1.00$
Effective length factor in minor axis	$K_y = 1.00$
Effective length factor for lateral-torsional buckling	$K_{LT} = 1.20$

Classification of cross sections - Section 3.5

$\varepsilon = \sqrt{[275 \text{ N/mm}^2 / p_y]} = 1.00$

Internal compression parts - Table 11

Depth of section	$d = 160.8$ mm
Stress ratios	$r1 = min(F_c / (d \times t \times p_{yw}), 1) = 0.253$
	$r2 = F_c / (A \times p_{yw}) = 0.05$
	$d / t = 22.3 \times \varepsilon <= max(80 \times \varepsilon / (1 + r1), 40 \times \varepsilon)$ Class 1 plastic

Outstand flanges - Table 11

Width of section	$b = B / 2 = 101.8$ mm
	$b / T = 9.3 \times \varepsilon <= 10 \times \varepsilon$ Class 2 compact

Section is class 2 compact

Shear capacity - Section 4.2.3

Design shear force	$F_{vx} = 13.4$ kN
	$d / t < 70 \times \varepsilon$

Web does not need to be checked for shear buckling

Shear area	$A_v = t \times D = 1463$ mm²
Design shear resistance	$P_{vx} = 0.6 \times p_y \times A_v = 241.4$ kN

PASS - Design shear resistance exceeds design shear force

Shear capacity - Section 4.2.3

Design shear force	$F_{vy} = 0$ kN

Moment capacity - Section 4.2.5

Design bending moment	$M = 37.3$ kNm
Moment capacity low shear - cl.4.2.5.2	$M_c = min(p_y \times S_{xx}, 1.2 \times p_y \times Z_{xx}) = 136.8$ kNm

Effective length for lateral-torsional buckling - Section 4.3.5

Effective length for lateral torsional buckling	$L_E = 1.2 \times L_y = 720$ mm
Slenderness ratio	$\lambda = L_E / r_{yy} = 14.023$

Equivalent slenderness - Section 4.3.6.7

Buckling parameter	$u = 0.847$
Torsional index	$x = 17.713$
Slenderness factor	$v = 1 / [1 + 0.05 \times (\lambda / x)^2]^{0.25} = 0.992$
Ratio - cl.4.3.6.9	$\beta_W = 1.000$
Equivalent slenderness - cl.4.3.6.7	$\lambda_{LT} = u \times v \times \lambda \times \sqrt{[\beta_W]} = 11.780$
Limiting slenderness - Annex B.2.2	$\lambda_{L0} = 0.4 \times (\pi^2 \times E / p_y)^{0.5} = 34.310$

$\lambda_{LT} < \lambda_{L0}$ - No allowance need be made for lateral-torsional buckling

Buckling resistance moment - Section 4.3.6.4

Bending strength	$p_b = p_y = 275$ N/mm²
Buckling resistance moment	$M_b = p_b \times S_{xx} = 136.8$ kNm

PASS - Moment capacity exceeds design bending moment

Compression members - Section 4.7

Design compression force	$F_c = 80.4$ kN

Effective length for major (x-x) axis buckling - Section 4.7.3

Effective length for buckling	$L_{Ex} = L_x \times K_x = 3000$ mm
Slenderness ratio - cl.4.7.2	$\lambda_x = L_{Ex} / r_{xx} = 34.017$

Compressive strength - Section 4.7.5

Limiting slenderness	$\lambda_0 = 0.2 \times (\pi^2 \times E / p_y)^{0.5} = 17.155$
Strut curve - Table 23	b
Robertson constant	$\alpha_x = 3.5$
Perry factor	$\eta_x = \alpha_x \times (\lambda_x - \lambda_0) / 1000 = 0.059$
Euler stress	$p_{Ex} = \pi^2 \times E / \lambda_x^2 = 1748.4$ N/mm²
	$\phi_x = (p_y + (\eta_x + 1) \times p_{Ex}) / 2 = 1063.3$ N/mm²
Compressive strength - Annex C.1	$p_{cx} = p_{Ex} \times p_y / (\phi_x + (\phi_x^2 - p_{Ex} \times p_y)^{0.5}) = 257.2$ N/mm²

Compression resistance - Section 4.7.4

Compression resistance - cl.4.7.4	$P_{cx} = A \times p_{cx} = 1510.6$ kN

PASS - Compression resistance exceeds design compression force

Effective length for minor (y-y) axis buckling - Section 4.7.3

Effective length for buckling $L_{Ey} = L_y \times K_y$ = **600** mm

Slenderness ratio - cl.4.7.2 $\lambda_y = L_{Ey} / r_{yy}$ = **11.686**

Compressive strength - Section 4.7.5

Limiting slenderness $\lambda_0 = 0.2 \times (\pi^2 \times E / p_y)^{0.5}$ = **17.155**

Strut curve - Table 23 c

Robertson constant α_y = **5.5**

Perry factor $\eta_y = \alpha_y \times (\lambda_y - \lambda_0) / 1000$ = **-0.030**

Euler stress $p_{Ey} = \pi^2 \times E / \lambda_y^2$ = **14815.2** N/mm²

$\phi_y = (p_y + (\eta_y + 1) \times p_{Ey}) / 2$ = **7322.3** N/mm²

Compressive strength - Annex C.1 $p_{cy} = p_{Ey} \times p_y / (\phi_y + (\phi_y^2 - p_{Ey} \times p_y)^{0.5})$ = **283.7** N/mm²

Compression resistance - Section 4.7.4

Compression resistance - cl.4.7.4 $P_{cy} = A \times p_{cy}$ = **1666.2** kN

PASS - Compression resistance exceeds design compression force

Compression members with moments - Section 4.8.3

Comb.compression & bending check - cl.4.8.3.2 $F_c / (A \times p_y) + M / M_c$ = **0.322**

PASS - Combined bending and compression check is satisfied

Member buckling resistance - Section 4.8.3.3

Max major axis moment governing M_b $M_{LT} = M_x$ = **37.30** kNm

Equivalent uniform moment factor for major axis flexural buckling

m_x = **1.000**

m_y = **1.000**

Buckling resistance checks - cl.4.8.3.3.2 $F_c / P_{cx} + m_x \times M / M_c \times (1 + 0.5 \times F_c / P_{cx})$ = **0.333**

$F_c / P_{cy} + m_{LT} \times M_{LT} / M_b$ = **0.321**

PASS - Member buckling resistance checks are satisfied

TRIGRAM PARTNERSHIP LLP
CONSULTING STRUCTURAL ENGINEERS

Job No	Sheet No.	Rev
4266		
Made By	**Dates**	**Chkd**
[initials]		

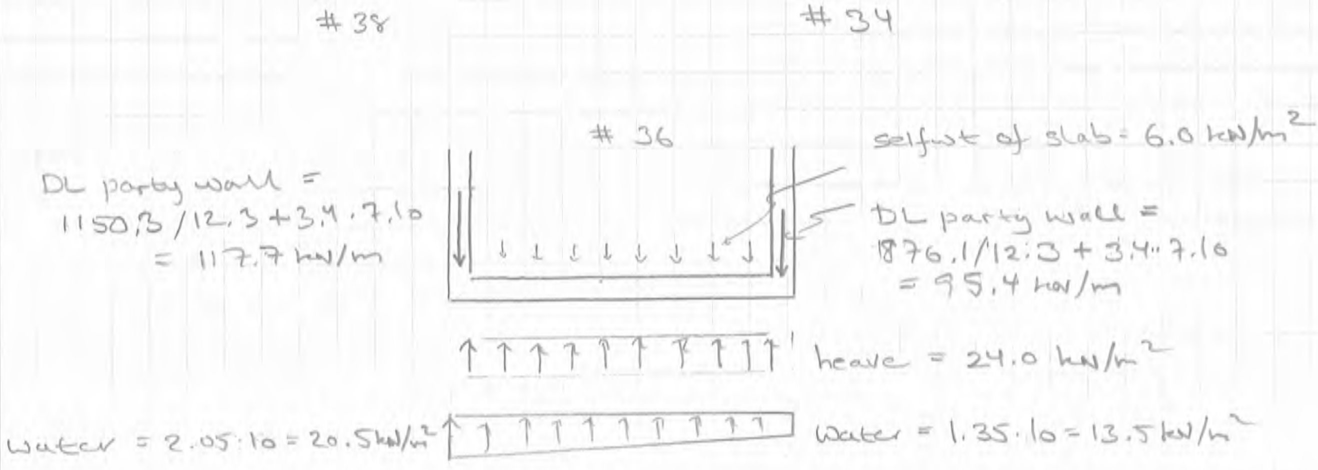
36 Flask Walk

8. Basement slab.

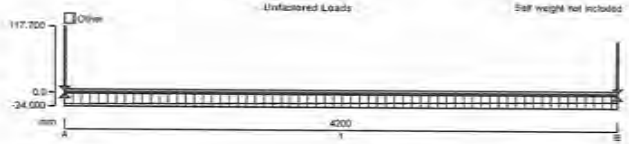
Flotation and residual heave calculations show that the uplift pressure applied to the underside of the basement slab is less than the downward forces.

The residual heave pressure is estimated to half the weight of the removed overburden, i.e. 0.5 · 2.4 · 20 = 24.0 kN/m²

The worst credible water level is at the garage floor level along the party wall 34/36 Flask Walk, and at the ground floor level of no. 38 Flask Walk for the opposite party wall.



Tedds Trigram Partnership Harling House 47-51 Great Suffolk Street London, SE1 0BS	Project 36 Flask Walk				Job no. 4266	
	Calcs for Basement slab				Start page no./Revision 1	
	Calcs by JF	Calcs date 02/06/2015	Checked by	Checked date	Approved by	Approved date



CONTINUOUS BEAM ANALYSIS - INPUT

BEAM DETAILS

Number of spans = **1**

Material Properties:

Modulus of elasticity = **25** kN/mm^2 Material density = **2400** kg/m^3

Support Conditions:

Support A   Vertically **"Restrained"**   Rotationally **"Free"**

Support B   Vertically **"Restrained"**   Rotationally **"Free"**

Span Definitions:

Span 1   Length = **4200** mm   Cross-sectional area = **250000** mm^2 Moment of inertia = **1.00×10^9** mm^4

LOADING DETAILS

Beam Loads:

Load 1   UDL Other load **6.0** kN/m

Load 2   Point Other load **117.7** kN at **0.000** m

Load 3   Point Other load **95.4** kN at **4.200** m

Load 4   UDL Other load **-24.0** kN/m

Load 5   VDL Other load **-20.5** kN/m to **-13.5** kN/m

Support A loads:

Load 2   Beam pointOther Load 117.7 kN

Support B loads:

Load 3   Beam pointOther Load 95.4 kN

LOAD COMBINATIONS

Load combination 1

Span 1   1×Other

Support A   1×Other

Support B   1×Other

CONTINUOUS BEAM ANALYSIS - RESULTS

RESULTS FOR COMBINATION 1

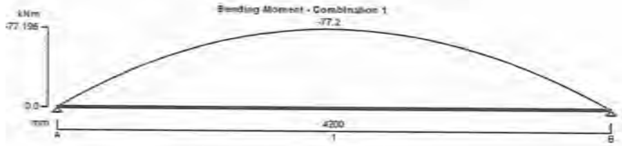
Support Reactions and Deflections - Combination 1 :

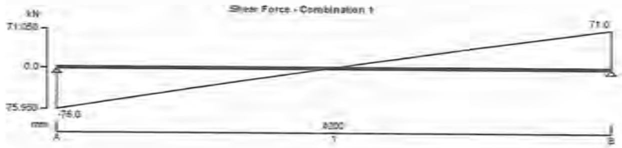
Support A   Reaction = **-41.7** kN   Moment = **0.0** kNm   Deflection = **0.0** mm   Rotation = **-249.27** deg

Support B   Reaction = **-24.3** kN   Moment = **0.0** kNm   Deflection = **0.0** mm   Rotation = **245.97** deg

?
net downward force
66.0 kN per m width of
basement slab.

Tedds Trigram Partnership Harling House 47-51 Great Suffolk Street London, SE1 0BS	Project 36 Flask Walk				Job no. 4266	
	Calcs for Basement slab				Start page no./Revision 2	
	Calcs by JF	Calcs date 02/06/2015	Checked by	Checked date	Approved by	Approved date





ELEMENT DESIGN to BS 8110:1997

SOLID SLABS

REINFORCED CONCRETE COUNCIL dti

INPUT Location Base slab

Design moment, M	93.0	kNm/m	fcu	35	N/mm²	γc = 1.50
ßb	1.00		fy	460	N/mm²	γs = 1.05
span	2600	mm				
Height, h	250	mm	Section location	SIMPLY SUPPORTED SP/		
Bar Ø	16	mm	Compression steel	NONE		
cover	30	mm to these bars		(deflection control only)		

OUTPUT Base slab Compression steel = NONE

d = 250 - 30 - 16/2 = 212.0 mm

(3.4.4.4) K' = 0.156 > K = 0.059 ok

(3.4.4.4) z = 212.0 [0.5 + (0.25 - 0.059 /0.893)]^½ = 197.0 > 0.95d = 201.4 mm

(3.4.4.1) As = 93.00E6 /460 /196.9 x 1.05 = 1078 > min As = 325 mm²/m

PROVIDE T16 @ 175 = 1149 mm²/m

(Eqn 8) fs = 2/3 x 460 x 1078 /1149 /1.00 = 287.8 N/mm²

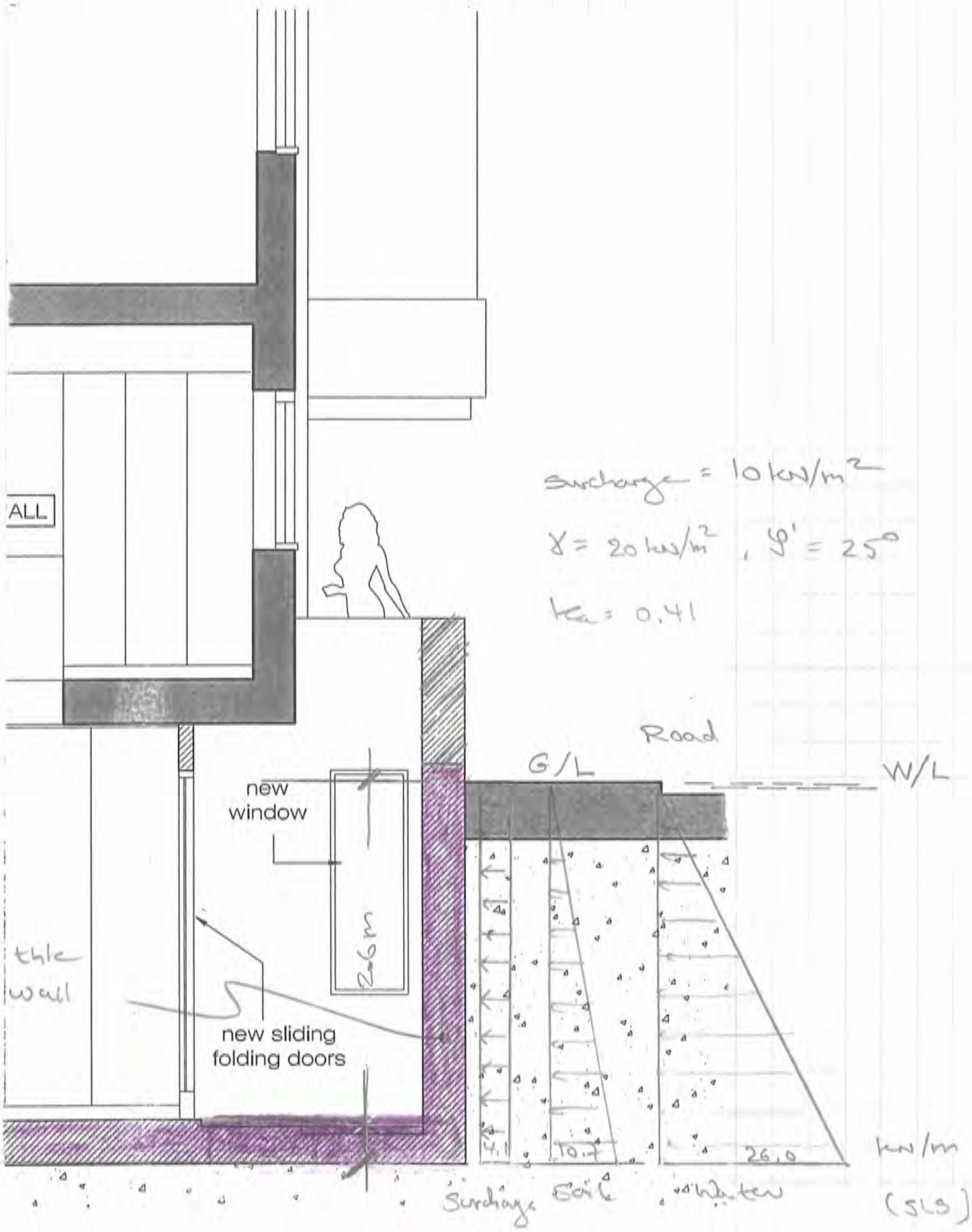
(Eqn 7) Tens mod factor = 0.55 + (477 - 287.8) /120 /(0.9 + 2.069) = 1.081

(3.4.6.3) Permissible L/d = 20.0 x 1.081 = 21.621

Actual L/d = 2600 /212.0 = 12.264 ok

4. Retaining RC wall

Worst case is wall at front to public footpath:



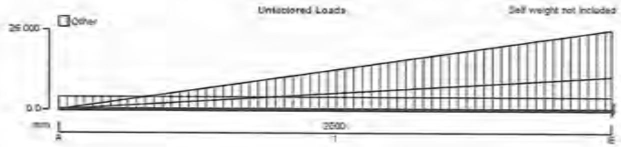
Lateral loading:

Surcharge : $p = 0.41 \cdot 10 = 4.1\ kN/m^2$

Soil (sat) : $p_{max} = 0.41 \cdot 2.6 \cdot (20-10) = 10.7\ kN/m^2$

Water $p_{max} = 2.6 \cdot 10 = 26.0\ kN/m^2$

Tedds Trigram Partnership Harling House 47-51 Great Suffolk Street London, SE1 0BS	Project 36 Flask Walk				Job no. 4266	
	Calcs for Retaining wall - Front				Start page no./Revision 1	
	Calcs by JF	Calcs date 02/06/2015	Checked by	Checked date	Approved by	Approved date



CONTINUOUS BEAM ANALYSIS - INPUT

BEAM DETAILS

Number of spans = **1**

Material Properties:

Modulus of elasticity = **25** kN/mm^2 Material density = **2400** kg/m^3

Support Conditions:

Support A Vertically **"Free"** Rotationally **"Free"**

Support B Vertically **"Restrained"** Rotationally **"Restrained"**

Span Definitions:

Span 1 Length = **2600** mm Cross-sectional area = **250000** mm^2 Moment of inertia = **1.00×10^6** mm^4

LOADING DETAILS

Beam Loads:

Load 1 UDL Other load **4.1** kN/m

Load 2 VDL Other load **0.0** kN/m to **10.7** kN/m

Load 3 VDL Other load **0.0** kN/m to **26.0** kN/m

LOAD COMBINATIONS

Load combination 1

Span 1 1×Other

Load combination 2

Span 1 1.2×Other

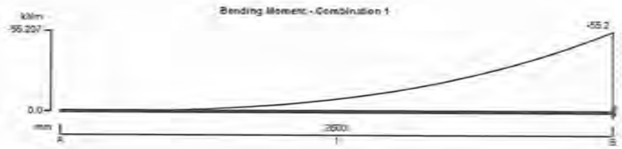
CONTINUOUS BEAM ANALYSIS - RESULTS

RESULTS FOR COMBINATION 1

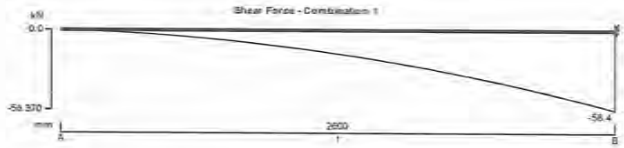
Support Reactions and Deflections - Combination 1 :

Support A Reaction = **0.0** kN Moment = **0.0** kNm Deflection = **3172.9** mm Rotation = **-89.12** deg

Support B Reaction = **-58.4** kN Moment = **55.2** kNm Deflection = **0.0** mm Rotation = **0.00** deg



Tedds Trigram Partnership Harling House 47-51 Great Suffolk Street London, SE1 0BS	Project 36 Flask Walk				Job no. 4266	
	Calcs for Retaining wall - Front				Start page no./Revision 2	
	Calcs by JF	Calcs date 02/06/2015	Checked by	Checked date	Approved by	Approved date

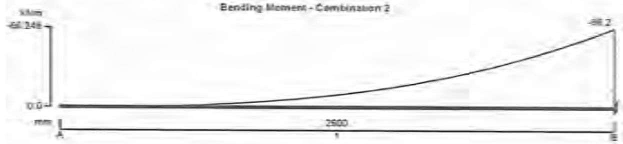


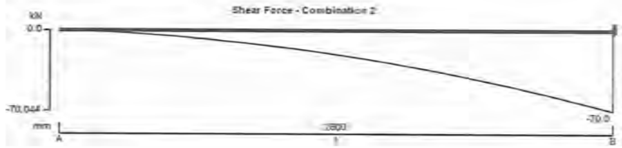
RESULTS FOR COMBINATION 2

Support Reactions and Deflections - Combination 2 :

Support A Reaction = **0.0** kN Moment = **0.0** kNm Deflection = **3807.5** mm Rotation = **-106.95** deg

Support B Reaction = **-70.0** kN Moment = **66.2** kNm Deflection = **0.0** mm Rotation = **0.00** deg





ELEMENT DESIGN to BS 8110:1997

SOLID SLABS

INPUT Location Retaining wall - Front

Design moment, M	66.2	kNm/m	fcu 35	N/mm²	γc = 1.50
ßb	1.00		fy 460	N/mm²	γs = 1.05
span	2600	mm			
Height, h	300	mm	Section location	CANTILEVER	
Bar Ø	16	mm	Compression steel	NONE	
cover	50	mm to these bars		*(deflection control only)*	

OUTPUT Retaining wall - Front Compression steel = NONE

d = 300 - 50 - 16/2 = 242.0 mm

(3.4.4.4) K' = 0.156 > K = 0.032 ok

(3.4.4.4) z = 242.0 [0.5 + (0.25 - 0.032 /0.893)]^½ = 233.0 > 0.95d = 229.9 mm

(3.4.4.1) As = 66.20E6 /460 /229.9 x 1.05 = 657 > min As = 390 mm²/m

PROVIDE T16 @ 225 = 894 mm²/m *As increased by 29.4% for deflection*

(Eqn 8) fs = 2/3 x 460 x 657 /894 /1.00 = 225.6 N/mm²

(Eqn 7) Tens mod factor = 0.55 + (477 - 225.6) /120 /(0.9 + 1.130) = 1.582

(3.4.6.3) Permissible L/d = 7.0 x 1.582 = 11.074

Actual L/d = 2600 /242.0 = 10.744 ok

ELEMENT DESIGN to BS 8110:1997

SLAB SHEAR

INPUT Location Retaining wall - Front

fcu = 35 N/mm² γc = 1.50

fyl = 460 N/mm² γs = 1.05

d	b
242	1000

Main Steel		Link	Legs	Side cover	Shear V	UDL
4.44	16	6	0	50	70.0	0.0
No	mm Ø	mm Ø	No	mm	kN	kN/m

OUTPUT Retaining wall - Front

As = 893 N/mm² = 0.369%

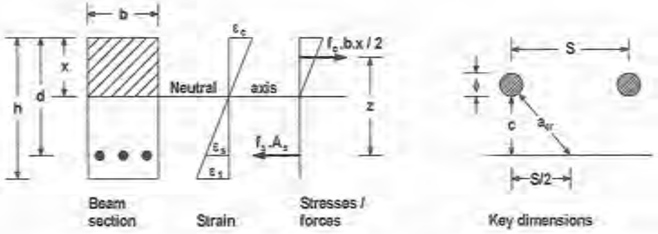
(Eqn 3) v = 70.0 x 10³ /1,000 /242 = 0.289 N/mm²

(Table 3.8) vc = 0.575 N/mm², from table 3.8

No links needed

#DIV/0!

Tedds Trigram Partnership Harling House 47-51 Great Suffolk Street London, SE1 0BS	Project 36 Flask Walk				Job no. 4266	
	Calcs for Retaining wall - Front				Start page no./Revision 1	
	Calcs by JF	Calcs date 02/06/2015	Checked by	Checked date	Approved by	Approved date



CRACK WIDTH CALCULATION TO BS8110:PART 2:1985

TEDDS calculation version 1.0.02

Beam details

Section width	b = **1000** mm
Section depth	h = **300** mm
Applied servicability limit state moment	M_s = **55.2** kNm

Material details

Characteristic strength of concrete	f_{cu} = **35** N/mm^2
Characteristic strength of reinforcement	f_y = **500** N/mm^2
Modulus of elasticity of the concrete	$E_c = (20kN/mm^2 + 200 \times f_{cu}) / 2$ = **13.5** kN/mm^2
Modulus of elasticity of reinforcement	E_s = 200 kN/mm^2

Reinforcement details

Area of tension reinforcement provided	A_s = **1340** mm^2
Diameter of tension reinforcement bars	ϕ = **16** mm
Maximum spacing of tension reinforcement bars	S = **150.0** mm → spacing reduced to achieve watertight concrete (BS 8007)
Minimum cover to tension reinforcement bars	c_{min} = **50** mm

Calculate design surface crack width

Effective depth of tension reinforcement	$d = h - c_{min} - \phi / 2$ = **242.0** mm
Modular ratio	$m = E_s / E_c$ = **14.815**
	$n = A_s / (b \times d)$ = **0.006**
Depth to neutral axis	$x = (- m \times n + \sqrt{((m \times n)^2 + 2 \times m \times n)}) \times d$ = **80.2** mm
Lever arm	$z = d - x / 3$ = **215.3** mm
Reinforcement stress	$f_s = M_s / (A_s \times z)$ = **191.351** N/mm^2
Concrete stress	$f_c = f_s \times A_s / (0.5 \times b \times x)$ = **6.397** N/mm^2
Strain at soffit of beam	$\varepsilon_1 = (f_s / E_s) \times (h - x) / (d - x)$ = **0.001300**
Strain due to stiffening of concrete between cracks	$\varepsilon_2 = 1N/mm^2 \times b \times (h - x)^2 / [3 \times E_s \times A_s \times (d - x)]$ = **0.000371**
Average strain at soffit of beam	$\varepsilon_m = \varepsilon_1 - \varepsilon_2$ = **0.000928**
Distance of crack to surface of nearest tension bar	$a_{cr} = \sqrt{((S / 2)^2 + (h - d)^2)} - \phi / 2$ = **86.8** mm
Design surface crack width	$w = 3 \times a_{cr} \times \varepsilon_m / (1 + 2 \times (a_{cr} - c_{min}) / (h - x))$ = **0.181** mm