Structural Methodology Statement

for

28 Charlotte Street

Fitzrovia

London W1T

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June 2023

Structural Methodology Statement

for

28 Charlotte Street
London W1T 2NF

for

Mr Matteo Caraccia

Job No 1964

Rev	Date	Notes
-	Oct 2022	First Issue
A	June 2023	Updated Trigger Levels for Vertical & Horizontal Movement

CONTENTS

1. INTRODUCTION

This Structural Methodology Statement is produced for submission to London Borough of Camden as part of a planning application for works to 28 Charlotte Street, W1T 4NF and should not be used for any other purposes, e.g. construction or Party Wall Awards.

2. SCOPE OF WORKS

A new single storey basement is proposed under the rear of the existing property. The current study room will be connected to a new lower ground space dedicated to video editing and contained within reinforced concrete walls and slab.

3. DESCRIPTION OF 28 CHARLOTTE STREET AND ADJOINING PROPERTIES

The front part of the building is a six storey mid-terraced Victorian property of masonry construction with timber floors to ground floor and upper levels and timber rafters to form the roof.

The rear walls to adjoining properties are of brick construction and they appear to be much deeper than the existing ground floor level (refer to proposed section in Appendix A).

The property is in a sound condition structurally. The adjoining properties are of similar construction and look to be in sound condition from an external non – intrusive visual examination.

4. GEOLOGY AND HIDROLOGY CONDITIONS

The existing site geology from British Geological Survey information is of Lynch Hill gravel formation, which has been partly confirmed by site investigation dated 11/01/2016.

A borehole made in the study (refer to Appendix D) has revealed the following sequence and final depth of strata.

Made Ground: 0m to 5.3m
Silty gravelly Sand: 5.3m to 7.7m
Clay with partings of silt and sand: 7.7m to 10.00m

From the same borehole the groundwater was recorded at ~5.3m bgl circa with ground becoming moist from 1.8m bgl circa.

Trial pits has been also undertaken during the site investigation and they all show made ground down to 4m from ground level and within the area composing the rear study (refer to Appendix D).

As well as the existing party walls, the proposed basement slab will be formed within a stratum of made ground and therefore it is proposed to avoid additional loads into the existing party walls creating a new concrete box detached from them and sitting on piles. The piles will then reach a suitable bearing level.

The building's design shall also resist floatation with a safety factor of not less than 1.1 as specified in BS8007:1987 cl. 2.2.3.2 and, Despite the depth of the recorded water table, it is assumed that ground water can reach 1.4m above basement formation level.

5. STRUCTURAL CALCULATIONS

See calculation sheets 1964/C1 – C8 showing the assumed loadings, loads on elements and design of structure composing the basement box. These calculations can be found in the Appendix C.

6. STRUCTURAL DRAWINGS

See drawings in Appendix A showing the proposed ground and basement floor layout, and sections through party walls. No structures will be connected to the existing party walls in a way to change their dimension or loads.

7. CONSTRUCTION METHOD STATEMENT

The temporary works will be the design responsibility of the contractor and once appointed, he will produce a complete method statement and temporary works design. This is to be submitted to the Structural Engineer for approval prior to commencement.

We anticipate that there will be a pre-commencement condition requiring compliance with the Code of Construction Practice that requires the appointed contractor to prepare a Construction Management Plan/ method statement and submit to the Council's environmental services team (separate to planning) for approval. They would then sign off the final Appendix A form and that signed form would be used to discharge the pre-commencement planning condition.

The construction method statement has been developed to ensure that the proposed works are constructed safely and with no impact on the structural stability of the existing and adjacent properties.

The proposed permanent and temporary works will not apply any significant additional loads onto the surrounding structures or utilities. Measures will be taken to ensure that the changes in stress and resultant movement in the soil surrounding the basement are minimised during the works and on completion.

There will be no adverse effect on the surrounding soil. This is ensured by the design of the earth retaining structures.

The existing geology, as described in the ground investigation, is capable of supporting the permanent and temporary works.

There are no unusual geological, hydrological or structural concerns which need to be addressed.

The following outlines the assumed method of construction to ensure stability of the existing structures in the temporary and permanent case.

SITE SET UP

Set up site with all contractor welfare and accommodation within the existing building.

Protect the site with hoarding, security measures, etc.

Terminate and protect all existing services.

Set up movement monitoring points on property and on neighboring properties and carry out baseline survey. Monitor regularly against this baseline survey and report results to engineer.

In order to minimize the environmental impact of construction the following are to be observed:

a. The contractor must be a member of the Considerate Contractor's Scheme.

b. Groundwork subcontractors must be registered with ASUC.

c. The provisions of the Control of Pollution Act (1974) and the Environmental Protection Act (1990) are to be observed.

d. Neighbours are to be notified of the work via individual letters, outlining the anticipated programme and contact details for the site.

e. The contractor must ensure the health and safety of all its operatives and members of the public in accordance with best practice and the Health and Safety at Work Act 1974.

f. Wastewater from construction activities must be dealt with as per BS6031:1981 Code of practice for earthworks.

g. Dust generating activities are to be enclosed to prevent dust escaping and dust is to be suppressed by means of spraying. Waste leaving site is to be enclosed with fly sheeting or sealed skips. Waste is to be handed down rather than dropped down to reduced dust generation.

h. All applicable plant is to be fitted with dust collection vacuum boxes.

i. All surface runoff to be contained on site.

j. Working hours are to be limited as per the planning conditions.

k. The contractor must control noise and vibration as per British Standard 5228-1 2:2009: 'Code of practice for noise and vibration control on construction and open sites - Part 1 (Noise) and Part 2 (Vibration).'

l. Modern, well maintained and silenced plant is to be used.

m. Delivery vehicles must switch off engines when parked up.

n. Site radios are not to be audible from the street.

o. Reduce use of percussive and vibrating machinery to a minimum.

CONSTRUCTION SEQUENCE AND TEMPORARY SUPPORT

See Appendix B for the proposed construction sequence drawings and description.

8. POTENTIAL IMPACT ON 28 CHARLOTTE STREET AND ADJOINING PROPERTIES

The proposed basement under the existing property will not be formed below existing walls but within them keeping the walls propped at all time to reduce the amount of potential movement to the adjacent structures.

Expected settlement is zero provided an experienced contractor is appointed who undertakes the works using good practice in accordance with the structural design and follows all agreed method statements, installing all necessary temporary vertical and lateral supports required. In practice some settlement is possible, but this should be no worse than 'aesthetic', according to the BRE's definition. If these conditions are met, any settlement that occurs is likely to be minimal and is likely to be accommodated in the elasticity of the superstructure. This has been borne out in the vast majority of past projects on similar properties.

The design and construction methodology, as described above, deals with the potential risks and ensures that the excavation and construction of the proposed basement will not affect the structural integrity of the property and adjoining properties.

9. SLOPE STABILITY

The site is located on ground that is relatively flat and so slope instability can only be initiated in the temporary condition as the proposed basement is being built, however this is highly unlikely due to the construction sequence and implementation of temporary works and is covered by the statement above on the impact on adjoining properties.

10. POTENTIAL IMPACT ON EXISTING AND SURROUNDING UTILITIES, INFRASTRUCTURE AND MAN – MADE CAVITIES

Any local services on the property's land will be maintained during construction and re – routed if necessary. The exact location of these services will not be known until the works commence. However, the impact will be negligible as these services will be maintained. If it is necessary to relocate or divert any utilities, the Contractor and Design Team will be under a statutory obligation to notify the utility owner prior to any works. This will be so that they can assess the impact of the works and grant or refuse their approval. There are no known man – made cavities (e.g. tunnels) in the vicinity of the proposed basement.

11. POTENTIAL IMPACT ON DRAINAGE, SEWAGE, SURFACE AND GROUND WATER LEVELS AND FLOWS INCLUDING SUDS

All existing drainage and sewage connections will be maintained throughout the construction works so there will be no impact on these existing systems.

The proposed refurbishment will not alter the current state of the property, which will remain as a mixed-use retail and residential building. Therefore, there will be no significant change in discharge to the existing drainage and sewage systems.

Surface water will not be altered as the proposed works are underground and there will be no change to the external 'hard surfaces'.

The site–specific borehole confirms that the new formation is above the ground water level, thus there will be no impact on ground water flows and levels.

12. POTENTIAL IMPACT ON EXISTING AND PROPOSED TREES

The property does not have a garden, therefore no existing trees will be felled during the construction of the proposed basement. In addition, there are no trees protected by Tree Preservation Orders in the vicinity of the proposed basement that will be damaged by the construction works.

13. NOISE, VIBRATION AND DUST CONTROL

Any basement works should be completed in such a way as to ensure that suitable measures to control the emission of dust and dirt during construction and ensure works will not generate noise audible at the site boundaries outside of permitted working hours are in place.

The current proposal is to create a new basement floor below the existing ground floor at the rear of the property, but outside the footprint area of the main building.

The proposal also includes the general refurbishment of the property with very minor.

The construction works involve the demolition of the existing concrete floor slab in the ground floor study room, as well as the excavation and creation of a new reinforced concrete box in the rear of the property at basement level. A detailed sequence of the works has been given in Appendix B. Those most likely to be affected by noise, dust and vibration will be the immediate neighbors at No 26 and No30 Charlotte Street, as well as No's 7-15 Whitfield Street.

The properties opposite side of the street are slightly more remote from the proposed development and are therefore less likely to be affected, however need to be considered. There might be some impact on other residents within Charlotte Street Road due to the related construction traffic..

Below we have described the mitigation measures that are proposed to keep noise, dust and vibration to acceptable levels.

Mitigation Measures for Demolition of Existing Slab

The breaking out of existing structures shall be carried out by diamond saw cutting and hydraulic bursting where possible to minimize noise and vibration to the adjacent properties. All demolition and excavation works will be undertaken in a carefully controlled sequence, taking into account the requirement to minimize vibration and noise. The contractor will need to utilize non-percussive breaking techniques where practicable.

As the property is terraced, careful consideration needs to be given to minimize noise and vibration transfer to the adjoining properties. The contractor should ensure that where any slab is adjacent to the boundary the concrete slab should be diamond saw cut first along the boundary to isolate the slab from any adjoining structures.

Dust suppression equipment should be used during the demolition process to ensure that any airborne dust is kept to a minimum. Where practical, concrete should also be wetted down prior to and during breakout to further inhibit airborne dust.

Mitigation Measures to Bulk Excavation

Due to size of the basement and restriction to access the rear of the property, it is likely that excavations will be undertaken with hand tools. However, if mechanical plant will be required to complete the bulk excavation, the contractor should ensure that any mechanical plant is switched off when not in use and is subject to regular maintenance checks and servicing. An electrically powered conveyor will be used as detailed above.

Mitigation Measures for the Construction of the Concrete Basement Shell

The contractor should ensure that any concrete pours are completed within the permitted hours for noise generating works. The contractor should allow for a contingency period to ensure that concrete pours can be completed within these hours regardless of unforeseen circumstances such as batching plant delays and traffic congestion.

The fabrication and cutting of steelwork for the reinforced concrete underpins and slabs shall take place off site. If any rebar needs to be trimmed on site this should be completed using hydraulic or pneumatic tools of angle grinders.

Dust Control

In order to reduce the amount of dust generated from the site, the contractor should ensure that any cutting, grinding and sawing should be completed off site where practicable. If cutting, grinding and sawing is being carried out on site, surfaces are to be wetted down prior to and during these types of work whenever possible. Any equipment used on site should be fitted with dust suppression or dust collection facilities.

The contractor will be responsible for ensuring good practice with regards to dust and should adopt regular sweeping, cleaning and washing down of the hoardings and scaffolding to ensure that the site is kept within good order. The Contractor selected will be member of the Considerate Contractors Scheme. Contact details of the contractor who will be responsible for containing dust and emissions within the site will be displayed on the site boundary so that the local residents can contact the contractor to raise any concerns regarding noise and dust.

The construction site will be enclosed within suitable scaffold sheeting and any stockpiles of sand or dust-generating materials will be covered. Cement, fine aggregates, sand and other fine powders should be sealed after use.

14. MONITORING AND LIMITS ON GROUND MOVEMENTS DURING EXCAVATION AND CONSTRUCTION

The contractor shall provide monitoring to the rear lightwell wall, rear and party walls of No28 Charlotte Street throughout their height during the basement construction.

Monitoring shall be completed as follows:

1. Two separate sets of readings one month prior to any works being started to provide a base reading.
2. Fortnight readings during he structurally critically phases, such as excavation and basement construction.
3. On a month basis thereafter for a 6 month period following completion of the notifiable works.
   Note: contingency should be set aside to allow for additional visits at increased frequencies, should trigger values be exceeded.

Cumulative movement of survey points must not exceed:

a. Vertical settlement
   Code amber trigger values: +/-3mm
   Code red trigger values: +/-5mm
b. Lateral displacement
   Code amber trigger values: +/-1.5mm
   Code red trigger values: +/-8mm

Movement approaching critical values:

Code amber trigger value:

All interested parties, including the Adjoining Owner's Surveyor and his Engineer should be informed and further actions immediately agreed between two of the three Surveyors and implements by the Building Owner. Notwithstanding the Party Wall requirements, the Contractor is to appoint, and to have permanently on site, a suitably qualified Structural Engineer who will be responsible for the reviewing of the movement monitoring results at the start and end of each day and provide immediate advice, remedial works and design as necessary in the event of movement being noted.

The Contractor is to ensure that he has 24 hour/7 days a week access to emergency support provision including but not limited to additional temporary props, needles, waling beams and concrete supply at the start of the excavation and prior to any likelihood of this trigger value being reached. If this value is reached the Contractor, and his Engineers, must without delay provide all interested parties with his plan to implement any emergency remedial and supporting works deemed necessary.

The Contractor must be ready to carry out these works without delay if the movement continues and approaches the trigger value above.

Code red trigger value:

All interested parties including Adjoining Owner’s Surveyor and Engineer will be informed immediately. Works will stop and be made safe using methods and equipment agreed at the above stage. The Contractor is to ensure that the movement has stopped as a result of the implemented remedial works designed and installed at this stage. The requirements of the Party Wall Act will also ensure that wo of the three Surveyors and their advising Engineers shall them enter into an addendum Award, setting out whether or not the Building Owner’s works can re-commence and when, and if so agree conditions.

Appendix A – Proposed Structural Scheme

For

28, Charlotte Street

Fitzrovia

London W1T

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October 2022

rodriguesassociates

DRAWING REGISTER + RECORD

1 Amwell Street , London, EC1R 1UL

JOB NO	**1964**	JOB NAME	**28 Charlotte Street**				
REF		ISSUE CODE			ISSUE DATES		
SHEET		FOR INFORMATION ONLY	I	CODE	I	I	I
TYPE	**Structural**	TENDER DOCUMENT	T	DAY	06	25	26
		CONSTRUCTION ISSUE	C	MONTH	03	3	10
		RECORD COPY	R	YEAR	20	20	22
		CONTRACT ISSUE	Co				

DRAWING NO (SERIES)		TITLE	SCALE	SIZE			
GENERAL	01	GENERAL NOTES	NTS	A1			/
PLANS	02	EX-BASEMENT FLOOR	1:25	A1			/
	03	EX-GROUND FLOOR SHT 1	1:25	A1			/
	04	EX-GROUND FLOOR SHT 2	1:25	A1			/
	12	PR-BASEMENT FLOOR SHT 1	1:25	A1	/		A
	13	PR-BASEMENT FLOOR SHT 2	1:25	A1	/		/
	14	PR-GROUND FLOOR SHT 1	1:25	A1	/		A
	15	PR-GROUND FLOOR SHT 1	1:25	A1	/		/
SECTIONS	50	PR-SECTION M-M	1:20	A1	/		A
	51	PR-SECTION N-N	1:20	A1	/		A
	52	PR-SECTION O-O	1:20	A1			/
OTHER	SCS-01	PR CONSTR. SEQUENCE - SHEET 1	1:100	A1		/	A
	SCS-02	PR CONSTR. SEQUENCE - SHEET 2	1:101	A1		/	A
	SCS-03	PR CONSTR. SEQUENCE - SHEET 3	1:102	A1		/	A

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For and on behalf of
RODRIGUES ASSOCIATES

GENERAL NOTES

1. ALL DRAWINGS TO BE READ IN CONJUNCTION WITH ALL RELEVANT SPECIFICATIONS, ARCHITECT'S DRAWINGS AND SERVICES ENGINEER'S DRAWINGS.

2. FOR SETTING OUT REFER TO ARCHITECT'S DRAWINGS.

3. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.

4. DO NOT SCALE FROM THE DRAWINGS OR THE COMPUTER DIGITAL DATA. ONLY FIGURED DIMENSIONS TO BE USED.

5. STRUCTURAL LEVELS ARE IN METRES AND RELATED TO ORDNANCE DATUM (OD). THEY ARE SHOWN THUS:

2.500m ON PLANS.

2.500m ON SECTIONS.

STRUCTURAL SLAB LEVEL (SSL) IS THE TOP SURFACE LEVEL OF THE CONCRETE SLAB IMMEDIATELY ADJACENT TO A COLUMN POSITION.

6. FOR ALL WATERPROOFING DETAILS SEE ARCHITECT'S DRAWINGS.

7. HOLES OF MAXIMUM DIMENSION LESS THAN 150mm ARE NOT SHOWN ON THE STRUCTURAL DRAWINGS. FOR DETAILS OF SUCH HOLES REFER TO RELEVANT ARCHITECT'S DRAWINGS AND SERVICES BUILDERS-WORK DRAWINGS.

8. THE WORKS CONTRACTOR IS TO PROVIDE ANY TEMPORARY BRACING NECESSARY TO MAINTAIN STRUCTURAL STABILITY DURING CONSTRUCTION.

9. THE WORKS HAVE BEEN DESIGNED AND SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE FOLLOWING EUROCODES AND THEIR CORRESPONDING NATIONAL ANNEXES. THIS LIST IS NOT EXHAUSTIVE AND IS ONLY INTENDED TO LIST THE PRINCIPAL CODES USED:

BS EN 1990:2002 BASIS OF STRUCTURAL DESIGN

BS EN 1991-1-1:2002 ACTIONS ON STRUCTURES. GENERAL ACTIONS. DENSITIES, SELF-WEIGHT, IMPOSED LOADS FOR BUILDINGS
BS EN 1991-1-2:2002 ACTIONS ON STRUCTURES. GENERAL ACTIONS. ACTIONS ON STRUCTURES EXPOSED TO FIRE
BS EN 1991-1-3:2003 ACTIONS ON STRUCTURES. GENERAL ACTIONS. SNOW LOADS
BS EN 1991-1-4:2005 ACTIONS ON STRUCTURES. GENERAL ACTIONS. WIND ACTIONS

10. THE WORKS HAVE BEEN DESIGNED FOR THE FINISH STATE. THE SUPERIMPOSED LOADS INDICATED IN THE CALCULATIONS HAVE BEEN USED IN THE DESIGN AND WILL BE MADE AVAILABLE ON REQUEST.

11. ALL WORKS SHALL COMPLY WITH BUILDING REGULATIONS AND OTHER RELEVANT STATUTORY NOTICES E.G. HEALTH AND SAFETY BYLAWS, COSHH ETC

TEMPORARY WORKS

1. THE TEMPORARY WORKS ARE THE RESPONSIBILITY OF THE CONTRACTOR AND TEMPORARY WORKS DESIGNER.

2. THE CONTRACTOR SHALL ENSURE THAT DURING PARTIAL REMOVAL OR DEMOLITION OF PARTS OF THE BUILDING, THE STABILITY OF THE REMAINING PARTS OF THE BUILDING ARE NOT COMPROMISED.

3. THE CONTRACTOR SHALL SUBMIT DESIGN RISK ASSESSMENTS FOR ALL TEMPORARY WORKS AND METHOD STATEMENTS IN ACCORDANCE WITH CDM (2015) PRIOR TO THE COMMENCEMENT OF THE WORKS.

4. ANY REPLACEMENT OF FLOORS OR ROOFS SHOULD BE DONE INCREMENTALLY SO AS TO NOT COMPROMISE THE STABILTY OF THE EXISTING STRUCTURE.

NOTES ON UNDERPINNING

1. THESE NOTES ARE TO BE READ IN CONJUNCTION WITH RELEVANT ARCHITECT'S DRAWINGS AND SPECIFICATIONS.

2. PINS TO BE MAXIMUM 1.0m AND LENGTH TO MATCH ADJACENT UNDERPINNING AND CAST IN SEQUENCE TO BE AGREED WITH THE ENGINEER PRIOR TO COMMENCEMENT OF THE WORKS.

3. SHEAR KEYS AND DOWEL BARS (MIN. 4No. 16ø x 800mm LONG BARS) TO BE INSERTED IN THE CONSTRUCTION JOINTS BETWEEN PINS.

4. MINIMUM 75mm DRY-PACK MORTAR, 1:3 EXPANDING CEMENT:SAND TO BE RAMMED INTO GAP BETWEEN EXISTING FOUNDATIONS AND NEW CONCRETE AFTER THE CONCRETE HAS GAINED FULL STRENGTH.

5. PINS TO BE EXCAVATED IN SEQUENCE SUCH THAT NO PINS ARE EXCAVATED WITHIN TWO METRES OF A JUST CAST PIN.

6. CONCRETE TO BE MIN. C32/40 GRADE

7. THE CONTRACTOR SHALL SUBMIT A METHOD STATEMENT WITH DIAGRAMS INDICATING THE CONSTRUCTION SEQUENCE AND TEMPORARY WORKS TO CONSTRUCT THE UNDERPINNING, WITH A PROGRAMME INDICATING WHEN THE PINS ARE TO BE CONSTRUCTED.

NOTES FOR CONCRETE

1. THESE NOTES ARE TO BE READ IN CONJUNCTION WITH RELEVANT ARCHITECT'S AND SERVICES ENGINEER'S DRAWINGS AND SPECIFICATIONS.

2. ALL CONCRETE SHALL COMPLY WITH BS 5328 "CONCRETE" AND BS 8110 "STRUCTURAL USE OF CONCRETE".

3. THE STRUCTURAL CONCRETE IS TO BE GRADE C30. MASS CONCRETE SHALL BE GRADE C20P. IF AN ALTERNATIVE SOURCE OR GRADE IS PROPOSED, THE MIX SHALL BE SUBJECT TO APPROVAL AS DESCRIBED IN BS 5328 AND BS 8110.

4. COVER TO REINFORCEMENT IS TO BE AS SHOWN ON THE DRAWINGS.

5. THE CONCRETE FINISHES ARE TO BE:

FINISH	LOCATION
3U	SURFACES OF ALL SLABS
A	ALL FORMED SURFACES

6. 50mm THICK BLINDING CONCRETE IS TO BE PLACED UNDER ALL REINFORCED CONCRETE IN CONTACT WITH THE GROUND. CONCRETE TO BE GRADE C20P.

7. REINFORCEMENT SHALL COMPLY WITH BS 4449 OR BS 4483 AS RELEVANT. THE CONTRACTOR SHALL PREPARE BENDING SCHEDULES BASED ON THE R.C. DETAILS SHOWN ON THE DRAWINGS.

8. OPENINGS SHOWN ON THE ENGINEER'S DRAWINGS ARE TO BE CHECKED BY THE CONTRACTOR WITH THE RELEVANT SERVICES BUILDERSWORK DRAWINGS PRIOR TO CONSTRUCTION. ANY DISCREPANCIES MUST BE DRAWN TO THE ATTENTION OF THE ARCHITECT.

9. NO HOLES IN REINFORCED CONCRETE ARE TO BE FORMED OR CUT WITHOUT THE ENGINEER'S PRIOR AGREEMENT.

10. THE POSITIONS AND DETAILS OF ALL CONSTRUCTION JOINTS ARE TO BE AGREED WITH THE ENGINEER BEFORE WORK COMMENCES. MAXIMUM LENGTH OF WALL SHALL BE 10m. MAXIMUM AREA OF SLAB SHALL BE 200m².

11. WATER BARS SHALL BE USED AT ALL CONSTRUCTION JOINTS AND PENETRATIONS. PUDDLE FLANGES SHALL BE USED ON PIPEWORK PASSING THROUGH RC WALLS OR SLABS.

12. SERVICEABILITY CRITERIA SHOWN BELOW HAVE BEEN ADOPTED IN DESIGN IN ACCORDANCE WITH BS 8110. CONTRACTOR TO ENSURE ALL SUPPORTED FINISHES ALLOW FOR THESE DEFLECTIONS. PREDEFLECTION MAY BE REQUIRED FOR SIGNIFICANT PERMANENT LOADS.

BEAMS – SPAN/250
CANTILEVERS – LENGTH/125
COLUMNS – HEIGHT/300

NOTES FOR TIMBER

1. THESE NOTES ARE TO BE READ IN CONJUNCTION WITH RELEVANT ARCHITECT'S AND SERVICES ENGINEER'S DRAWINGS AND SPECIFICATION.

2. ALL TIMBER-WORK SHALL COMPLY WITH BS EN 1995-1-1:2004 DESIGN OF TIMBER STRUCTURES. GENERAL. COMMON RULES AND RULES FOR BUILDINGS

3. ALL SOLID TIMBER SHALL COMPLY WITH BS EN 14081-1 AND BE GRADE C24 UNLESS NOTED OTHERWISE. EVIDENCE OF GRADING SHALL BE PROVIDED BEFORE WORK COMMENCES.

4. THE SIZES SHOWN ON THE DRAWINGS ARE FINISHED SIZES.

5. PLYWOOD SHALL COMPLY WITH BS EN 636 AND BE AS FOLLOWS:

(i) TYPE – SWEDISH GRAGE P30 SPRUCE PINE
(ii) GRADE – SELECT UNSANDED
(iii) NOMINAL THICKNESS – 18.0mm
(iv) NUMBER OF PLIES – 5

6. IN JOINT ZONES, WANES, SHAKES AND KNOTS ARE NOT PERMITTED.

7. TIMBER TO BE CAREFULLY CUT AND PLANED TO ENSURE TIGHT FIT AND CONTINUOUS BEARING AGAINST METALWORK.

8. ALL GAPS BETWEEN TIMBER AND METALWORK TO BE RESIN-GROUTED, TO THE APPROVAL OF THE ENGINEER.

9. ALL CONNECTORS, BOLTS, NAILS ETC. SHALL BE GALVANISED.

10. ADHESIVE SHALL BE TO BS EN 301 OR BS EN 15425 TYPE WBP

11. ALL TIMBER TO BE TREATED IN ACCORDANCE WITH THE BRITISH WOOD PRESERVATIVE AND DAMP-PROOFING ASSOCIATION COMMODITY SPECIFICATION C8 FOR 40 YEARS DESIRED SERVICE LIFE.

12. ALL TIMBER FLAT ROOFS TO BE TIED DOWN WITH EXPAMET STSS STAINLESS STEEL VERTICAL RESTRAINT STRAPS @ 1200mm c/c. ALL WALLS TO BE LATERALLY RESTRAINED WITH EXPAMET HS HORIZONTAL RESTRAINT STRAPS @ 1200mm c/c.

13. SERVICEABILITY CRITERIA SHOWN BELOW HAVE BEEN ADOPTED IN DESIGN IN ACCORDANCE WITH BS EN 1995-1-1. CONTRACTOR TO ENSURE ALL SUPPORTED FINISHES ALLOW FOR THESE DEFLECTIONS. PREDEFLECTION MAY BE REQUIRED FOR SIGNIFICANT PERMANENT LOADS. ALSO NOTE THAT TIMBER EXHIBITS LONG TERM CREEP AND WILL THEREFORE CONTINUE TO DEFLECT AFTER LOAD HAS BEEN APPLIED.

BEAMS – SPAN/250
CANTILEVERS – LENGTH/125
COLUMNS – HEIGHT/300

NOTES FOR STRUCTURAL STEELWORK

1. THESE NOTES ARE TO BE READ IN CONJUNCTION WITH RELEVANT ARCHITECT'S AND SERVICES ENGINEER'S DRAWINGS AND SPECIFICATIONS.

2. THE DESIGN, FABRICATION & ERECTION OF THE STRUCTURAL STEELWORK IS TO BE IN ACCORDANCE WITH THE FOLLOWING DOCUMENTS:

BS EN 1993-1-1:2005 DESIGN OF STEEL STRUCTURES. GENERAL RULES AND RULES FOR BUILDINGS
NATIONAL STRUCTURAL STEELWORK SPECIFICATION FOR BUILDING CONSTRUCTION –THE LATEST EDITION.

ALL CLAUSES OF THE ABOVE, INCLUDING APPENDICES ARE DEEMED TO BE PART OF THIS SPECIFICATION.

3. FABRICATION DRAWINGS SHALL BE SUBMITTED FOR APPROVAL 14 DAYS PRIOR TO COMMENCEMENT OF FABRICATION, UNLESS AGREED OTHERWISE. IF FABRICATION DRAWINGS ARE NOT TO BE SUBMITTED THE FABRICATOR SHALL BE RESPONSIBLE FOR COORDINATION OF THE ARCHITECT'S AND ENGINEER'S DRAWINGS. ANY DISCREPANCY SHALL BE NOTIFIED IMMEDIATELY TO THE CONTRACT ADMINISTRATOR, AND PRIOR TO COMMENCEMENT OF FABRICATION.

4. ALL STEELWORK SHALL COMPLY WITH BS EN 10025-1 to 6, BS EN 10210-1.

5. ALL ROLLED STEEL SHALL BE GRADE S355 UNLESS NOTED OTHERWISE. STEEL GRADE SHALL CONFORM WITH TABLE 3.1 OF BS EN 1993-1-1. ALL HOLLOW SECTION STEELWORK TO BE CELSIUS 355 TO BS EN 10210-1.

6. UNLESS NOTED OTHERWISE ALL BUTT WELDS SHALL BE FULL PENETRATION.

7. UNLESS NOTED OTHERWISE ALL FILLET WELDS SHALL BE FULL PROFILE WITH A MINIMUM LEG LENGTH OF 6mm.

8. UNLESS NOTED OTHERWISE ALL ORDINARY BOLT ASSEMBLIES SHALL BE M16 GRADE 8.8.

9. UNLESS NOTED OTHERWISE ALL HOLDING DOWN BOLTS SHALL BE M16 GRADE 8.8 ANCHORED A MINIMUM OF 200mm DEPTH INTO THE SUPPORTING CONCRETE WITH A 100x100x8 THICK WASHER PLATE AT THE EMBEDDED HEAD OF THE BOLT.

10. THE CLEARANCE OF BASE PLATES FROM SUPPORTING CONCRETE SHALL BE A MINIMUM OF 20mm AND ON COMPLETION OF ERECTION THIS SHALL BE GROUTED SOLID UNDER THE FULL AREA OF THE BASE PLATE WITH 1:2 SAND: CEMENT GROUT.

11. CORROSION PROTECTION FOR INTERNAL STEELWORK:

a) SURFACE PROTECTION – BLAST CLEAN TO SA 2.5 QUALITY BS EN ISO 8501-1.
b) PREFABRICATOR PRIMER – EPOXY ZINC PHOSPHATE HB: 50 MICRONS (DFT).
c) FINISHING COAT – SEE ARCH'S SPEC.
d) SEE ARCH'S SPECIFICATION FOR DETAILS ON COLOUR AND TEXTURE.

12. CORROSION PROTECTION FOR EXTERNAL STEELWORK TO BE HOT DIP GALVANIZED.

13. FIRE PROTECTION TO BE SPECIFIED BY THE ARCHITECT AND TO BE ACHIEVED AS FOLLOWS

½ HOUR ONE LAYER OF PLASTERBOARD AND SKIM COAT OR INTUMESCENT PAINT TO MANUFACTURER'S SPECIFICATION.

1 HOUR TWO LAYERS OF PLASTERBOARD WITH JOINTS STAGGERED AND SKIM COAT OR INTUMESCENT PAINT TO MANUFACTURER'S SPECIFICATION.

14. SERVICEABILITY CRITERIA SHOWN BELOW HAVE BEEN ADOPTED IN DESIGN IN ACCORDANCE WITH NA TO BS EN 1993-1-1. CONTRACTOR TO ENSURE ALL SUPPORTED FINISHES ALLOW FOR THESE DEFLECTIONS. PREDEFLECTION MAY BE REQUIRED FOR SIGNIFICANT PERMANENT LOADS.

BEAMS – SPAN/360
CANTILEVERS – LENGTH/180
COLUMNS – HEIGHT/300

NOTES FOR MASONRY

1. THESE NOTES ARE TO BE READ IN CONJUNCTION WITH RELEVANT ARCHITECT'S SERVICES ENGINEER'S DRAWINGS AND SPECIFICATIONS.

2. ALL BRICKWORK SHALL COMPLY WITH BS EN 1996-1-1:2005 DESIGN OF MASONRY STRUCTURES. GENERAL RULES FOR REINFORCED AND UNREINFORCED MASONRY STRUCTURES.

3. ALL BRICKS SHALL HAVE A MINIMUM CRUSHING STRENGTH OF 20N/mm².

4. BLOCKWORK SHALL HAVE A MINIMUM CRUSHING STRENGTH OF 7N/mm².

5. MORTAR SHALL BE CLASS (iii) / M4 CEMENT: LIME: SAND MIX (1:1:6), UNLESS INDICATED OTHERWISE.

6. ALL VERTICAL JOINTS SHALL BE COMPLETELY FILLED. BRICKS SHALL BE LAID FROG UP. THE VOIDS IN PERFORATED BRICKS SHALL BE FILLED.

7. FISSURED BRICKS OR BRICKS WITH VOIDS SHALL NOT BE USED.

8. HORIZONTAL CHASES ARE PROHIBITED. VERTICAL CHASES AND BUILDERSWORK HOLES SHALL BE AGREED WITH THE ARCHITECT.

9. WALL TIES TO BE ANCON ST1 TYPE 1 TIE AT 450mm VERTICALLY AND 900mm HORIZONTALLY UNLESS OTHERWISE STATED

Rev	Date	By	Rev
–	26.10.22	AB	SCHEME

CDM STATEMENT
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DRAWING STATUS: SCHEME

CLIENT: MR MATTEO CARACCIA, 28 CHARLOTTE STREET, LONDON W1T

DRAWING TITLE: GENERAL NOTES AND SPECIFICATIONS

JOB TITLE: 28 CHARLOTTE STREET FITZROVIA, LONDON W1T 2NF

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DATE	SCALE	DRAWN AB
26-10-2022	N/A	CHECKED –
JOB No.	DRG No.	REVISION
1964	01	–

NOTES

1. FOR GENERAL NOTES SEE DRAWING 1967 – 01
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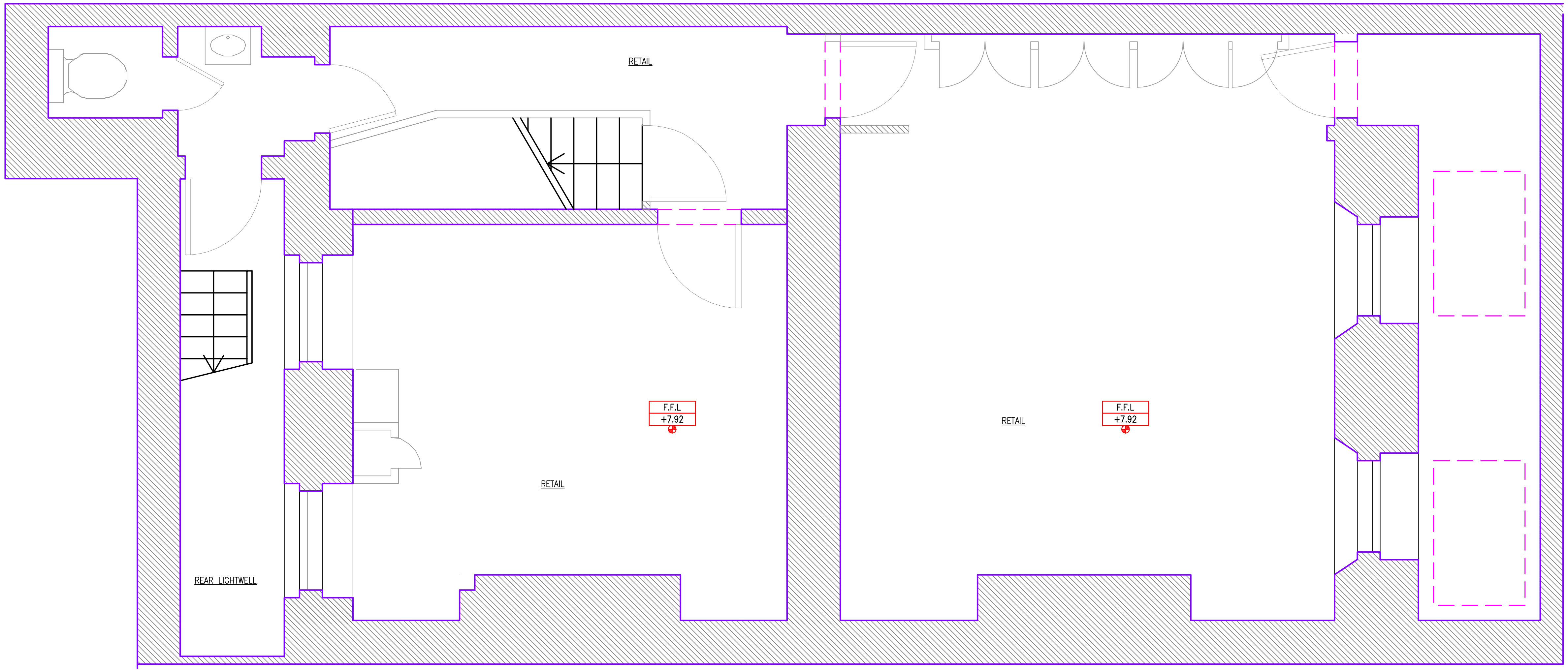
4. ALL TEMPORARY WORKS TO BE DESIGNED BY THE CONTRACTOR AND METHODS STATEMENTS TO BE SUBMITTED TO THE ENGINEER PRIOR TO COMMENCEMENT OF WORKS.



1 0 1 2 3 4 5 METRES

Rev	Date	By	Rev
–	26.10.22	AB	SCHEME

CDM STATEMENT
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DRAWING STATUS: SCHEME

CLIENT: MR MATTEO CARACCIA, 28 CHARLOTTE STREET, LONDON W1T

DRAWING TITLE: EXISTING BASEMENT PLAN

JOB TITLE: 28 CHARLOTTE STREET, FITZROVIA, LONDON W1T 2NF

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DATE	SCALE	DRAWN AB
26-10-2022	A1 – 1:25 A3 – 1:50	CHECKED –
JOB No. 1964	DRG No. 02	REVISION –

NOTES

1. FOR GENERAL NOTES SEE DRAWING 1967 – 01
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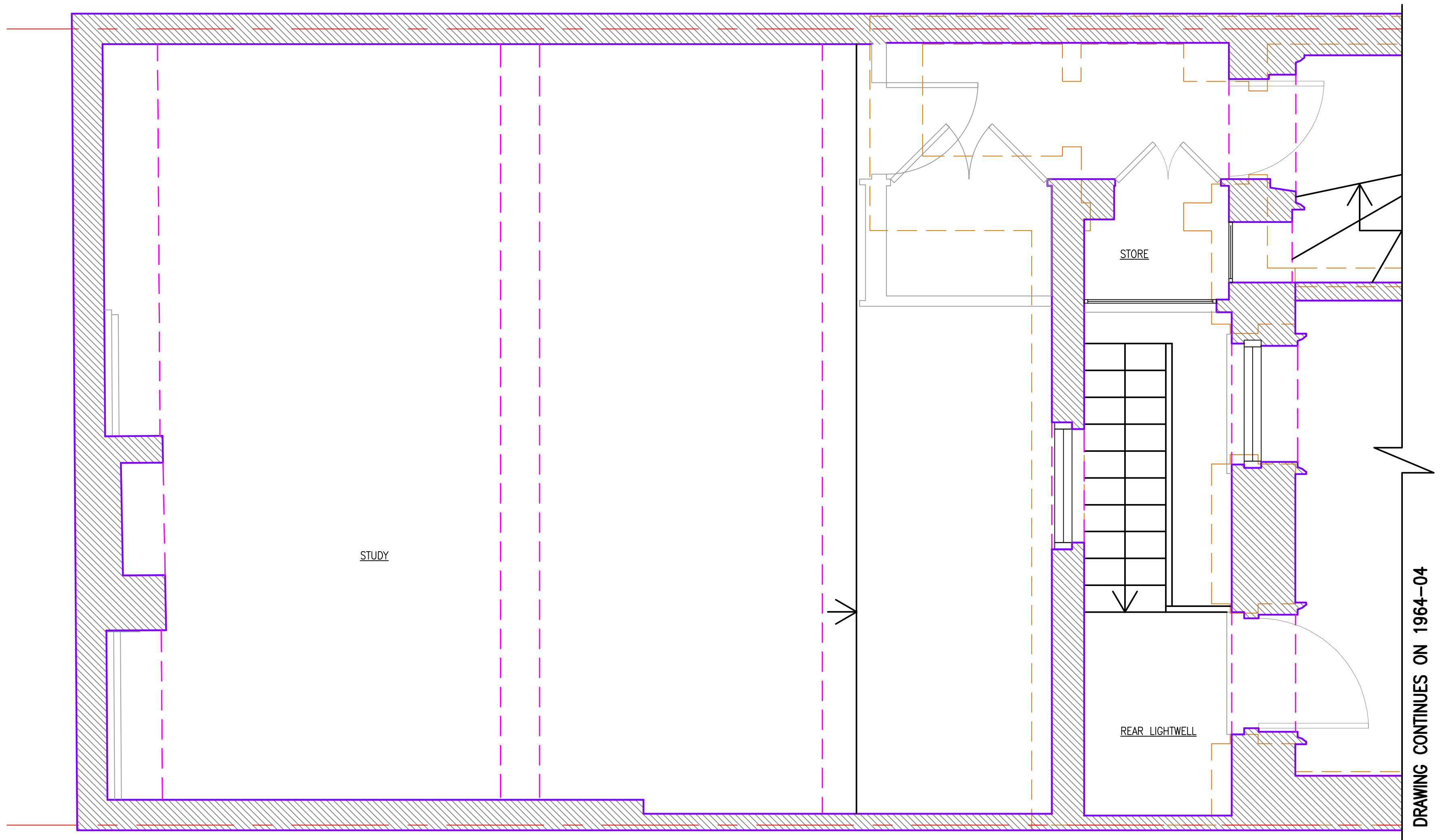

DRAWING CONTINUES ON 1964–04

1 0 1 2 3 4 5 METRES

Rev	Date	By	Rev
–	26.10.22	AB	SCHEME

CDM STATEMENT
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DRAWING STATUS SCHEME

CLIENT MR MATTEO CARACCIA
28 CHARLOTTE STREET
LONDON W1T

DRAWING TITLE
EXISTING GROUND FLOOR PLAN
SHEET 1

JOB TITLE
28 CHARLOTTE STREET
FITZROVIA, LONDON W1T 2NF

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SCALE A1 – 1:25 A3 – 1:50
DRAWN AB
CHECKED –
JOB No. 1964
DRG No. 03
REVISION –

NOTES

1. FOR GENERAL NOTES SEE DRAWING 1967 – 01
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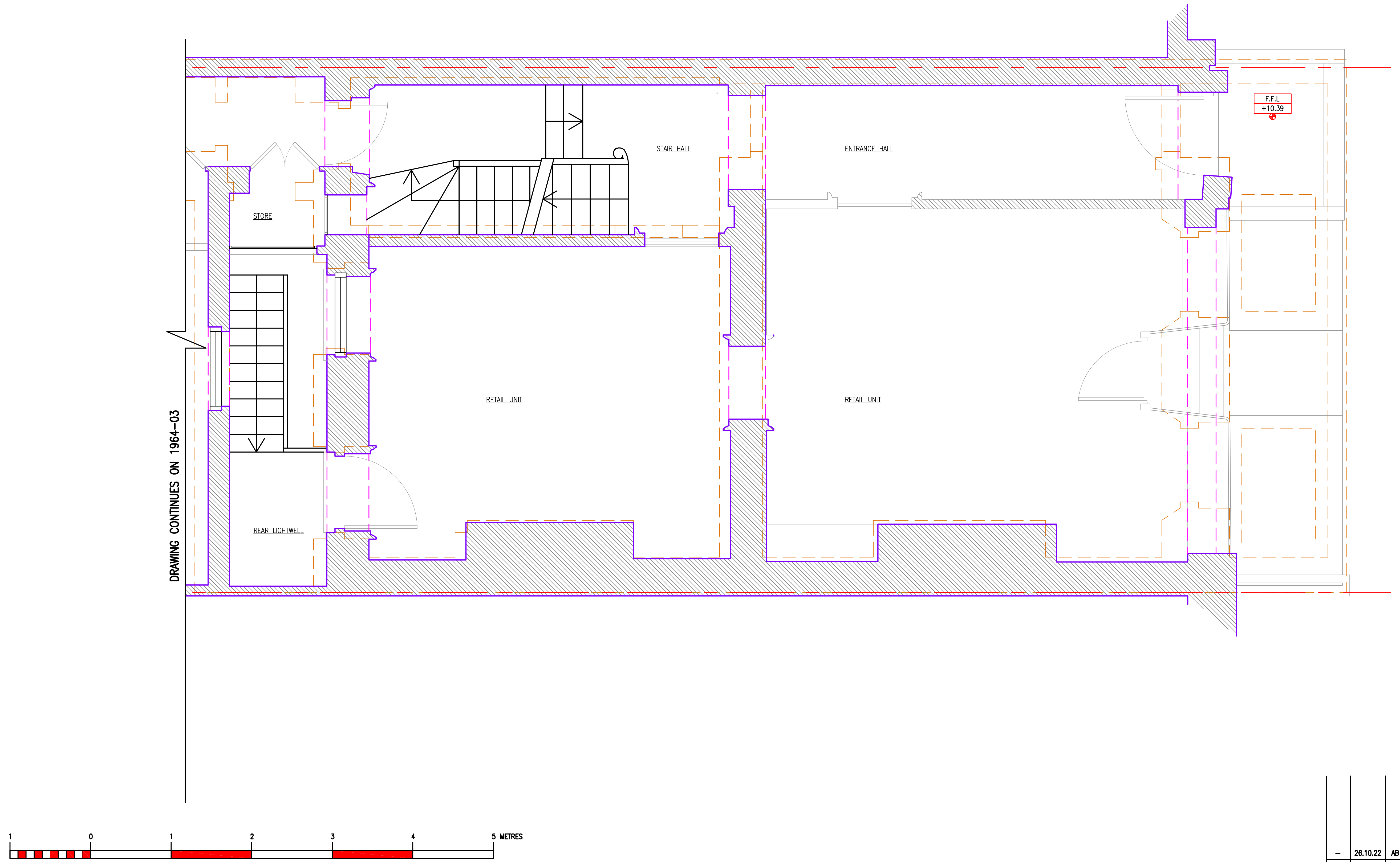

Rev	Date	By	Rev
–	26.10.22	AB	SCHEME

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DRAWING STATUS: SCHEME

CLIENT: MR MATTEO CARACCIA, 28 CHARLOTTE STREET, LONDON W1T

DRAWING TITLE: EXISTING GROUND FLOOR PLAN SHEET 2

JOB TITLE: 28 CHARLOTTE STREET FITZROVIA, LONDON W1T 2NF

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DATE: 26-10-2022
SCALE: A1 – 1:25, A3 – 1:50
DRAWN: AB
CHECKED: –
JOB No.: 1964
DRG No.: 04
REVISION: –

NOTES

1. FOR GENERAL NOTES SEE DRAWING 1967 – 01
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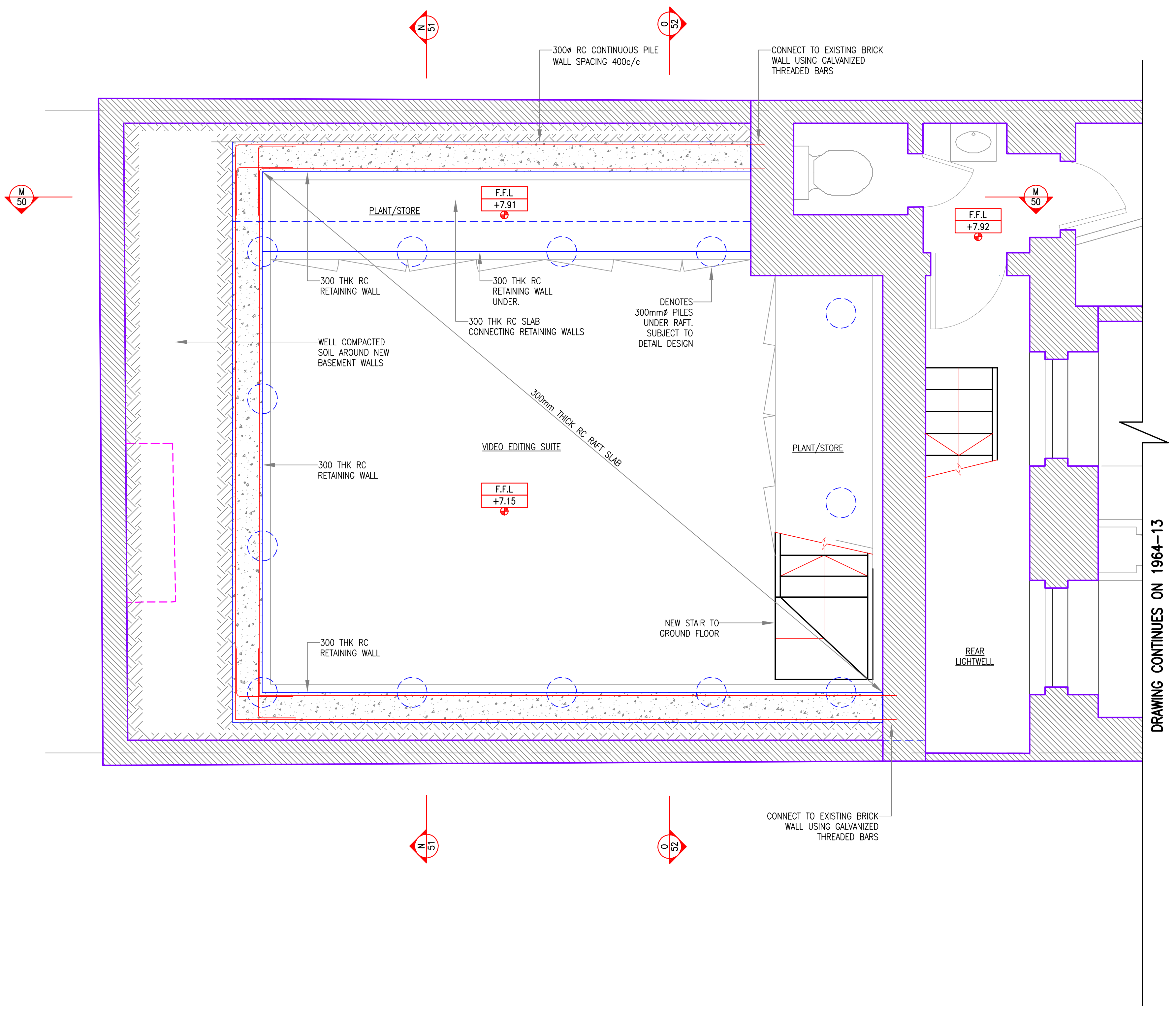

1 0 1 2 3 4 5 METRES

Rev	Date	By	Rev
A	26.10.22	AB	SCHEME
–	06.03.20	IG	INITIAL DRAFT

CDM STATEMENT
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DRAWING STATUS: SCHEME

CLIENT: MR MATTEO CARACCIA, 28 CHARLOTTE STREET, LONDON W1T

DRAWING TITLE: PROPOSED BASEMENT PLAN SHEET 1

JOB TITLE: 28 CHARLOTTE STREET FITZROVIA, LONDON W1T 2NF

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DATE	SCALE	DRAWN IG
04-03-2020	A1 – 1:25 A3 – 1:50	CHECKED CB
JOB No. 1964	DRG No. 12	REVISION A

NOTES

1. FOR GENERAL NOTES SEE DRAWING 1967 – 01
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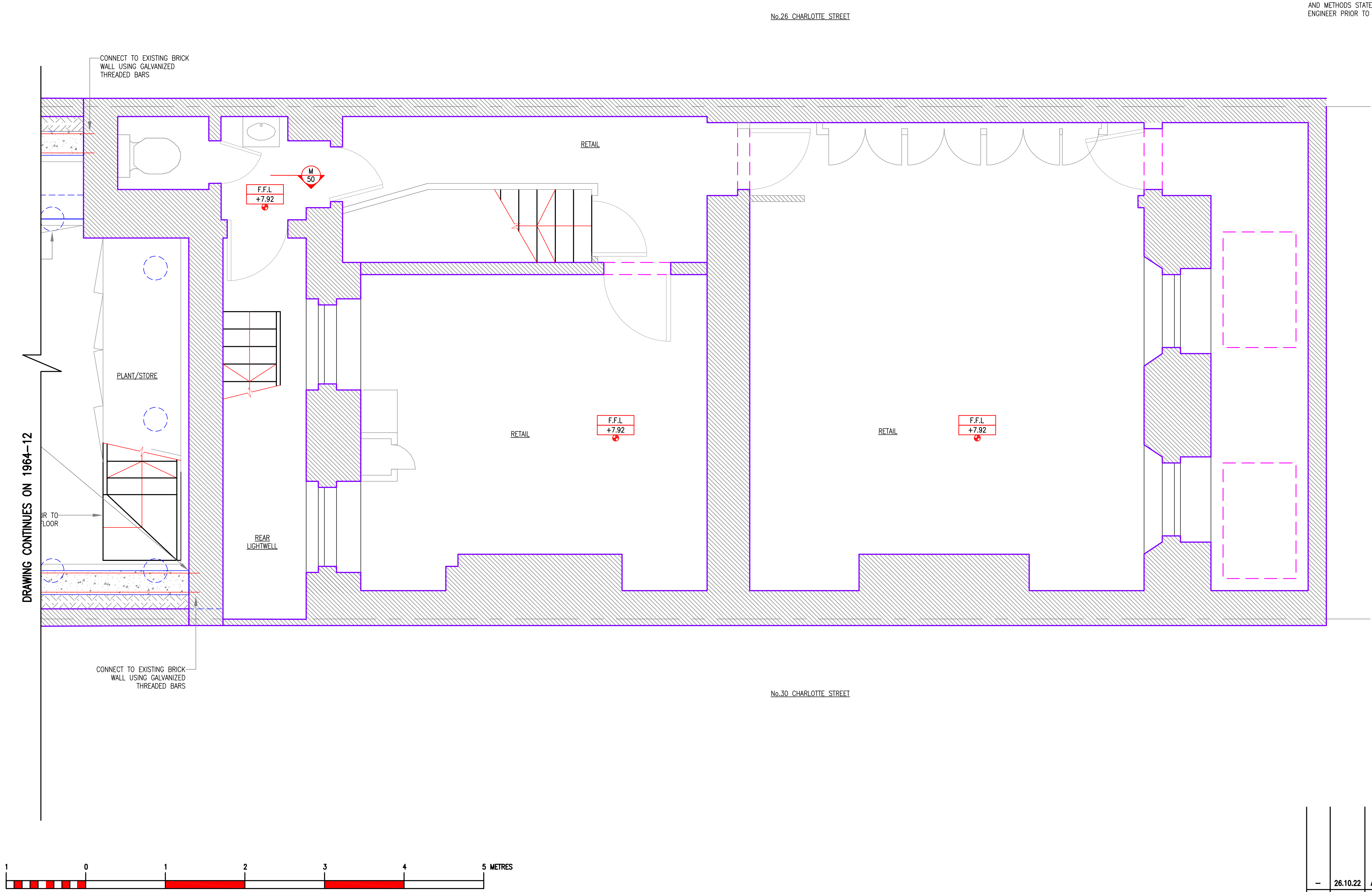

Rev	Date	By	Rev
–	26.10.22	AB	SCHEME

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DRAWING STATUS: SCHEME

CLIENT: MR MATTEO CARACCIA, 28 CHARLOTTE STREET, LONDON W1T

DRAWING TITLE: PROPOSED BASEMENT PLAN SHEET 2

JOB TITLE: 28 CHARLOTTE STREET FITZROVIA, LONDON W1T 2NF

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26-10-2022	A1 – 1:25 A3 – 1:50	CHECKED –
JOB No. 1964	DRG No. 13	REVISION –

NOTES

1. FOR GENERAL NOTES SEE DRAWING 1967 – 01
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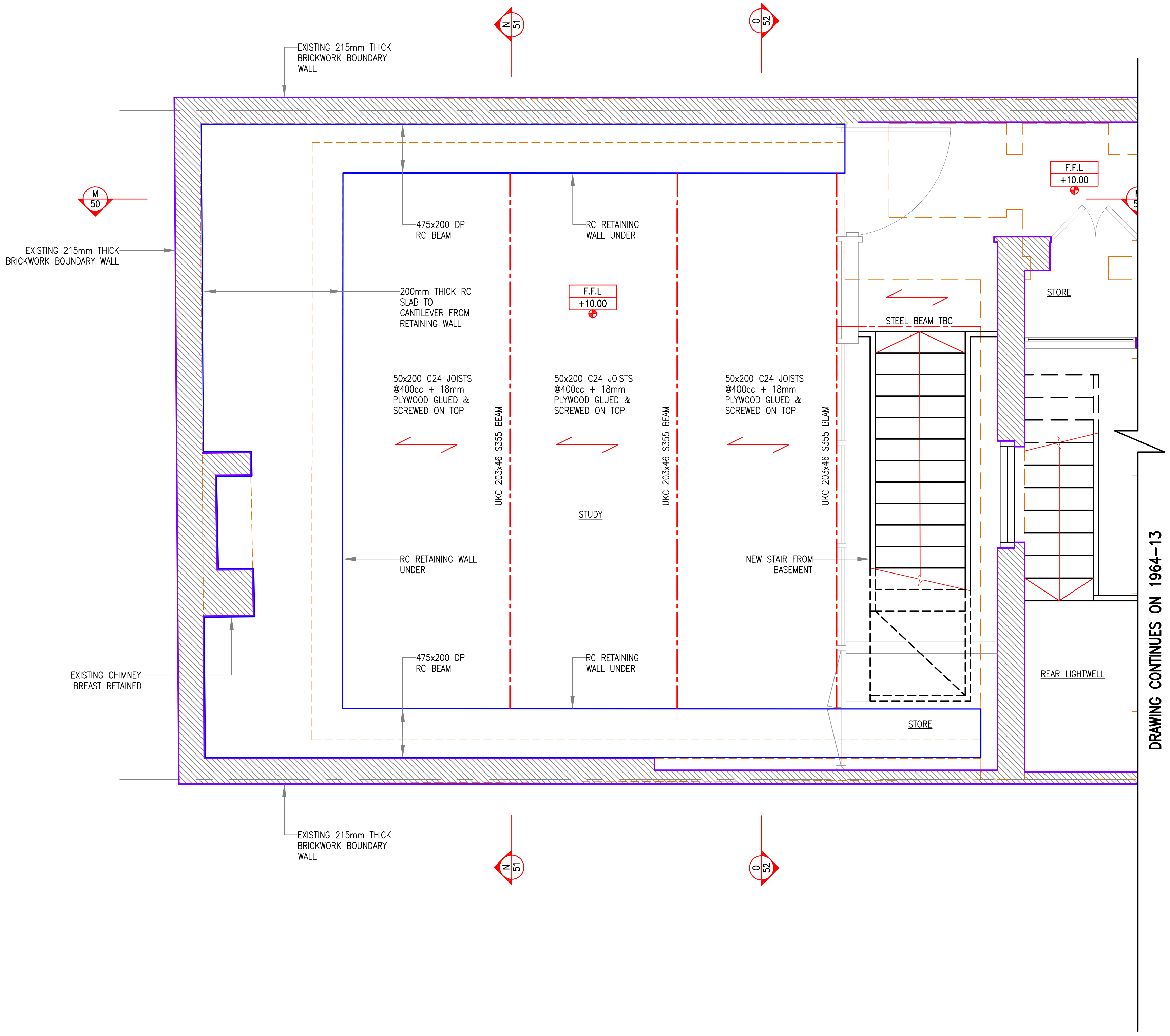

1 0 1 2 3 4 5 METRES

Rev	Date	By	Rev
A	26.10.22	AB	SCHEME
–	06.03.20	IG	INITIAL DRAFT

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DRAWING STATUS: SCHEME

CLIENT: MR MATTEO CARACCIA, 28 CHARLOTTE STREET, LONDON W1T

DRAWING TITLE: PROPOSED GROUND FLOOR PLAN SHEET 1

JOB TITLE: 28 CHARLOTTE STREET FITZROVIA, LONDON W1T 2NF

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DATE	SCALE	DRAWN IG
04-03-2020	A1 – 1:25 A3 – 1:50	CHECKED CB
JOB No. 1964	DRG No. 14	REVISION A

NOTES

1. FOR GENERAL NOTES SEE DRAWING 1967 – 01

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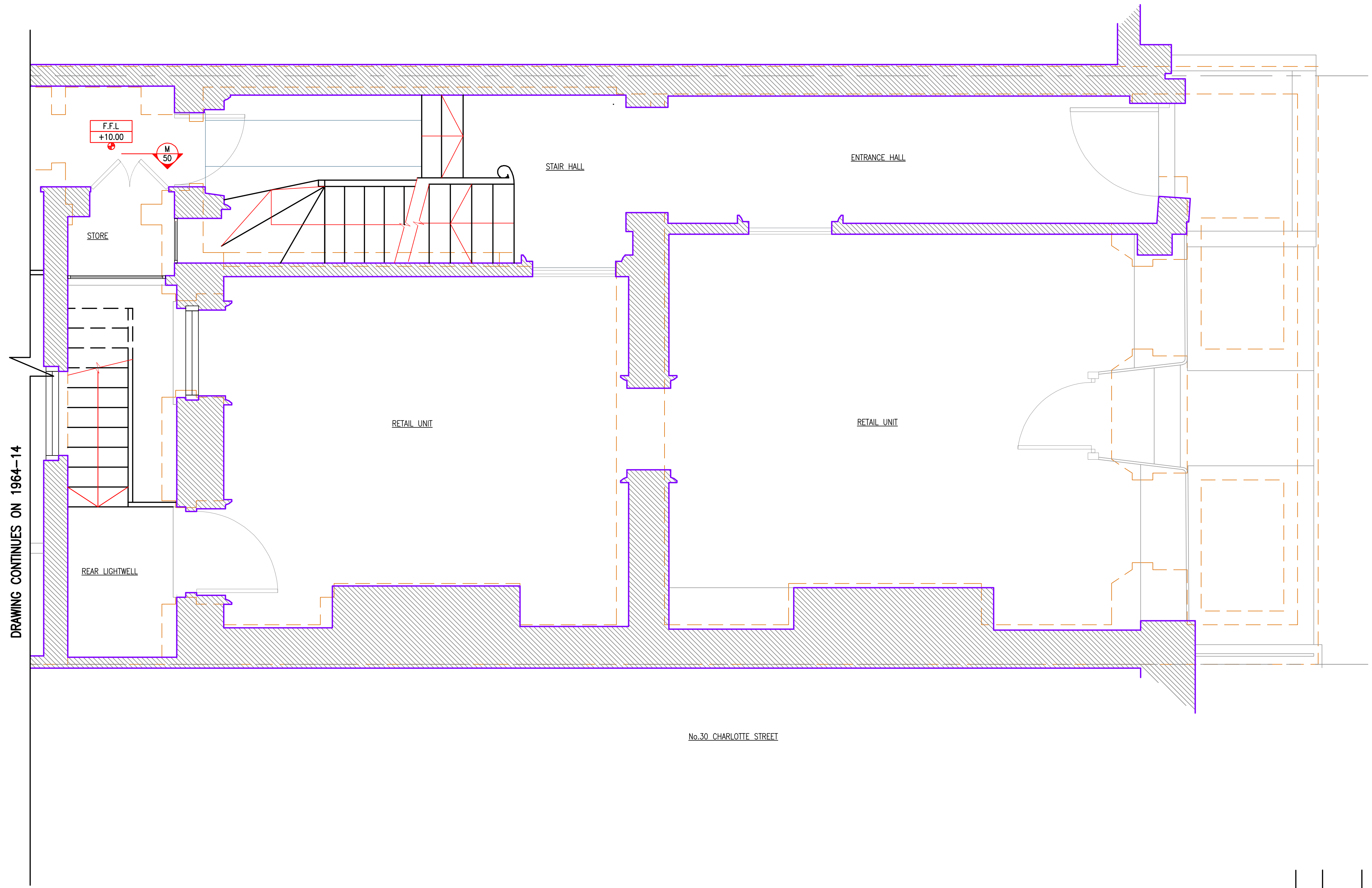

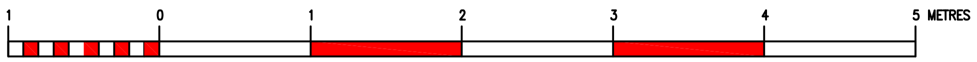

Rev	Date	By	Rev
–	26.10.22	AB	SCHEME

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DRAWING STATUS SCHEME

CLIENT MR MATTEO CARACCIA
28 CHARLOTTE STREET
LONDON W1T

DRAWING TITLE
PROPOSED GROUND FLOOR PLAN
SHEET 2

JOB TITLE
28 CHARLOTTE STREET
FITZROVIA, LONDON W1T 2NF

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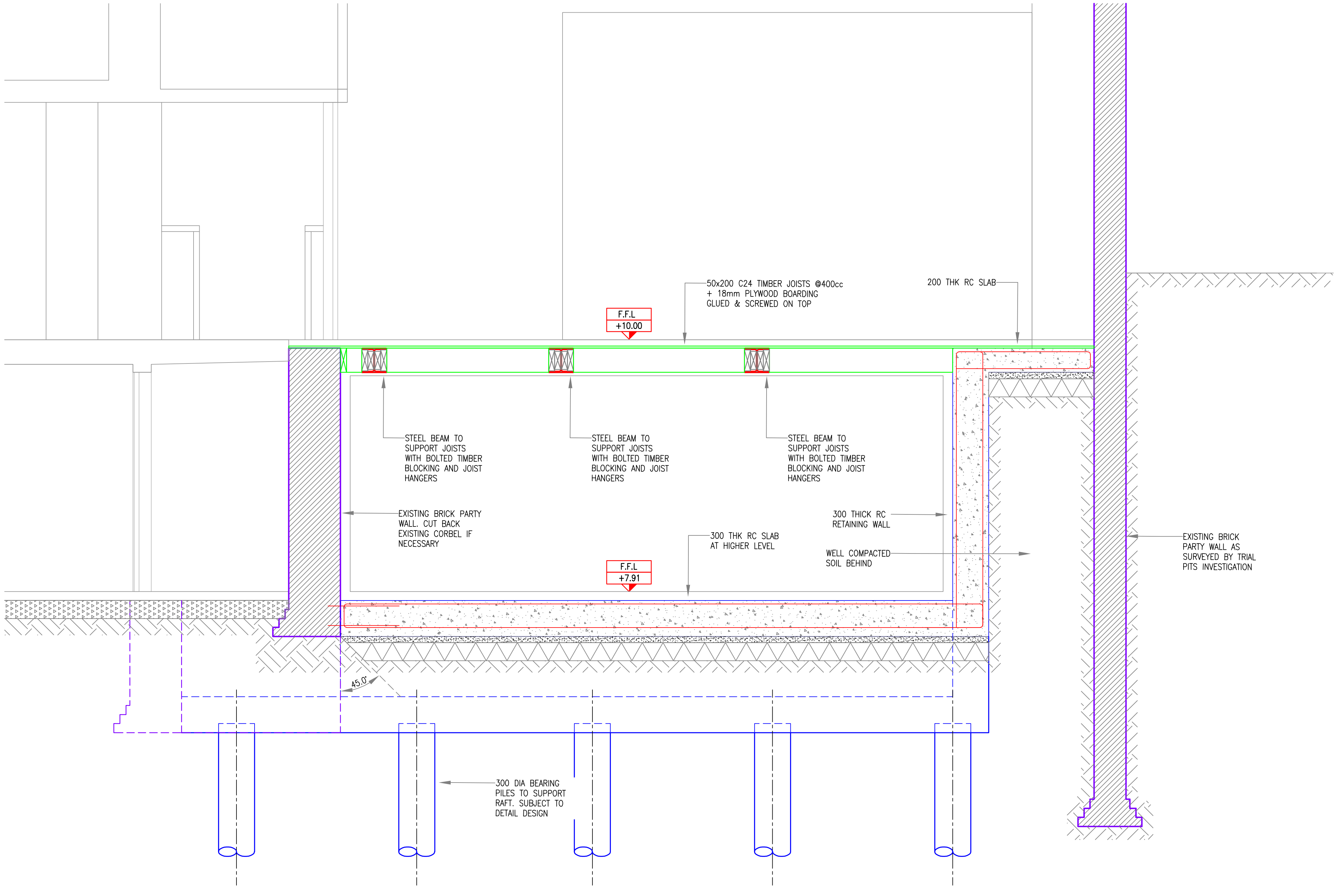
DATE 26-10-2022
SCALE A1 – 1:25
A3 – 1:50
DRAWN AB
CHECKED –
JOB No. 1964
DRG No. 15
REVISION –



SECTION M-M

NOTES

1. FOR GENERAL NOTES SEE DRAWING 1967 – 01
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1 0 1 2 3 4 5

Rev	Date	By	Rev
A	26.10.22	AB	SCHEME REVISED
–	06.03.20	IG	INITIAL DRAFT

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DRAWING STATUS: SCHEME

CLIENT: MR MATTEO CARACCIA, 28 CHARLOTTE STREET, LONDON, W1T

DRAWING TITLE: PROPOSED SECTION M–M

JOB TITLE: 28 CHARLOTTE STREET, FITZROVIA, LONDON W1T 2NF

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DATE	SCALE	DRAWN IG
04-03-2020	A1 – 1:20 A3 – 1:40	CHECKED CB
JOB No.	DRG No.	REVISION
1964	50	A

NOTES

1. FOR GENERAL NOTES SEE DRAWING 1967 – 01
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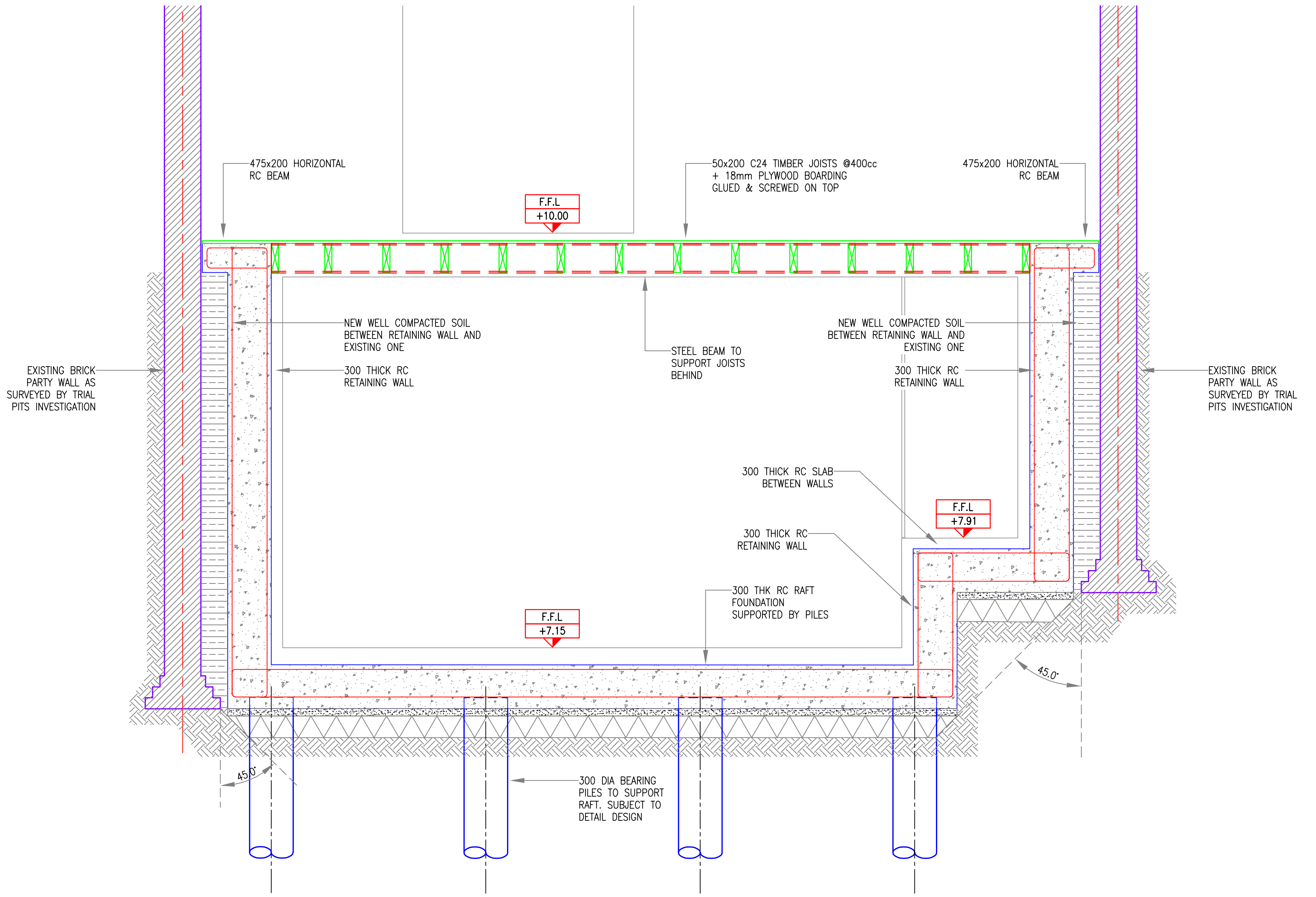
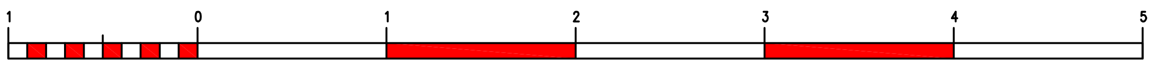


SECTION N–N



Rev	Date	By	Rev
A	21.10.22	AB	SCHEME REVISED
–	06.03.20	IG	INITIAL DRAFT

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DRAWING STATUS: SCHEME

CLIENT: MR MATTEO CARACCIA, 28 CHARLOTTE STREET, LONDON, W1T

DRAWING TITLE: PROPOSED SECTION N–N

JOB TITLE: 28 CHARLOTTE STREET, FITZROVIA, LONDON W1T 2NF

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DATE	SCALE	DRAWN / CHECKED
04–03–2020	A1 – 1:20 A3 – 1:40	DRAWN IG CHECKED CB
JOB No.	DRG No.	REVISION
1964	51	A

NOTES

1. FOR GENERAL NOTES SEE DRAWING 1967 – 01
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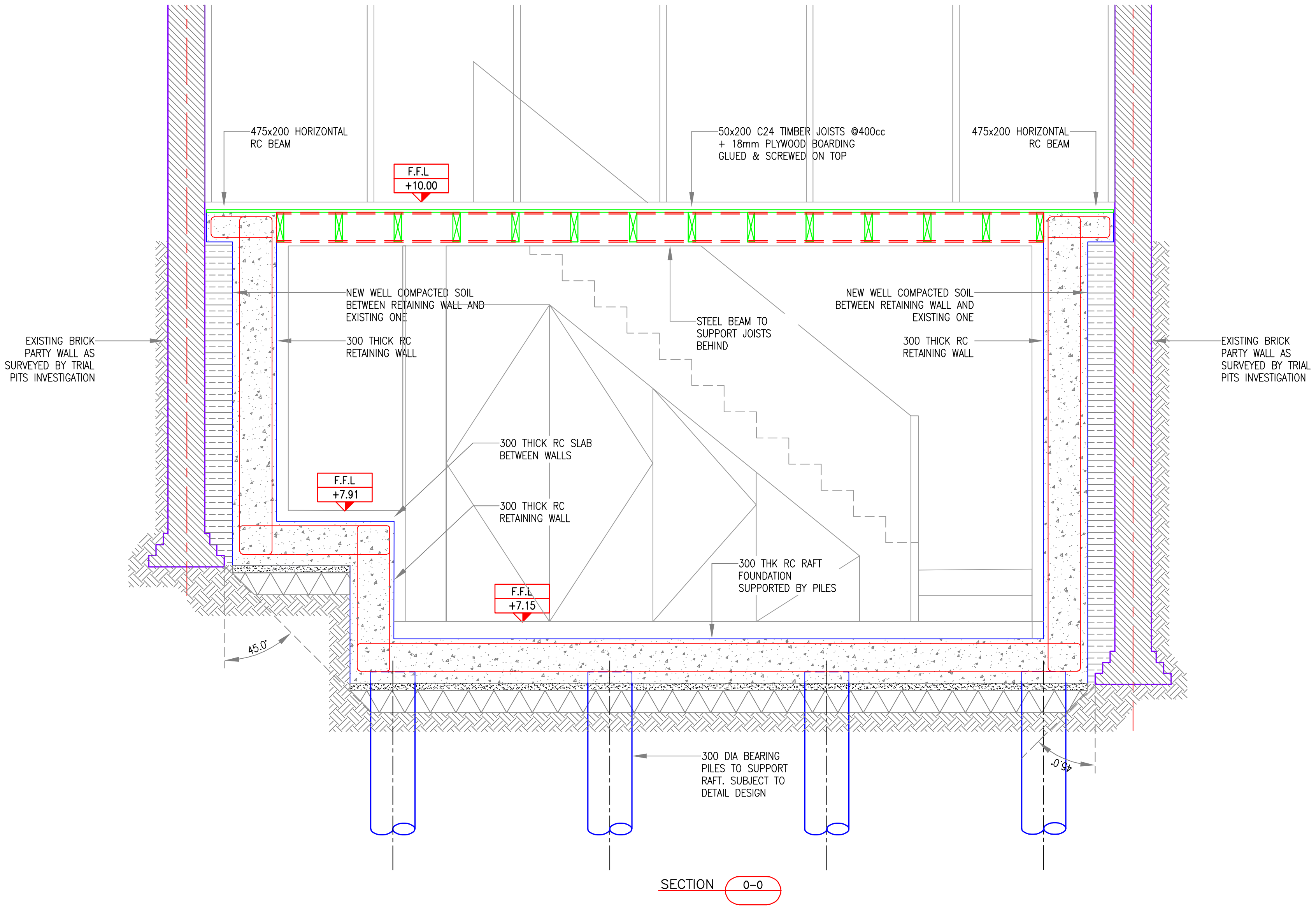
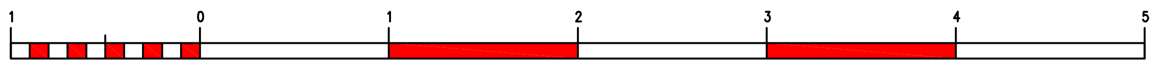


SECTION 0–0



Rev	Date	By	Rev
–	26.10.22	AB	SCHEME REVISED

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DRAWING STATUS: SCHEME

CLIENT: MR MATTEO CARACCIA, 28 CHARLOTTE STREET, LONDON, W1T

DRAWING TITLE: PROPOSED SECTION 0–0

JOB TITLE: 28 CHARLOTTE STREET FITZROVIA, LONDON W1T 2NF

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DATE	SCALE	DRAWN AB
26–10–2022	A1 – 1:20 A3 – 1:40	CHECKED –
JOB No. 1964	DRG No. 52	REVISION –

Appendix B – Proposed Construction Sequence

For

28, Charlotte Street

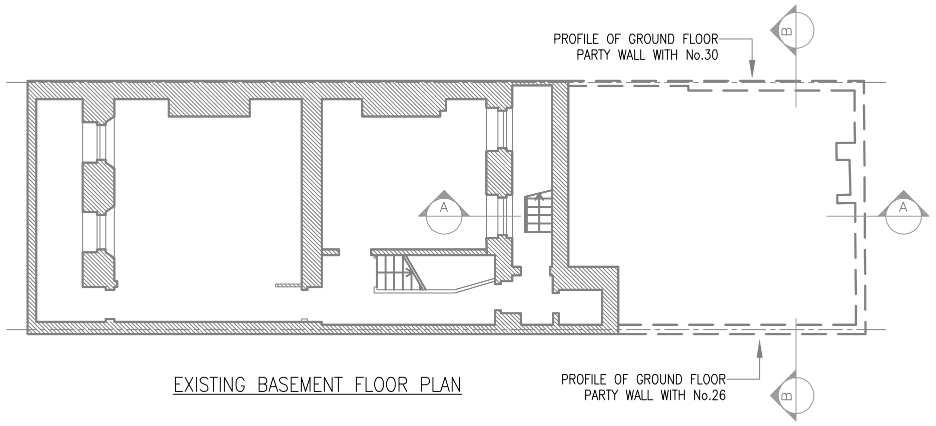
Fitzrovia

London W1T

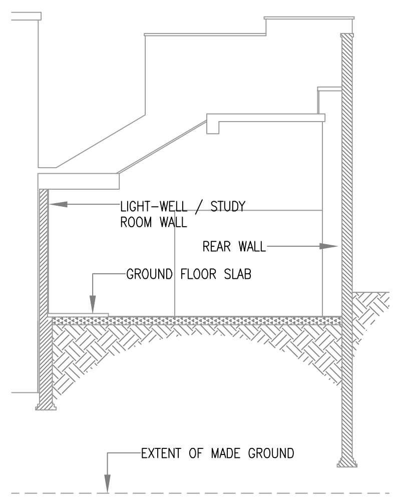
rodriguesassociates
1 Amwell Street
London
EC1R 1UL
tel: (+44) 020 7837 1133
www.rodriguesassociates.com
October 2022

PRE-SITE START & STAGE 0

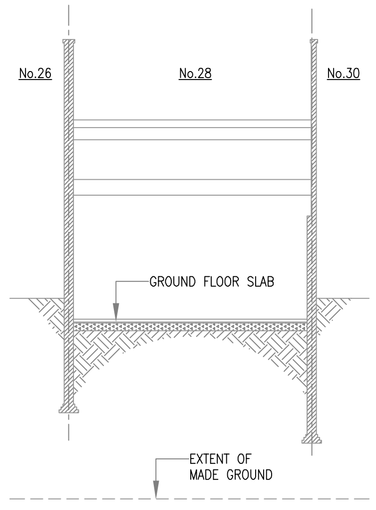
- INSTALL MONITORING POSITIONS ON WALLS AND DO BASELINE SURVEY.
- SAW CUT ANY EXISTING LOWER GROUND FLOOR SCREED, WHERE IT IS PRESENT, TO ITS FULL DEPTH PARALLEL TO THE PARTY WALLS AS CLOSE TO IT AS FEASIBLE AND REMOVE THE PORTION AGAINST THE PARTY WALL TO LIMIT VIBRATION BORN NOISE THROUGH THE PARTY WALL DURING DEMOLITION.
- THE EXISTING BUILDING IS TO BE STRIPPED OUT AS REQUIRED TO REVEAL THE EXISTING STRUCTURES.
- A CONVEYOR BELT WILL BE SET UP THROUGH THE EXISTING BASEMENT TO CONVEY THE SPOIL FROM THE EXCAVATION TO A SKIP PLACED ON THE ROAD FOR DISPOSAL.



EXISTING BASEMENT FLOOR PLAN



SECTION A–A



SECTION B–B

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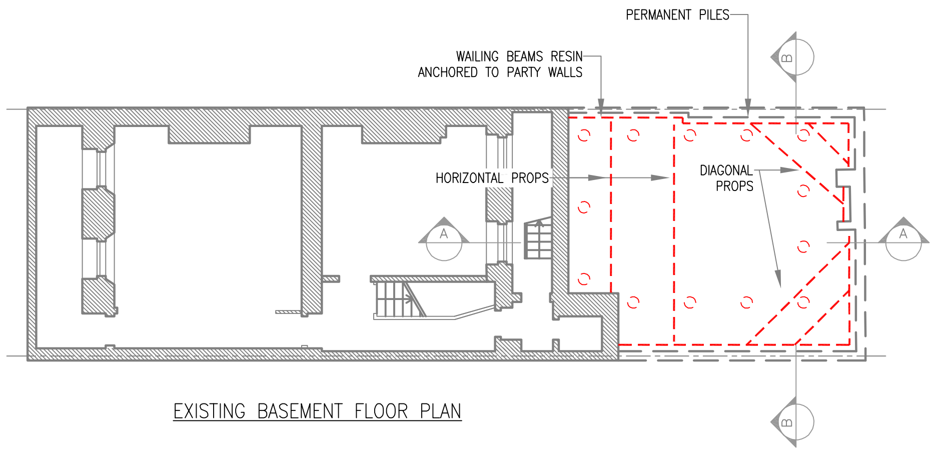
STAGE 1 – PILING AND HIGH LEVEL PROPPING

- REMOVE EXISTING GROUND FLOOR SLAB.
- INSTALL PILES AS SHOWN ON PLAN AND UP TO EXISTING GROUND FLOOR LEVEL USING SLEEVED TOP.
- RESIN ANCHOR WAILING BEAMS TO PARTY WALLS AND INSTALL PROPRIETARY HEAVY DUTY PROPS BY MAYBE OR SIMILAR APPROVED.



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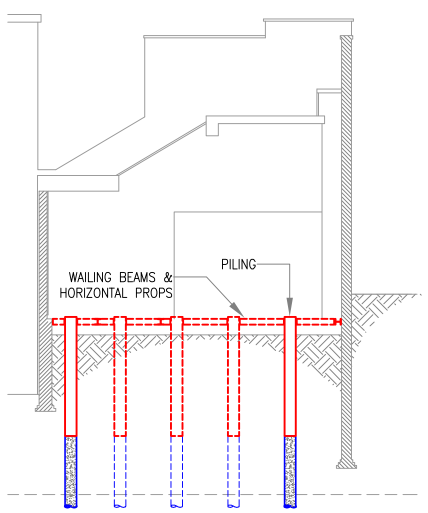

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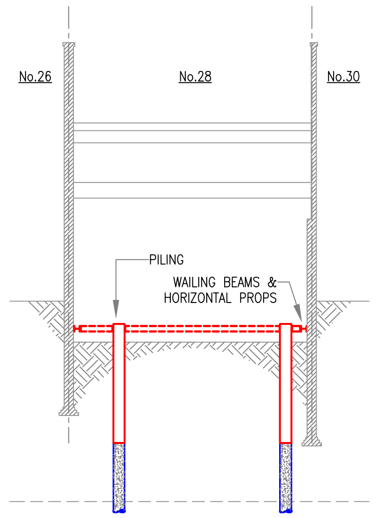

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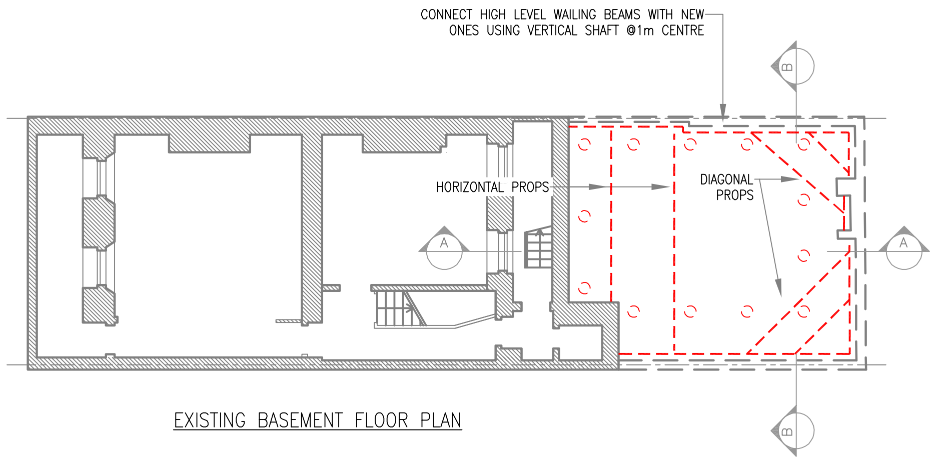
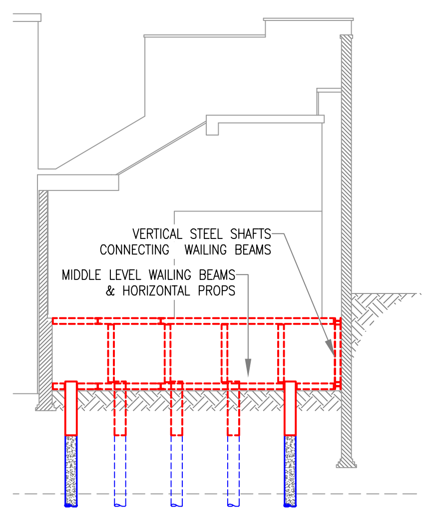
STAGE 2 – EXCAVATION & MIDDLE LEVEL PROPPING

- EXCAVATE DOWN TO 1.5m.
- REMOVE PORTION OF PILING SLEEVES ABOVE EXCAVATION LEVEL.
- RESIN ANCHOR WAILING BEAMS TO PARTY WALLS AND INSTALL PROPRIETARY HEAVY DUTY PROPS BY MAYBE OR SIMILAR APPROVED LIKE HIGH LEVEL ONES.
- CONNECT HIGH LEVEL WAILING BEAMS WITH LOWER ONES USING BOLTED VERTICAL STEEL SHAFTS @1.5m CENTRE.



EXISTING BASEMENT FLOOR PLAN



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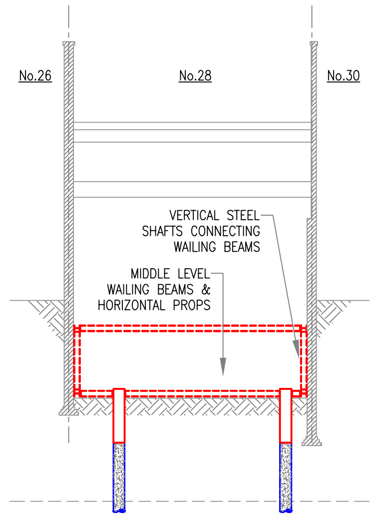

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DRAWING STATUS SCHEME

CLIENT MR MATTEO CARACCIA
28 CHARLOTTE STREET
LONDON W1T

DRAWING TITLE SUGGESTED CONSTRUCTION SEQUENCE – SHEET 1

JOB TITLE 28 CHARLOTTE STREET
FITZROVIA, LONDON W1T 2NF

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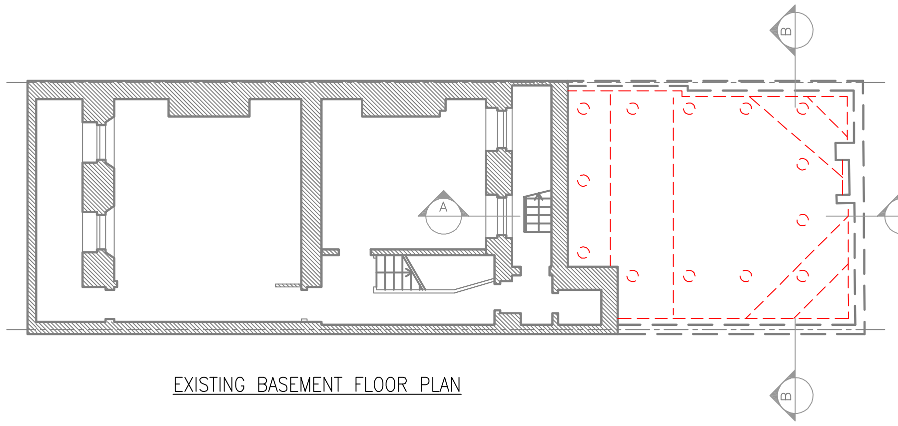
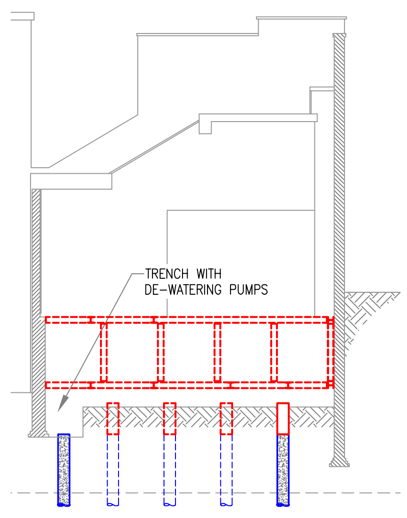
STAGE 3 – EXCAVATION & MIDDLE LEVEL PROPPING

- EXCAVATE DOWN TO FORMATION LEVEL OF PARTY WALL WITH No.26.
- REMOVE PORTION OF PILING SLEEVES ABOVE EXCAVATION LEVEL.
- INGRESS OF GROUNDWATER INTO BASEMENT EXCAVATION IS TO BE PREVENTED AT ALL TIME AND A DE-WATERING SYSTEM COMPOSED BY SUMP PUMPS IN THE FLOOR OF THE EXCAVATION MUST BE PUT IN PLACE.



EXISTING BASEMENT FLOOR PLAN



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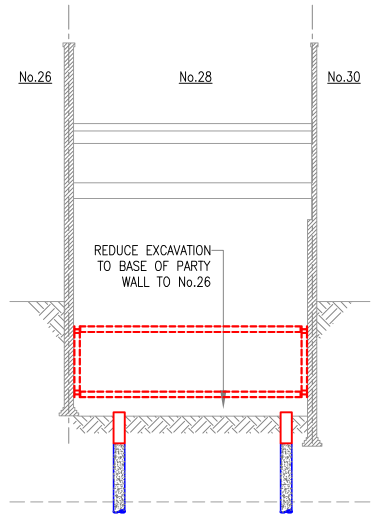

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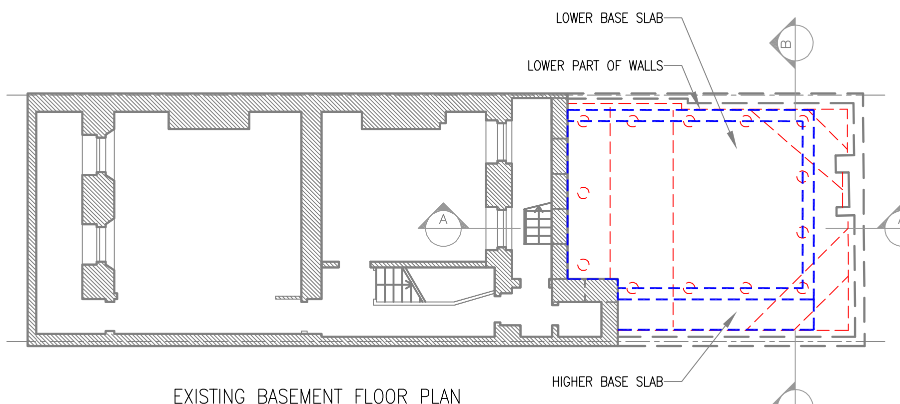
STAGE 4 – BASEMENT SLAB AND LOWER LEVEL OF RETAINING WALLS

- REDUCE EXCAVATION, BLIND FORMATION LEVEL AND CAST BASEMENT SLAB CONNECTING TO PILING REINFORCEMENT.
- PROVIDE WELL COMPACTED SOIL BETWEEN EXISTING BRICK WALL AND NEW BASEMENT SLAB UP-STANDS/KICKERS.
- WHEN CONCRETE HAS GAINED SUFFICIENT STRENGTH, CAST SIDE WALL TO No.26 UP TO U/S OF HIGHER LEVEL SLAB AND PROVIDE WELL COMPACTED SOIL BEHIND AFTERWARDS.
- WHEN CONCRETE HAS GAINED SUFFICIENT STRENGTH, CAST HIGHER LEVEL SLAB, LOWER THIRD OF BACK WALL AND LOWER THIRD OF SIDE RETAINING WALL TO No.30 UP TO LOWER LEVEL PROPS. PROVIDE WELL COMPACTED SOIL BEHIND AFTERWARDS.



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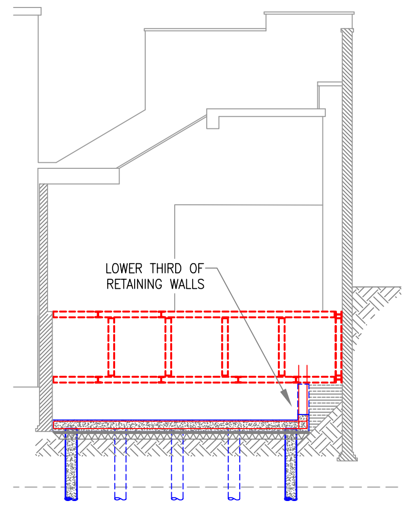

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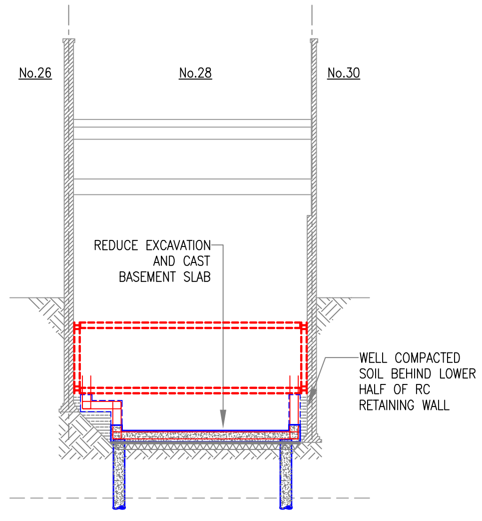

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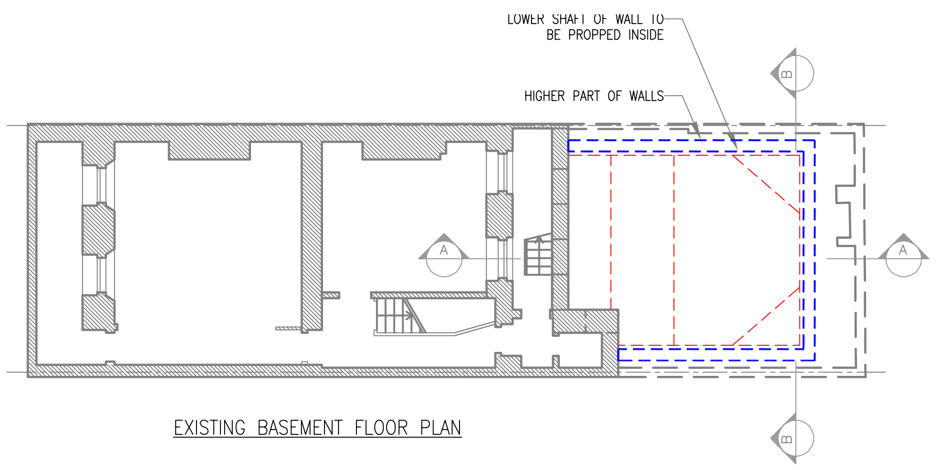
STAGE 5 – HIGHER LEVEL OF RETAINING WALLS

- MOVE DOWN LOWER LEVEL OF HORIZONTAL PROPPING AND AGAINST CONCRETE WALLS.
- REMOVE VERTICAL WALING BEAMS AGAINST PARTY WALLS AND CAST HIGHER LEVEL OF RETAINING WALLS UP TO U/S OF NEW GROUND FLOOR.
- WHEN CONCRETE HAS GAINED SUFFICIENT STRENGTH PROVIDE WELL COMPACTED SOIL BEHIND.



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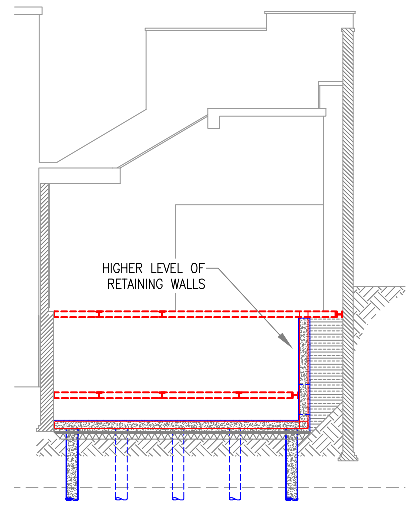

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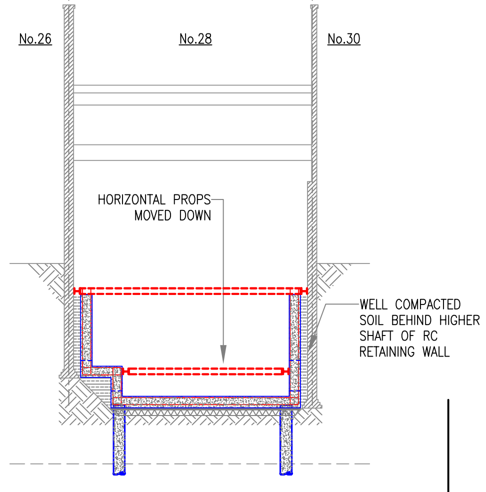

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DRAWING STATUS: SCHEME

CLIENT: MR MATTEO CARACCIA, 28 CHARLOTTE STREET, LONDON W1T

DRAWING TITLE: SUGGESTED CONSTRUCTION SEQUENCE – SHEET 2

JOB TITLE: 28 CHARLOTTE STREET, FITZROVIA, LONDON W1T 2NF

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DRG No.: SCS-02
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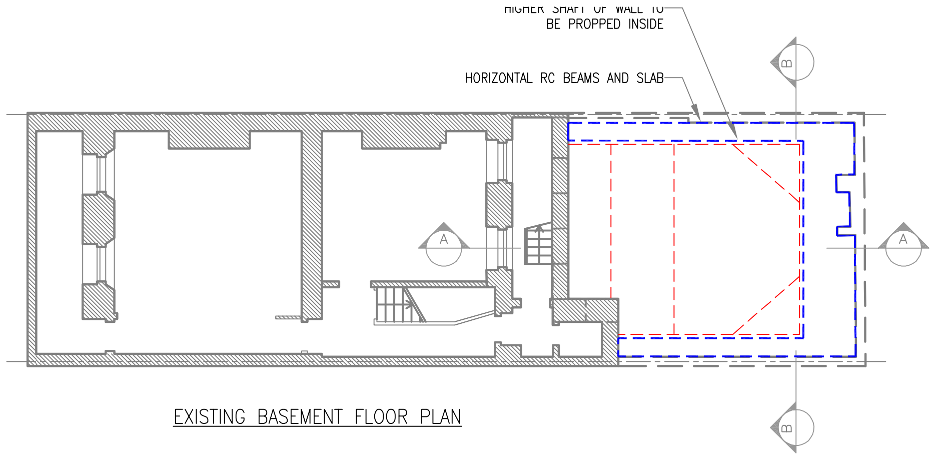
STAGE 6 – GROUND FLOOR RC STRUCTURE

- MOVE DOWN HIGHER LEVEL OF HORIZONTAL PROPPING AND AGAINST CONCRETE WALLS.
- REMOVE LOWER LEVEL OF PROPPING.
- CAST HORIZONTAL REINFORCED CONCRETE BEAMS AND SLAB AT GROUND FLOOR LEVEL.



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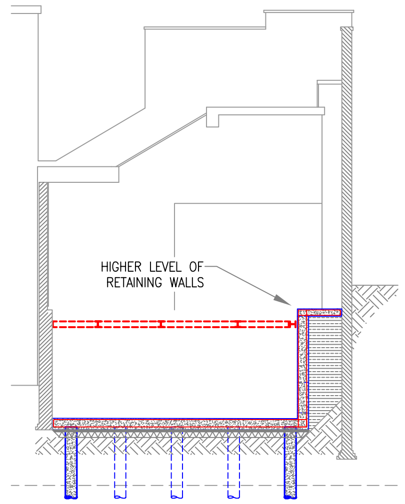

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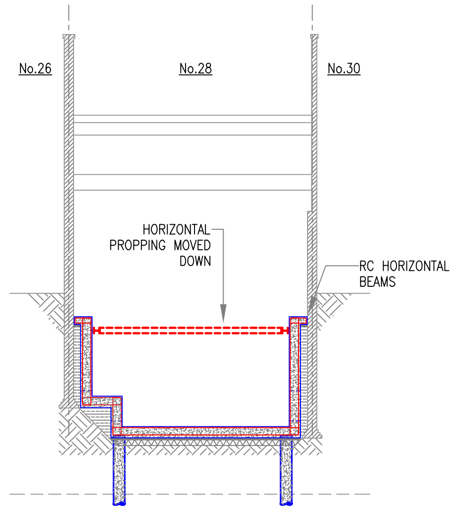

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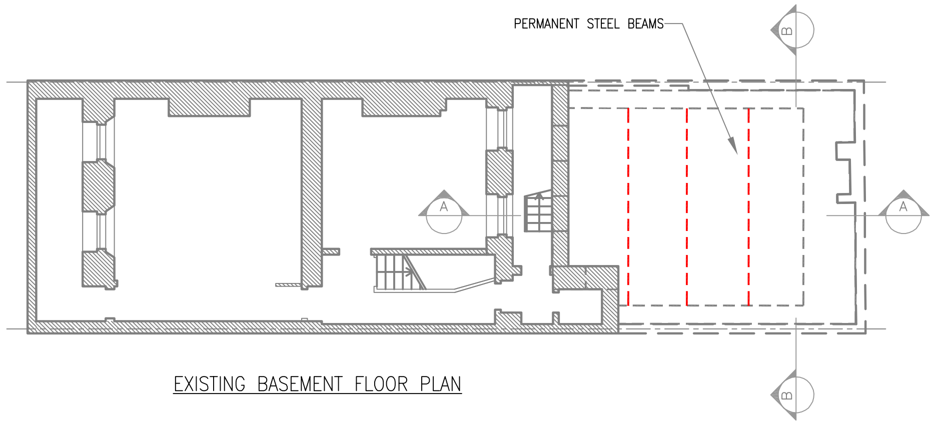
STAGE 7 – GROUND FLOOR STEEL/TIMBER STRUCTURE

- WHEN CONCRETE HAS GAINED SUFFICIENT STRENGTH, INSTALLE PERMANENT STEEL BEAMS.
- REMOVE TEMPORARY PROPPING.
- INSTALL TIMBER JOISTS AND BOARDING TO COMPLETE FLOOR STRUCTURE.
- COMPLETE CONSTRUCTION AND FINISHES AS PER ARCH'S SPECIFICATION.



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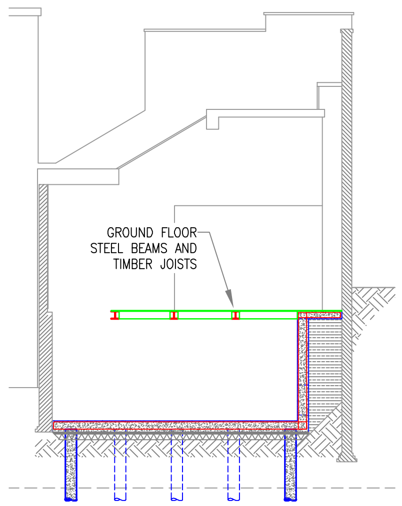

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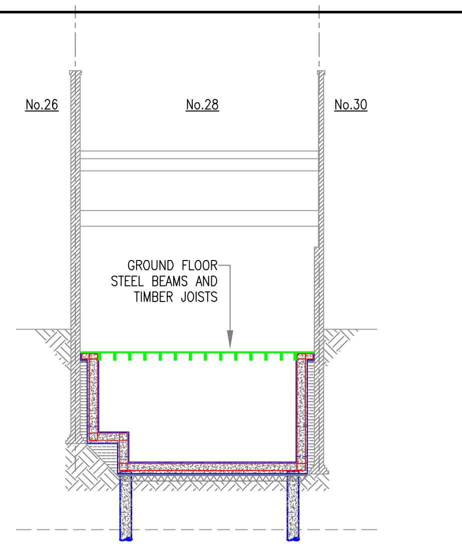

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28 CHARLOTTE STREET
LONDON W1T

DRAWING TITLE
SUGGESTED CONSTRUCTION SEQUENCE – SHEET 3

JOB TITLE
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FITZROVIA, LONDON W1T 2NF

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1964	SCS-03	A

Appendix C – Preliminary Structural Calculations

For

28, Charlotte Street

Fitzrovia

London W1T

rodriguesassociates
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EC1R 1UL
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October 2022

rodriguesassociates 1 Amwell Street, London, EC1R 1UL t: 020 7837 1133, e: www.rodriguesassociates.com	Job No.: 1964	Sheet No.: C1. 1	Rev: -
Job title: 28 Charlotte Street			
Calculations: Area Loads	Designed: AB	Date: 26/10/2022	Ckd:

Existing flat roof

Dead	Asphalt	0.40 kN/m^2
	Boarding	0.14 kN/m^2
	Insulation	0.05 kN/m^2
	Joists	0.15 kN/m^2
	Services	0.05 kN/m^2
	Plasterboard and skim coat	0.18 kN/m^2
		0.97 kN/m^2
Imposed (allowing for maintenance of structure above)		1.50 kN/m^2

External brick wall

Dead	345mm brickwork	7.70 kN/m^2
	Plaster	0.25 kN/m^2
		7.95 kN/m^2

External brick wall

Dead	215mm brickwork	4.73 kN/m^2
	Plaster	0.25 kN/m^2
		4.98 kN/m^2

Proposed ground floor internal

Dead	Finishes	0.15 kN/m^2
	Screed	1.40 kN/m^2
	Insulation	0.05 kN/m^2
	200 dp joists	0.15 kN/m^2
	Services	0.15 kN/m^2
	Plasterboard and skim coat	0.18 kN/m^2
		2.08 kN/m^2
Imposed		1.50 kN/m^2
	Partitions	1.00 kN/m^2
		2.50 kN/m^2

Proposed basement floor

Dead	Finishes	0.15 kN/m^2
	75mm Screed	1.40 kN/m^2
	Insulation	0.05 kN/m^2
	300mm RC slab	7.20 kN/m^2
		8.80 kN/m^2
Imposed		1.50 kN/m^2
	Partitions	1.00 kN/m^2
		2.50 kN/m^2

Typical floor

Dead	Finishes	0.15 kN/m^2
	Boarding	0.14 kN/m^2
	Joists	0.15 kN/m^2
	Insulation	0.05 kN/m^2
	Services	0.05 kN/m^2
	Plasterboard and skim coat	0.18 kN/m^2
		0.72 kN/m^2
Imposed		1.50 kN/m^2
	Partitions	1.00 kN/m^2
		2.50 kN/m^2

RC Retaining wall

Dead	300mm reinf. Concrete	6.00 kN/m^2
	Render	0.60 kN/m^2
	Insulation & Waterproofing	0.20 kN/m^2
	Plaster	0.25 kN/m^2
		7.05 kN/m^2

FLOTATION SEMPLIFIED CHECKS

Flotation force = Uplift as noted below

Basement area =	36.15	m2	
GW above formation level =	1.40	m	assumed 1.8m below GL
Water weight =	10	kN/m3	
F = UPLIFT	**506**	**kN**	

Resistance

Reference	Area/L m2	Dead kN/m2	kN
Proposed ground floor	26.7	2.08	55.5
Basement RC walls 300 thk	47.27	7.20	340.3
Basement RC slab 300 thk	36.15	7.20	260.3
GF RC slab and beams 200 thk	8.1	4.80	38.9

Sum = **695 kN**

F.o.S = R / F   1.37   >   1.10 Acceptable
Anchor piles are not required

Refer to relevant sheet for RC Raft design under High Groundwater Pressure
Case 1: WATER UPLIFT

Design for water = 1.4 x 10	14.00	kN/m2		
SWT of 300 thk raft = 0.3 x 24 =	-7.20	kN/m2	6.80	kN/m2 uplift

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Job title: 28 Charlotte Street			
Calculations: Calculations	Designed: AB	Date: 26/10/2022	Ckd: 0

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Job title: 28 Charlotte Street			
Calculations: Calculations	Designed: AB	Date: 26/10/2022	Ckd: 0

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Job No.: 1964	Sheet No.: C2. 1	Rev: -		
Job title: 28 Charlotte Street				
Calculations: Loads on elements	Designed: AB	Date: 26/10/2022	Ckd: 0	

Beam & Load description	Span	Area loads		Width	Location		UDL		Point loads	
		DL	LL		from	to	DL	LL	DL	LL
	mm	kN/m^2	kN/m^2	mm	mm	mm	kN/m	kN/m	kN	kN
GF steel beams										
	5200									
GF new timber floor		2.08	2.50	1630			3.39	4.08		
New basement side retaing walls supporting new GF beams										
GF new timber floor		2.08	2.50	2600			5.41	6.50		
GF RC beams to restrain top of side retaining wall										
	1630+1630+1630+1400									
retaining wall top propping force							4.00	16.20		
Piles on No 26 side										
	assumed indicative 1.5m centre									
GF	1500	2.08	2.50	2600					8.11	9.75
BF retaining wall	1500	7.20		2900					31.32	0.00
BF	1500	8.80	2.50	3300					43.56	12.38
									82.99	22.13
Piles on No 30 side										
	assumed indicative 1.5m centre									
GF	1500	2.08	2.50	2600					8.11	9.75
BF retaining wall	1500	7.20		2900					31.32	0.00
BF	1500	8.80	2.50	2500					33.00	9.38
									72.43	19.13
Piles to rear wall										
	assumed indicative 1.5m centre									
GF	1500	2.08	2.50	800					2.50	3.00
BF retaining wall	1500	7.20		2900					31.32	0.00
BF	1500	8.80	2.50	1050					13.86	3.94
GF Rc slab	1500	6.40	2.50	1000					9.60	3.75
									57.28	10.69

TIMBER JOIST ANALYSIS & DESIGN (EN1995-1-1:2004)

In accordance with EN1995-1-1:2004 + A2:2014 incorporating corrigendum June 2006 and the UK national annex

Tedds calculation version 1.0.06

Joist details

Joist spacing s_{Joist} = **400** mm

Forces input on Joist

Vertical permanent load on joist F_{G_Joist}= **2.10** kN/m^2

Vertical imposed load on joist F_{Q_Joist}= **2.50** kN/m^2

Joist loading details

Distributed loads

Vertical permanent load on joist p_G= **0.84** kN/m

Vertical imposed load on joist p_Q= **1.00** kN/m

Member results summary	Unit	Capacity	Maximum	Utilisation	Result
Bearing stress	N/mm^2	1.7	0.5	0.274	PASS
Bending stress	N/mm^2	16.2	2.8	0.175	PASS
Shear stress	N/mm^2	2.7	0.5	0.192	PASS
Beam stability check				0.175	PASS
Deflection	mm	6.5	1.1	0.170	PASS

ANALYSIS

Tedds calculation version 1.0.37

Loading

Self weight included (Permanent x 1)

Load combination factors

Load combination	Permanent	Imposed	Snow	Wind
1.35G + 1.50Q (Strength)	1.35	1.50	0.00	0.00
1.00G + 1.00Q (Service)	1.00	1.00	0.00	0.00

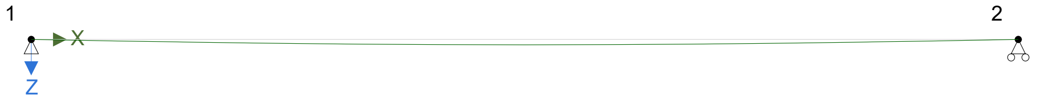
Member Loads

Member	Load case	Load Type	Orientation	Description
Member	Permanent	UDL	GlobalZ	0.84 kN/m at 0 m to 1.63 m
Member	Imposed	UDL	GlobalZ	1 kN/m at 0 m to 1.63 m

Results

Total deflection

1.35G + 1.50Q (Strength) - Total deflection



1.00G + 1.00Q (Service) - Total deflection

Node deflections

Load combination: 1.35G + 1.50Q (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.08032	
2	0	0	-0.08032	

Load combination: 1.00G + 1.00Q (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.05616	
2	0	0	-0.05616	

Total base reactions

Load case/combination	Force	
	FX (kN)	FZ (kN)
1.35G + 1.50Q (Strength)	0	4.4
1.00G + 1.00Q (Service)	0	3.1

Element end forces

Load combination: 1.35G + 1.50Q (Strength)

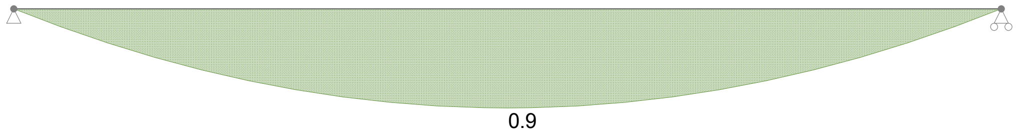
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	1.63	1	0	-2.2	0
		2	0	-2.2	0

Load combination: 1.00G + 1.00Q (Service)

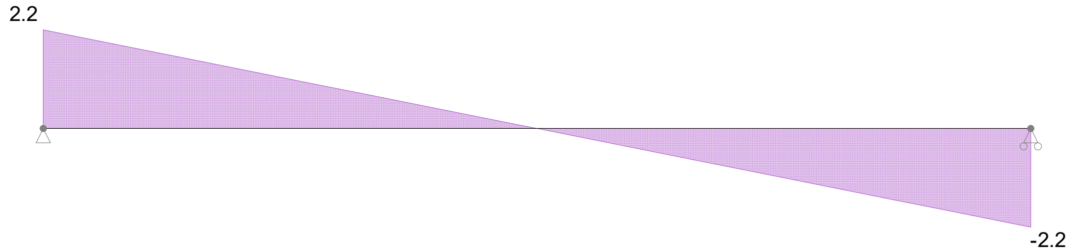
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	1.63	1	0	-1.5	0
		2	0	-1.5	0

Forces

Strength combinations - Moment envelope (kNm)



Strength combinations - Shear envelope (kN)



Member results

Envelope - Strength combinations

Member	Position (m)	Shear force (kN)		Moment (kNm)	
Member	0	2.2 (max abs)		0 (min)	
	0.815	0		0.9 (max)	
	1.63	-2.2		0 (min)	

Tedds calculation version 2.2.17

Member - Span 1

Partial factor for material properties and resistances

Partial factor γ_M = **1.300**

Member details

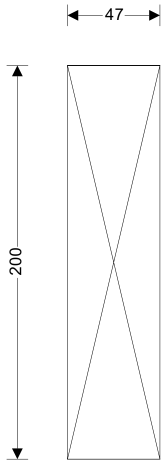
Load duration Medium-term Service class 2

Timber section details

Number of timber sections N = **1**

Breadth of sections b = **47** mm Depth of sections h = **200** mm

Timber strength class **C24**



47x200 timber section
Cross-sectional area, A, 9400 mm^2
Section modulus, W_y, 313333.3 mm^3
Section modulus, W_z, 73633 mm^3
Second moment of area, I_y, 31333333 mm^4
Second moment of area, I_z, 1730383 mm^4
Radius of gyration, i_y, 57.7 mm
Radius of gyration, i_z, 13.6 mm
Timber strength class C24
Characteristic bending strength, $f_{m.k}$, 24 N/mm^2
Characteristic shear strength, $f_{v.k}$, 4 N/mm^2
Characteristic compression strength parallel to grain, $f_{c.0.k}$, 21 N/mm^2
Characteristic compression strength perpendicular to grain, $f_{c.90.k}$, 2.5 N/mm^2
Characteristic tension strength parallel to grain, $f_{t.0.k}$, 14.5 N/mm^2
Mean modulus of elasticity, $E_{0.mean}$, 11000 N/mm^2
Fifth percentile modulus of elasticity, $E_{0.05}$, 7400 N/mm^2
Shear modulus of elasticity, G_{mean}, 690 N/mm^2
Characteristic density, ρ_k, 350 kg/m^3
Mean density, ρ_{mean}, 420 kg/m^3

Span details

Bearing length L_b = **100** mm

Consider Combination 1 - 1.35G + 1.50Q (Strength)

Check design at start of span

Check compression perpendicular to the grain - cl.6.1.5

Des.perp.comp.stress $\sigma_{c,y,90,d}$ = **0.464** N/mm^2 Des.perp.comp.strength $f_{c,y,90,d}$ = **1.692** N/mm^2

Utilisation = **0.274**

PASS - Design perpendicular compression strength exceeds design perpendicular compression stress

Check shear force - Section 6.1.7

Design shear stress $\tau_{y,d}$ = **0.520** N/mm^2 Design shear strength $f_{v,y,d}$ = **2.708** N/mm^2

Utilisation = **0.192**

PASS - Design shear strength exceeds design shear stress

Check design 815 mm along span

Check bending moment - Section 6.1.6

Design bending stress $\sigma_{m,y,d}$ = **2.838** N/mm^2 Design bending strength $f_{m,y,d}$ = **16.246** N/mm^2

Utilisation = **0.175**

PASS - Design bending strength exceeds design bending stress

Check beams subjected to either bending or combined bending and compression - cl.6.3.3

Utilisation = **0.175**

PASS - Beam stability is acceptable

Check design at end of span

Check compression perpendicular to the grain - cl.6.1.5

Des.perp.comp.stress $\sigma_{c,y,90,d}$ = **0.464** N/mm^2 Des.perp.comp.strength $f_{c,y,90,d}$ = **1.692** N/mm^2

Utilisation = **0.274**

PASS - Design perpendicular compression strength exceeds design perpendicular compression stress

Check shear force - Section 6.1.7

Design shear stress $\tau_{y,d}$ = **0.520** N/mm^2 Design shear strength $f_{v,y,d}$ = **2.708** N/mm^2

Utilisation = **0.192**

PASS - Design shear strength exceeds design shear stress

Consider Combination 2 - 1.00G + 1.00Q (Service)

Check design 815 mm along span

Check y-y axis deflection - Section 7.2

Final deflection with creep $\delta_{y,Final}$ = **1.1** mm

Allowable deflection $\delta_{y,Allowable}$ = **6.5** mm

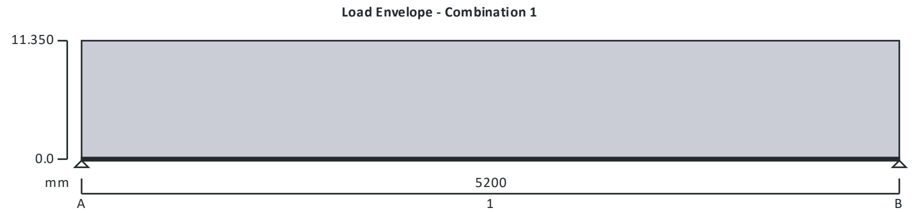
Utilisation = **0.17**

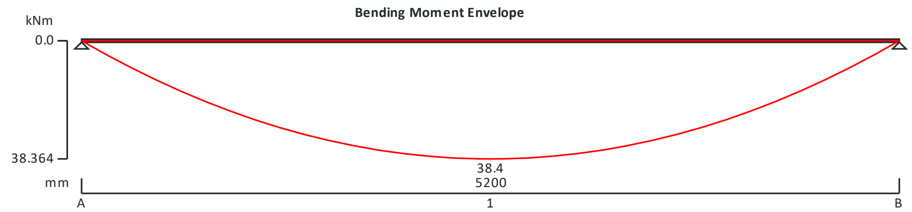
PASS - Allowable deflection exceeds final deflection

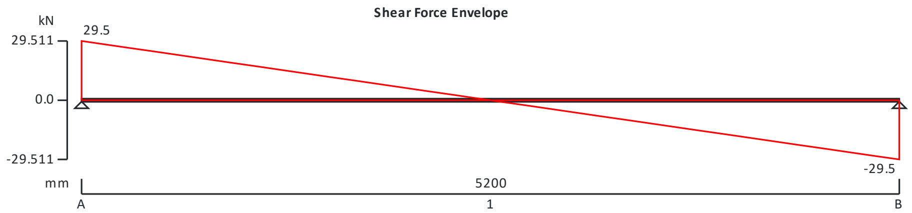
STEEL BEAM ANALYSIS & DESIGN (EN1993-1-1:2005)

In accordance with EN1993-1-1:2005 incorporating Corrigenda February 2006 and April 2009 and the UK national annex

TEDDS calculation version 3.0.14







Support conditions

Support A	Vertically restrained
	Rotationally free
Support B	Vertically restrained
	Rotationally free

Applied loading

Beam loads	Permanent self weight of beam × 1
	Permanent full UDL 3.4 kN/m
	Variable full UDL 4.1 kN/m

Load combinations

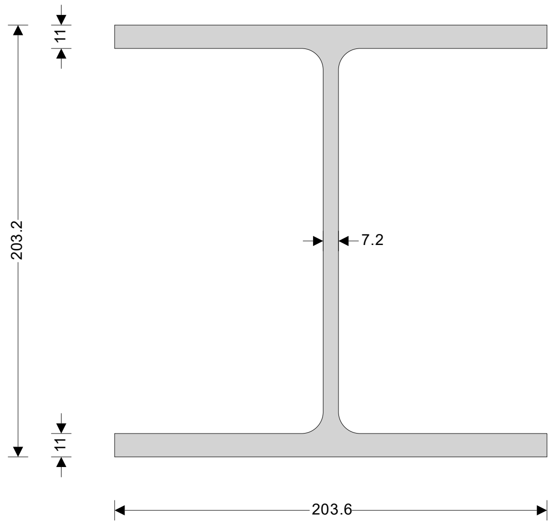
Load combination 1	Support A	Permanent × 1.35
		Variable × 1.50
		Permanent × 1.35
		Variable × 1.50
	Support B	Permanent × 1.35
		Variable × 1.50

Analysis results

Maximum moment	M_{max} = **38.4** kNm	M_{min} = **0** kNm
Maximum shear	V_{max} = **29.5** kN	V_{min} = **-29.5** kN
Deflection	δ_{max} = **7.9** mm	δ_{min} = **0** mm
Maximum reaction at support A	R_{A_max} = **29.5** kN	R_{A_min} = **29.5** kN
Unfactored permanent load reaction at support A	$R_{A\_Permanent}$ = **10** kN	
Unfactored variable load reaction at support A	$R_{A\_Variable}$ = **10.7** kN	
Maximum reaction at support B	R_{B_max} = **29.5** kN	R_{B_min} = **29.5** kN
Unfactored permanent load reaction at support B	$R_{B\_Permanent}$ = **10** kN	
Unfactored variable load reaction at support B	$R_{B\_Variable}$ = **10.7** kN	

Section details

Section type **UC 203x203x46 (BS4-1)** Steel grade **S355**



Section classification **Class 2**

Check shear - Section 6.2.6

Design shear force V_{Ed} = **30** kN Design shear resistance $V_{c,Rd}$ = **347.9** kN

PASS - Design shear resistance exceeds design shear force

Check bending moment - Section 6.2.5

Design bending moment M_{Ed} = **38.4** kNm Des.bending resist.moment $M_{c,Rd}$ = **176.6** kNm

Slenderness ratio for lateral torsional buckling

LTB slenderness ratio $\bar{\lambda}_{LT}$ = **1.493** Limiting slenderness ratio $\bar{\lambda}_{LT,0}$ = **0.400**

$\bar{\lambda}_{LT}$ > $\bar{\lambda}_{LT,0}$ - Lateral torsional buckling cannot be ignored

Design resistance for buckling - Section 6.3.2.1

Des.buckling resist.moment $M_{b,Rd}$ = **76** kNm

PASS - Design buckling resistance moment exceeds design bending moment

Check compression - Section 6.2.4

Design compression force N_{Ed} = **83** kN Design resistance of section $N_{c,Rd}$ = **2085** kN

Design resistance for buckling - Section 6.3.1.1

Design buckling resistance $N_{b,y,Rd}$ = **1546.5** kN

PASS - Design buckling resistance exceeds design compression force

Design resistance for buckling - Section 6.3.1.1

Design buckling resistance $N_{b,z,Rd}$ = **788.6** kN

PASS - Design buckling resistance exceeds design compression force

Check torsional and torsional-flexural buckling

Torsional buckling force $N_{cr,T}$ = **2770.7** kN

Torsional-flexural buckling $N_{cr,TF}$ = **2770.7** kN

Design resistance for buckling - Section 6.3.1.1

Design buckling resistance $N_{b,T,Rd}$ = **1292.6** kN

PASS - Design buckling resistance exceeds design compression force

Combined bending and axial force - Section 6.2.9

Bending and axial force check $N_{Ed} <= \min(0.25 \times N_{pl,Rd}, 0.5 \times h_w \times t_w \times f_y / \gamma_{M0})$

No allowance on the plastic moment need to be accounted for due to the effect of axial force

Interaction factors k_{ij} for members not susceptible to torsional deformations - Table B.1

Interaction formulae $N_{Ed} / (\chi_y \times N_{Rk} / \gamma_{M1}) + k_{yy} \times M_{Ed} / (\chi_{LT} \times M_{Rk} / \gamma_{M1})$ = **0.548**

$N_{Ed} / (\chi_z \times N_{Rk} / \gamma_{M1}) + k_{zy} \times M_{Ed} / (\chi_{LT} \times M_{Rk} / \gamma_{M1})$ = **0.402**

PASS - Combined bending and compression checks are satisfied

Check vertical deflection - Section 7.2.1

Consider deflection due to permanent and variable loads

Limiting deflection δ_{lim} = **14.4** mm

Maximum deflection δ = **7.892** mm

PASS - Maximum deflection does not exceed deflection limit

RETAINING WALL ANALYSIS

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.9.16

Retaining wall details

Stem type	Propped cantilever
Stem height	h_{stem} = **2700** mm
Prop height	h_{prop} = **2700** mm
Stem thickness	t_{stem} = **300** mm
Angle to rear face of stem	α = **90** deg
Stem density	γ_{stem} = **25** kN/m^3
Toe length	l_{toe} = **1000** mm
Base thickness	t_{base} = **350** mm
Base density	γ_{base} = **25** kN/m^3
Height of retained soil	h_{ret} = **2700** mm
Angle of soil surface	β = **0** deg
Depth of cover	d_{cover} = **0** mm
Height of water	h_{water} = **2700** mm
Water density	γ_w = **9.8** kN/m^3

Retained soil properties

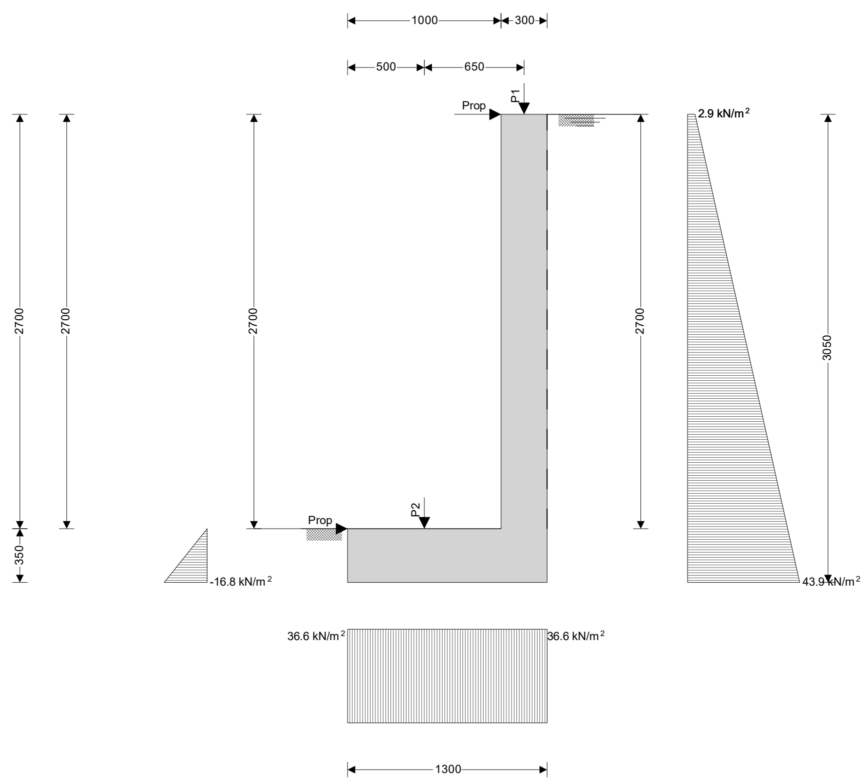
Soil type	Medium dense well graded sand and gravel
Moist density	γ_{mr} = **20** kN/m^3
Saturated density	γ_{sr} = **22.3** kN/m^3
Characteristic effective shear resistance angle	$\phi'_{r.k}$ = **30** deg
Characteristic wall friction angle	$\delta_{r.k}$ = **15** deg

Base soil properties

Soil type	Very loose brick hardcore
Soil density	γ_b = **13** kN/m^3
Characteristic effective shear resistance angle	$\phi'_{b.k}$ = **26** deg
Characteristic wall friction angle	$\delta_{b.k}$ = **13** deg
Characteristic base friction angle	$\delta_{bb.k}$ = **17.3** deg
Presumed bearing capacity	$P_{bearing}$ = **50** kN/m^2

Loading details

Variable surcharge load	$Surcharge_Q$ = **10** kN/m^2
Vertical line load at 1150 mm	P_{G1} = **5.4** kN/m
	P_{Q1} = **6.5** kN/m
Vertical line load at 500 mm	P_{G2} = **1.6** kN/m
	P_{Q2} = **2.5** kN/m



General arrangement - sketch pressures relate to bearing check

Calculate retaining wall geometry

Base length $l_{base} = l_{toe} + t_{stem} = \mathbf{1300}$ mm

Saturated soil height $h_{sat} = h_{water} + d_{cover} = \mathbf{2700}$ mm

Moist soil height $h_{moist} = h_{ret} - h_{water} = \mathbf{0}$ mm

Length of surcharge load $l_{sur} = l_{heel} = \mathbf{0}$ mm

- Distance to vertical component $x_{sur\_v} = l_{base} - l_{heel} / 2 = \mathbf{1300}$ mm

Effective height of wall $h_{eff} = h_{base} + d_{cover} + h_{ret} = \mathbf{3050}$ mm

- Distance to horizontal component $x_{sur\_h} = h_{eff} / 2 = \mathbf{1525}$ mm

Area of wall stem $A_{stem} = h_{stem} \times t_{stem} = \mathbf{0.81}$ m^2

- Distance to vertical component $x_{stem} = l_{toe} + t_{stem} / 2 = \mathbf{1150}$ mm

Area of wall base $A_{base} = l_{base} \times t_{base} = \mathbf{0.455}$ m^2

- Distance to vertical component $x_{base} = l_{base} / 2 = \mathbf{650}$ mm

Using Coulomb theory

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

Passive pressure coefficient $K_P = \sin(90 - \phi'_{b.k})^2 / (\sin(90 + \delta_{b.k}) \times [1 - \sqrt{[\sin(\phi'_{b.k} + \delta_{b.k}) \times \sin(\phi'_{b.k}) / (\sin(90 + \delta_{b.k}))]}]^2) = \mathbf{3.787}$

Bearing pressure check

Vertical forces on wall

Wall stem $F_{stem} = A_{stem} \times \gamma_{stem} = \mathbf{20.3}$ kN/m

Wall base $F_{base} = A_{base} \times \gamma_{base} = \mathbf{11.4}$ kN/m

Line loads	$F_{P\_v} = P_{G1} + P_{Q1} + P_{G2} + P_{Q2} =$ **16** kN/m
Total	$F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} + F_{water\_v} =$ **47.6** kN/m

Horizontal forces on wall

Surcharge load	$F_{sur\_h} = K_A \times \cos(\delta_{r.k}) \times Surcharge_Q \times h_{eff} =$ **8.9** kN/m
Saturated retained soil	$F_{sat\_h} = K_A \times \cos(\delta_{r.k}) \times (\gamma_{sr} - \gamma_w) \times (h_{sat} + h_{base})^2 / 2 =$ **16.8** kN/m
Water	$F_{water\_h} = \gamma_w \times (h_{water} + d_{cover} + h_{base})^2 / 2 =$ **45.6** kN/m
Base soil	$F_{pass\_h} = -K_P \times \cos(\delta_{b.k}) \times \gamma_b \times (d_{cover} + h_{base})^2 / 2 =$ **-2.9** kN/m
Total	$F_{total\_h} = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} + F_{pass\_h} =$ **68.4** kN/m

Moments on wall

Wall stem	$M_{stem} = F_{stem} \times x_{stem} =$ **23.3** kNm/m
Wall base	$M_{base} = F_{base} \times x_{base} =$ **7.4** kNm/m
Surcharge load	$M_{sur} = -F_{sur\_h} \times x_{sur\_h} =$ **-13.5** kNm/m
Line loads	$M_P = (P_{G1} + P_{Q1}) \times p_1 + (P_{G2} + P_{Q2}) \times p_2 =$ **15.7** kNm/m
Saturated retained soil	$M_{sat} = -F_{sat\_h} \times x_{sat\_h} =$ **-17.1** kNm/m
Water	$M_{water} = -F_{water\_h} \times x_{water\_h} =$ **-46.4** kNm/m
Moist retained soil	$M_{moist} = -F_{moist\_h} \times x_{moist\_h} =$ **0** kNm/m
Total	$M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{sat} + M_{water} + M_{moist} =$ **-30.6** kNm/m

Check bearing pressure

Propping force to stem	$F_{prop\_stem} = (F_{total\_v} \times l_{base} / 2 - M_{total}) / (h_{prop} + t_{base}) =$ **20.2** kN/m
Propping force to base	$F_{prop\_base} = F_{total\_h} - F_{prop\_stem} =$ **48.2** kN/m
Moment from propping force	$M_{prop} = F_{prop\_stem} \times (h_{prop} + t_{base}) =$ **61.6** kNm/m
Distance to reaction	$\bar{x} = (M_{total} + M_{prop}) / F_{total\_v} =$ **650** mm
Eccentricity of reaction	$e = \bar{x} - l_{base} / 2 =$ **0** mm
Loaded length of base	$l_{load} = l_{base} =$ **1300** mm
Bearing pressure at toe	$q_{toe} = F_{total\_v} / l_{base} \times (1 - 6 \times e / l_{base}) =$ **36.6** kN/m²
Bearing pressure at heel	$q_{heel} = F_{total\_v} / l_{base} \times (1 + 6 \times e / l_{base}) =$ **36.6** kN/m²
Factor of safety	$FoS_{bp} = P_{bearing} / \max(q_{toe}, q_{heel}) =$ **1.365**

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

RETAINING WALL DESIGN

In accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 2.9.16

Concrete details - Table 3.1 - Strength and deformation characteristics for concrete

Concrete strength class	C32/40
Characteristic compressive cylinder strength	$f_{ck} =$ **32** N/mm²
Characteristic compressive cube strength	$f_{ck,cube} =$ **40** N/mm²
Mean value of compressive cylinder strength	$f_{cm} = f_{ck} + 8$ N/mm² = **40** N/mm²
Mean value of axial tensile strength	$f_{ctm} = 0.3$ N/mm² $\times (f_{ck} / 1$ N/mm²$)^{2/3} =$ **3.0** N/mm²
5% fractile of axial tensile strength	$f_{ctk,0.05} = 0.7 \times f_{ctm} =$ **2.1** N/mm²
Secant modulus of elasticity of concrete	$E_{cm} = 22$ kN/mm² $\times (f_{cm} / 10$ N/mm²$)^{0.3} =$ **33346** N/mm²
Partial factor for concrete - Table 2.1N	$\gamma_C =$ **1.50**
Compressive strength coefficient - cl.3.1.6(1)	$\alpha_{cc} =$ **0.85**
Design compressive concrete strength - exp.3.15	$f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_C =$ **18.1** N/mm²
Maximum aggregate size	$h_{agg} =$ **20** mm

Ultimate strain - Table 3.1 ε_{cu2} = **0.0035**

Shortening strain - Table 3.1 ε_{cu3} = **0.0035**

Effective compression zone height factor λ = **0.80**

Effective strength factor η = **1.00**

Bending coefficient k_1 K_1 = **0.40**

Bending coefficient k_2 $K_2 = 1.00 \times (0.6 + 0.0014/\varepsilon_{cu2})$ = **1.00**

Bending coefficient k_3 K_3 =**0.40**

Bending coefficient k_4 $K_4 = 1.00 \times (0.6 + 0.0014/\varepsilon_{cu2})$ =**1.00**

Reinforcement details

Characteristic yield strength of reinforcement f_{yk} = **500** N/mm^2

Modulus of elasticity of reinforcement E_s = **200000** N/mm^2

Partial factor for reinforcing steel - Table 2.1N γ_S = **1.15**

Design yield strength of reinforcement $f_{yd} = f_{yk} / \gamma_S$ = **435** N/mm^2

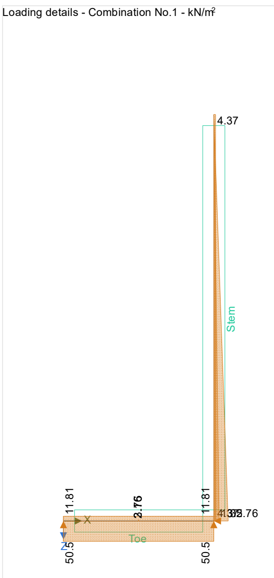
Cover to reinforcement

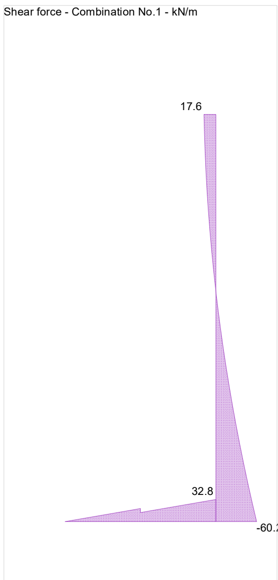
Front face of stem c_{sf} = **25** mm

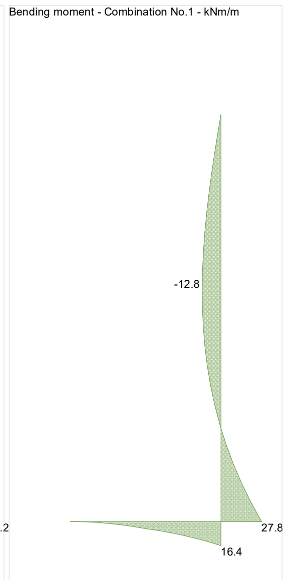
Rear face of stem c_{sr} = **50** mm

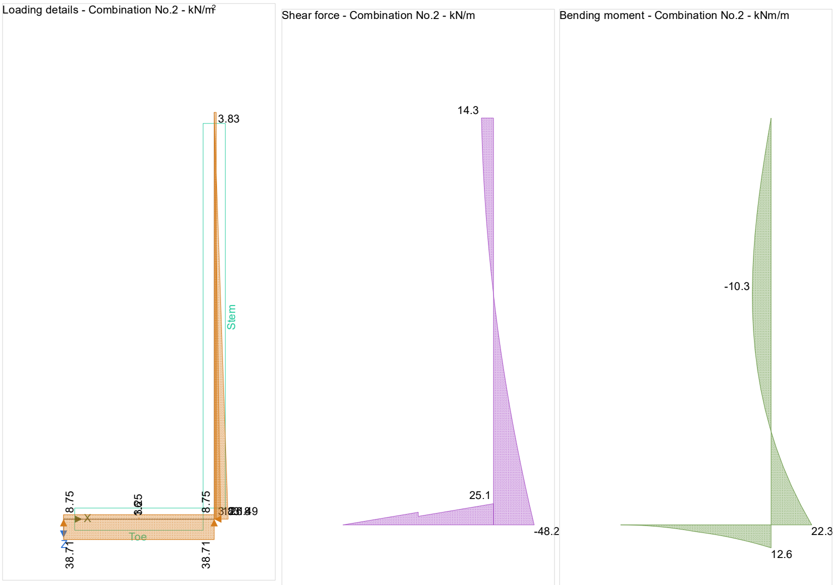
Top face of base c_{bt} = **25** mm

Bottom face of base c_{bb} = **75** mm









Check stem design at 1350 mm

Depth of section — $h = \mathbf{300}$ mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 — $M = \mathbf{12.8}$ kNm/m

Depth to tension reinforcement — $d = h - c_{sf} - \phi_{sx} - \phi_{sfM} / 2 = \mathbf{257}$ mm

$K = M / (d^2 \times f_{ck}) = \mathbf{0.006}$

$K' = (2 \times \eta \times \alpha_{cc}/\gamma_C)\times(1 - \lambda \times (\delta - K_1)/(2 \times K_2))\times(\lambda \times (\delta - K_1)/(2 \times K_2))$

$K' = \mathbf{0.207}$

K' > K - No compression reinforcement is required

Lever arm — $z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_C))^{0.5}, 0.95) \times d = \mathbf{244}$ mm

Depth of neutral axis — $x = 2.5 \times (d – z) = \mathbf{32}$ mm

Area of tension reinforcement required — $A_{sfM.req} = M / (f_{yd} \times z) = \mathbf{121}$ mm²/m

Tension reinforcement provided — 12 dia.bars @ 200 c/c

Area of tension reinforcement provided — $A_{sfM.prov} = \pi \times \phi_{sfM}^2 / (4 \times s_{sfM}) = \mathbf{565}$ mm²/m

Minimum area of reinforcement - exp.9.1N — $A_{sfM.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d = \mathbf{404}$ mm²/m

Maximum area of reinforcement - cl.9.2.1.1(3) — $A_{sfM.max} = 0.04 \times h = \mathbf{12000}$ mm²/m

$\max(A_{sfM.req}, A_{sfM.min}) / A_{sfM.prov} = \mathbf{0.715}$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single output

Deflection control - Section 7.4

Reference reinforcement ratio — $\rho_0 = \sqrt{}(f_{ck} / 1\ \text{N/mm}^2) / 1000 = \mathbf{0.006}$

Required tension reinforcement ratio — $\rho = A_{sfM.req} / d = \mathbf{0.000}$

Required compression reinforcement ratio — $\rho' = A_{sfM.2.req} / d_2 = \mathbf{0.000}$

Structural system factor - Table 7.4N — $K_b = \mathbf{1}$

Reinforcement factor - exp.7.17 — $K_s = \min(500\ \text{N/mm}^2 / (f_{yk} \times A_{sfM.req} / A_{sfM.prov}), 1.5) = \mathbf{1.5}$

Limiting span to depth ratio - exp.7.16.a — $\min(K_s \times K_b \times [11 + 1.5 \times \sqrt{}(f_{ck} / 1\ \text{N/mm}^2) \times \rho_0 / \rho + 3.2 \times \sqrt{}(f_{ck} / 1\ \text{N/mm}^2) \times (\rho_0 / \rho - 1)^{3/2}], 40 \times K_b) = \mathbf{40}$

Actual span to depth ratio — $h_{prop} / d = \mathbf{10.5}$

PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3

Limiting crack width	w_{max} = **0.3** mm
Variable load factor - EN1990 – Table A1.1	ψ_2 = **0.6**
Serviceability bending moment	M_{sls} = **8.7** kNm/m
Tensile stress in reinforcement	$\sigma_s = M_{sls} / (A_{sfM.prov} \times z)$ = **63.4** N/mm^2
Load duration	Long term
Load duration factor	k_t = **0.4**
Effective area of concrete in tension	$A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$
	$A_{c.eff}$ = **89292** mm^2/m
Mean value of concrete tensile strength	$f_{ct.eff} = f_{ctm}$ = **3.0** N/mm^2
Reinforcement ratio	$\rho_{p.eff} = A_{sfM.prov} / A_{c.eff}$ = **0.006**
Modular ratio	$\alpha_e = E_s / E_{cm}$ = **5.998**
Bond property coefficient	k_1 = **0.8**
Strain distribution coefficient	k_2 = **0.5**
	k_3 = **3.4**
	k_4 = **0.425**
Maximum crack spacing - exp.7.11	$s_{r.max} = k_3 \times c_{sf} + k_1 \times k_2 \times k_4 \times \phi_{sfM} / \rho_{p.eff}$ = **407** mm
Maximum crack width - exp.7.8	$w_k = s_{r.max} \times \max(\sigma_s - k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$
	w_k = **0.077** mm
	w_k / w_{max} = **0.258**

PASS - Maximum crack width is less than limiting crack width

Check stem design at base of stem

Depth of section	h = **300** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1	M = **27.8** kNm/m
Depth to tension reinforcement	$d = h - c_{sr} - \phi_{sr} / 2$ = **244** mm
	$K = M / (d^2 \times f_{ck})$ = **0.015**
	$K' = (2 \times \eta \times \alpha_{cc}/\gamma_C)\times(1 - \lambda \times (\delta - K_1)/(2 \times K_2))\times(\lambda \times (\delta - K_1)/(2 \times K_2))$
	K' = **0.207**

K' > K - No compression reinforcement is required

Lever arm	$z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_C))^{0.5}, 0.95) \times d$ = **232** mm
Depth of neutral axis	$x = 2.5 \times (d - z)$ = **31** mm
Area of tension reinforcement required	$A_{sr.req} = M / (f_{yd} \times z)$ = **276** mm^2/m
Tension reinforcement provided	12 dia.bars @ 200 c/c
Area of tension reinforcement provided	$A_{sr.prov} = \pi \times \phi_{sr}^2 / (4 \times s_{sr})$ = **565** mm^2/m
Minimum area of reinforcement - exp.9.1N	$A_{sr.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d$ = **384** mm^2/m
Maximum area of reinforcement - cl.9.2.1.1(3)	$A_{sr.max} = 0.04 \times h$ = **12000** mm^2/m
	$\max(A_{sr.req}, A_{sr.min}) / A_{sr.prov}$ = **0.678**

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single output

Deflection control - Section 7.4

Reference reinforcement ratio	$\rho_0 = \sqrt{}(f_{ck} / 1 \text{ N/mm}^2) / 1000$ = **0.006**
Required tension reinforcement ratio	$\rho = A_{sr.req} / d$ = **0.001**
Required compression reinforcement ratio	$\rho' = A_{sr.2.req} / d_2$ = **0.000**
Structural system factor - Table 7.4N	K_b = **1**
Reinforcement factor - exp.7.17	$K_s = \min(500 \text{ N/mm}^2 / (f_{yk} \times A_{sr.req} / A_{sr.prov}), 1.5)$ = **1.5**

Limiting span to depth ratio - exp.7.16.a — $\min(K_s \times K_b \times [11 + 1.5 \times \sqrt{}(f_{ck} / 1 \text{ N/mm}^2) \times \rho_0 / \rho + 3.2 \times \sqrt{}(f_{ck} / 1 \text{ N/mm}^2) \times (\rho_0 / \rho - 1)^{3/2}], 40 \times K_b) = \mathbf{40}$

Actual span to depth ratio — $h_{prop} / d = \mathbf{11.1}$

PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3

Limiting crack width — $w_{max} = \mathbf{0.3}$ mm

Variable load factor - EN1990 – Table A1.1 — $\psi_2 = \mathbf{0.6}$

Serviceability bending moment — $M_{sls} = \mathbf{19.2}$ kNm/m

Tensile stress in reinforcement — $\sigma_s = M_{sls} / (A_{sr.prov} \times z) = \mathbf{146.6}$ N/mm^2

Load duration — Long term

Load duration factor — $k_t = \mathbf{0.4}$

Effective area of concrete in tension — $A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$

$A_{c.eff} = \mathbf{89833}$ mm^2/m

Mean value of concrete tensile strength — $f_{ct.eff} = f_{ctm} = \mathbf{3.0}$ N/mm^2

Reinforcement ratio — $\rho_{p.eff} = A_{sr.prov} / A_{c.eff} = \mathbf{0.006}$

Modular ratio — $\alpha_e = E_s / E_{cm} = \mathbf{5.998}$

Bond property coefficient — $k_1 = \mathbf{0.8}$

Strain distribution coefficient — $k_2 = \mathbf{0.5}$

$k_3 = \mathbf{3.4}$

$k_4 = \mathbf{0.425}$

Maximum crack spacing - exp.7.11 — $s_{r.max} = k_3 \times c_{sr} + k_1 \times k_2 \times k_4 \times \phi_{sr} / \rho_{p.eff} = \mathbf{494}$ mm

Maximum crack width - exp.7.8 — $w_k = s_{r.max} \times \max(\sigma_s – k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$

$w_k = \mathbf{0.217}$ mm

$w_k / w_{max} = \mathbf{0.724}$

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force — $V = \mathbf{60.2}$ kN/m

$C_{Rd,c} = 0.18 / \gamma_C = \mathbf{0.120}$

$k = \min(1 + \sqrt{}(200 \text{ mm} / d), 2) = \mathbf{1.905}$

Longitudinal reinforcement ratio — $\rho_l = \min(A_{sr.prov} / d, 0.02) = \mathbf{0.002}$

$v_{min} = 0.035 \text{ N}^{1/2}/\text{mm} \times k^{3/2} \times f_{ck}^{0.5} = \mathbf{0.521}$ N/mm^2

Design shear resistance - exp.6.2a & 6.2b — $V_{Rd.c} = \max(C_{Rd.c} \times k \times (100 \text{ N}^2/\text{mm}^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$

$V_{Rd.c} = \mathbf{127.1}$ kN/m

$V / V_{Rd.c} = \mathbf{0.474}$

PASS - Design shear resistance exceeds design shear force

Check stem design at prop

Depth of section — $h = \mathbf{300}$ mm

Rectangular section in shear - Section 6.2

Design shear force — $V = \mathbf{17.6}$ kN/m

$C_{Rd,c} = 0.18 / \gamma_C = \mathbf{0.120}$

$k = \min(1 + \sqrt{}(200 \text{ mm} / d), 2) = \mathbf{1.905}$

Longitudinal reinforcement ratio — $\rho_l = \min(A_{sr1.prov} / d, 0.02) = \mathbf{0.002}$

$v_{min} = 0.035 \text{ N}^{1/2}/\text{mm} \times k^{3/2} \times f_{ck}^{0.5} = \mathbf{0.521}$ N/mm^2

Design shear resistance - exp.6.2a & 6.2b — $V_{Rd.c} = \max(C_{Rd.c} \times k \times (100 \text{ N}^2/\text{mm}^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$

$V_{Rd.c} = \mathbf{127.1}$ kN/m

$V / V_{Rd.c}$ = **0.139**

PASS - Design shear resistance exceeds design shear force

Horizontal reinforcement parallel to face of stem - Section 9.6

Minimum area of reinforcement – cl.9.6.3(1) — $A_{sx.req} = \max(0.25 \times A_{sr.prov}, 0.001 \times t_{stem})$ = **300** mm²/m

Maximum spacing of reinforcement – cl.9.6.3(2) — s_{sx_max} = **400** mm

Transverse reinforcement provided — 12 dia.bars @ 200 c/c

Area of transverse reinforcement provided — $A_{sx.prov} = \pi \times \phi_{sx}^2 / (4 \times s_{sx})$ = **565** mm²/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Check base design at toe

Depth of section — h = **350** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 — M = **16.4** kNm/m

Depth to tension reinforcement — $d = h - c_{bb} - \phi_{bb} / 2$ = **269** mm

$K = M / (d^2 \times f_{ck})$ = **0.007**

$K' = (2 \times \eta \times \alpha_{cc}/\gamma_C)\times(1 - \lambda \times (\delta - K_1)/(2 \times K_2))\times(\lambda \times (\delta - K_1)/(2 \times K_2))$

K' = **0.207**

K' > K - No compression reinforcement is required

Lever arm — $z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_C))^{0.5}, 0.95) \times d$ = **256** mm

Depth of neutral axis — $x = 2.5 \times (d - z)$ = **34** mm

Area of tension reinforcement required — $A_{bb.req} = M / (f_{yd} \times z)$ = **147** mm²/m

Tension reinforcement provided — 12 dia.bars @ 200 c/c

Area of tension reinforcement provided — $A_{bb.prov} = \pi \times \phi_{bb}^2 / (4 \times s_{bb})$ = **565** mm²/m

Minimum area of reinforcement - exp.9.1N — $A_{bb.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d$ = **423** mm²/m

Maximum area of reinforcement - cl.9.2.1.1(3) — $A_{bb.max} = 0.04 \times h$ = **14000** mm²/m

$\max(A_{bb.req}, A_{bb.min}) / A_{bb.prov}$ = **0.748**

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single output

Crack control - Section 7.3

Limiting crack width — w_{max} = **0.3** mm

Variable load factor - EN1990 – Table A1.1 — ψ_2 = **0.6**

Serviceability bending moment — M_{sls} = **12.4** kNm/m

Tensile stress in reinforcement — $\sigma_s = M_{sls} / (A_{bb.prov} \times z)$ = **85.8** N/mm²

Load duration — Long term

Load duration factor — k_t = **0.4**

Effective area of concrete in tension — $A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$

$A_{c.eff}$ = **105458** mm²/m

Mean value of concrete tensile strength — $f_{ct.eff} = f_{ctm}$ = **3.0** N/mm²

Reinforcement ratio — $\rho_{p.eff} = A_{bb.prov} / A_{c.eff}$ = **0.005**

Modular ratio — $\alpha_e = E_s / E_{cm}$ = **5.998**

Bond property coefficient — k_1 = **0.8**

Strain distribution coefficient — k_2 = **0.5**

k_3 = **3.4**

k_4 = **0.425**

Maximum crack spacing - exp.7.11 — $s_{r.max} = k_3 \times c_{bb} + k_1 \times k_2 \times k_4 \times \phi_{bb} / \rho_{p.eff}$ = **635** mm

Maximum crack width - exp.7.8 — $w_k = s_{r.max} \times \max(\sigma_s - k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$

w_k = **0.163** mm

w_k / w_{max} = **0.545**

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force — V = **32.8** kN/m

$C_{Rd,c}$ = 0.18 / γ_C = **0.120**

k = min(1 + √(200 mm / d), 2) = **1.862**

Longitudinal reinforcement ratio — ρ_l = min($A_{bb.prov}$ / d, 0.02) = **0.002**

v_{min} = 0.035 $N^{1/2}$/mm × $k^{3/2}$ × $f_{ck}^{0.5}$ = **0.503** N/mm²

Design shear resistance - exp.6.2a & 6.2b — $V_{Rd.c}$ = max($C_{Rd.c}$ × k × (100 N²/mm⁴ × ρ_l × f_{ck})$^{1/3}$, v_{min}) × d

$V_{Rd.c}$ = **135.3** kN/m

V / $V_{Rd.c}$ = **0.242**

PASS - Design shear resistance exceeds design shear force

Secondary transverse reinforcement to base - Section 9.3

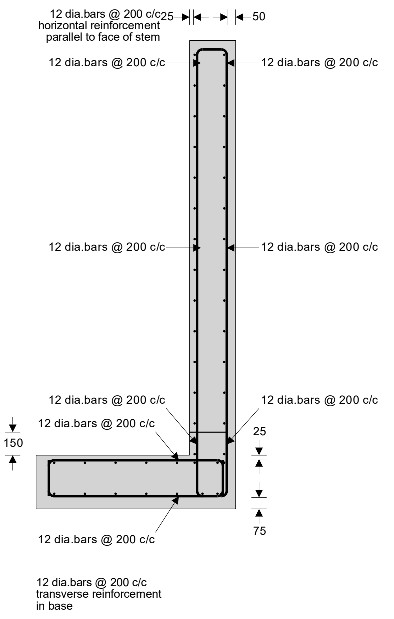
Minimum area of reinforcement – cl.9.3.1.1(2) — $A_{bx.req}$ = 0.2 × $A_{bb.prov}$ = **113** mm²/m

Maximum spacing of reinforcement – cl.9.3.1.1(3) — s_{bx_max} = **450** mm

Transverse reinforcement provided — 12 dia.bars @ 200 c/c

Area of transverse reinforcement provided — $A_{bx.prov}$ = π × ϕ_{bx}^2 / (4 × s_{bx}) = **565** mm²/m

PASS - Area of reinforcement provided is greater than area of reinforcement required



Reinforcement details

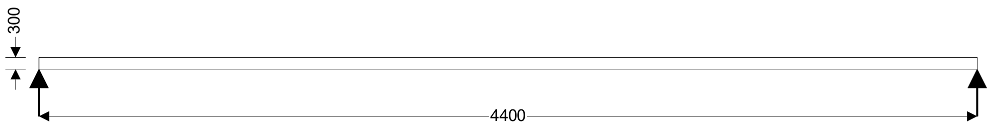
RC SLAB DESIGN

In accordance with EN1992-1-1:2004 incorporating corrigendum January 2008 and the UK national annex

Tedds calculation version 1.0.22

Design summary

Description	Unit	Provided	Required	Utilisation	Result
Support 1					
Tension reinf.	mm²/m	565	415	0.734	PASS
Tension bar spacing	mm	200	300	0.667	PASS
Shear	kN/m	133.7	38.0	0.284	PASS
Span 1					
Tension reinf.	mm²/m	565	344	0.609	PASS
Tension bar spacing	mm	200	300	0.667	PASS
Allow. span-to-depth ratio		20.09	40.00	0.502	PASS
Support 2					
Tension reinf.	mm²/m	565	415	0.734	PASS
Tension bar spacing	mm	200	300	0.667	PASS
Shear	kN/m	133.7	38.0	0.284	PASS
Cover					
Min cover top	mm	30	22	0.733	PASS
Min cover bottom	mm	75	22	0.293	PASS



Slab definition

Slab reference name **basement slab**

Overall slab depth h = **300** mm

Number of spans N_{spans} = **1**

First support **Monolithic**

Last support **Monolithic**

Nominal cover to top reinforcement c_{nom_t} = **30** mm

Nominal cover to bottom reinforcement c_{nom_b} = **75** mm

Loading

Ratio of quasi-permanent to ultimate load r_q = **0.620**

Concrete properties

Concrete strength class C32/40

Characteristic cylinder strength f_{ck} = **32** N/mm²

Partial factor (Table 2.1N) γ_C = **1.50**

Compressive strength factor (cl. 3.1.6) α_{cc} = **0.85**

Design compressive strength (cl. 3.1.6) f_{cd} = **18.1** N/mm²

Mean axial tensile strength (Table 3.1) $f_{ctm} = 0.30\ N/mm^2 \times (f_{ck} / 1\ N/mm^2)^{2/3}$ = **3.0** N/mm²

Maximum aggregate size d_g = **20** mm

Reinforcement properties

Characteristic yield strength f_{yk} = **500** N/mm²

Partial factor (Table 2.1N) γ_S = **1.15**

Design yield strength (fig. 3.8) $f_{yd} = f_{yk} / \gamma_S$ = **434.8** N/mm²

Concrete cover to reinforcement

Nominal cover to top reinforcement c_{nom_t} = **30** mm

Nominal cover to bottom reinforcement c_{nom_b} = **75** mm

Fire resistance period to top of slab R_{top} = **60** min

Fire resistance period to bottom of slab R_{btm} = **30** min

Axis distance to top reinft (Table 5.8) a_{fi_t} = **20** mm

Axis distance to bottom reinft (Table 5.8) a_{fi_b} = **10** mm

Max bar diameter in top ϕ_{max_t} = **12** mm

Max bar diameter in bottom ϕ_{max_b} = **12** mm

Min. top cover requirement with regard to bond $c_{min,b\_t} = \phi_{max\_t}$ = **12** mm

Min. btm cover requirement with regard to bond $c_{min,b\_b} = \phi_{max\_b}$ = **12** mm

Reinforcement fabrication **Not subject to QA system**

Cover allowance for deviation Δc_{dev} = **10** mm

Min. required nominal cover to top reinft $c_{nom\_t\_min} = \max(a_{fi\_t} - \phi_{max\_t} / 2, c_{min,b\_t} + \Delta c_{dev})$ = **22.0** mm

Min. required nominal cover to bottom reinft $c_{nom\_b\_min} = \max(a_{fi\_b} - \phi_{max\_b} / 2, c_{min,b\_b} + \Delta c_{dev})$ = **22.0** mm

PASS - There is sufficient cover to the top reinforcement

PASS - There is sufficient cover to the bottom reinforcement

Bending design checks

Redistribution ratio δ = **1.0**

Limiting value of K $K' = 0.598 \times \delta - 0.18 \times \delta^2 - 0.21$ = **0.208**

Reinforcement design at midspan of span 1 (cl.6.1)

Length of span 1 l_1 = **4400** mm

Design bending moment M_{p1} = **27.8** kNm/m

Reinforcement provided **12 mm dia. bars at 200 mm centres**

Area provided A_{sp1} = **565** mm²/m

Effective depth to tension reinforcement $d_{p1} = h - c_{nom\_b} - \phi_{p1} / 2$ = **219.0** mm

K factor $K = M_{p1} / (b \times d_{p1}^2 \times f_{ck})$ = **0.018**

K < K' - Compression reinforcement is not required

Lever arm $z = \min(0.95 \times d_{p1}, d_{p1} / 2 \times (1 + \sqrt{(1 - 3.53 \times K)}))$

z = **208.0** mm

Area of reinforcement required for bending $A_{sp1\_m} = M_{p1} / (f_{yd} \times z)$ = **307** mm²/m

Minimum area required $A_{sp1\_min} = \max(0.26 \times (f_{ctm}/f_{yk}), 0.0013) \times b \times d_{p1}$ = **344** mm²/m

Area of reinforcement required $A_{sp1\_req} = \max(A_{sp1\_m}, A_{sp1\_min})$ = **344** mm²/m

PASS - Area of tension reinforcement provided is adequate (0.609)

Check reinforcement spacing

Reinforcement service stress $\sigma_s = (f_{yk} / \gamma_S) \times \min((A_{sp1\_m}/A_{sp1}), 1.0) \times r_q$ = **146.5** N/mm²

Maximum allowable spacing (Table 7.3N) s_{max_p1} = **300** mm

Actual bar spacing s_{p1} = **200** mm

PASS - The reinforcement spacing is acceptable

Reinforcement design at support 1 (cl.6.1)

Design bending moment M_{n1} = **27.8** kNm/m

Reinforcement provided **12 mm dia. bars at 200 mm centres**

Area provided A_{sn1} = **565** mm²/m

Effective depth to tension reinforcement $d_{n1} = h - c_{nom\_t} - \phi_{n1} / 2$ = **264.0** mm

K factor $K = M_{n1} / (b \times d_{n1}^2 \times f_{ck})$ = **0.012**

K < K' - Compression reinforcement is not required

Lever arm $z = \min(0.95 \times d_{n1}, d_{n1} / 2 \times (1 + \sqrt{(1 - 3.53 \times K)}))$

$z = \mathbf{250.8}$ mm

Area of reinforcement required for bending $A_{sn1\_m} = M_{n1} / (f_{yd} \times z) = \mathbf{255}$ mm²/m

Minimum area required $A_{sn1\_min} = \max(0.26 \times (f_{ctm}/f_{yk}), 0.0013) \times b \times d_{n1} = \mathbf{415}$ mm²/m

Area of reinforcement required $A_{sn1\_req} = \max(A_{sn1\_m}, A_{sn1\_min}) = \mathbf{415}$ mm²/m

PASS - Area of tension reinforcement provided is adequate (0.734)

Check reinforcement spacing

Reinforcement service stress $\sigma_s = (f_{yk} / \gamma_S) \times \min((A_{sn1\_m}/A_{sn1}), 1.0) \times r_q =$ **121.5** N/mm²

Maximum allowable spacing (Table 7.3N) $s_{max\_n1} = \mathbf{300}$ mm

Actual bar spacing $s_{n1} = \mathbf{200}$ mm

PASS - The reinforcement spacing is acceptable

Reinforcement design at support 2 (cl.6.1)

Design bending moment $M_{n2} = \mathbf{27.8}$ kNm/m

Reinforcement provided **12 mm dia. bars at 200 mm centres**

Area provided $A_{sn2} = \mathbf{565}$ mm²/m

Effective depth to tension reinforcement $d_{n2} = h - c_{nom\_t} - \phi_{n2} / 2 = \mathbf{264.0}$ mm

K factor $K = M_{n2} / (b \times d_{n2}^2 \times f_{ck}) = \mathbf{0.012}$

K < K' - Compression reinforcement is not required

Lever arm $z = \min(0.95 \times d_{n2}, d_{n2} / 2 \times (1 + \sqrt{(1 - 3.53 \times K)}))$

$z = \mathbf{250.8}$ mm

Area of reinforcement required for bending $A_{sn2\_m} = M_{n2} / (f_{yd} \times z) = \mathbf{255}$ mm²/m

Minimum area required $A_{sn2\_min} = \max(0.26 \times (f_{ctm}/f_{yk}), 0.0013) \times b \times d_{n2} = \mathbf{415}$ mm²/m

Area of reinforcement required $A_{sn2\_req} = \max(A_{sn2\_m}, A_{sn2\_min}) = \mathbf{415}$ mm²/m

PASS - Area of tension reinforcement provided is adequate (0.734)

Check reinforcement spacing

Reinforcement service stress $\sigma_s = (f_{yk} / \gamma_S) \times \min((A_{sn2\_m}/A_{sn2}), 1.0) \times r_q =$ **121.5** N/mm²

Maximum allowable spacing (Table 7.3N) $s_{max\_n2} = \mathbf{300}$ mm

Actual bar spacing $s_{n2} = \mathbf{200}$ mm

PASS - The reinforcement spacing is acceptable

Shear design checks

Shear resistance constant (cl. 6.2.2) $C_{Rd,c} = 0.18 \text{ N/mm}^2 / \gamma_C = \mathbf{0.12}$ N/mm²

Shear capacity check at support 1

Shear force $V_1 =$ **38.0** kN/m

Effective depth factor (cl. 6.2.2) $k = \min(2.0, 1 + (200 \text{ mm} / d_{n1})^{0.5}) = \mathbf{1.870}$

Reinforcement ratio $\rho_l = \min(0.02, A_{sn1} / (b \times d_{n1})) = \mathbf{0.0021}$

Minimum shear resistance (Exp. 6.3N) $V_{Rd,c\_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{n1}$

$V_{Rd,c\_min} = \mathbf{133.7}$ kN/m

Shear resistance (Exp. 6.2a) $V_{Rd,c1} = \max(V_{Rd,c\_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck}/1 \text{ N/mm}^2))^{0.333} \times b \times d_{n1})$

$V_{Rd,c1} = \mathbf{133.7}$ kN/m

PASS - Shear capacity is adequate (0.284)

Shear capacity check at support 2

Shear force $V_2 =$ **38.0** kN/m

Effective depth factor (cl. 6.2.2) $k = \min(2.0, 1 + (200 \text{ mm} / d_{n2})^{0.5})$ = **1.870**

Reinforcement ratio $\rho_l = \min(0.02, A_{sn2} / (b \times d_{n2}))$ = **0.0021**

Minimum shear resistance (Exp. 6.3N) $V_{Rd,c\_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{n2}$

V_{Rd,c_min} = **133.7** kN/m

Shear resistance (Exp. 6.2a) $V_{Rd,c2} = \max(V_{Rd,c\_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck}/1 \text{ N/mm}^2))^{0.333} \times b \times d_{n2})$

$V_{Rd,c2}$ = **133.7** kN/m

PASS - Shear capacity is adequate (0.284)

Deflection checks

Basic span-to-depth ratio deflection check span 1 (cl. 7.4.2)

Reference reinforcement ratio $\rho_0 = (f_{ck} / 1 \text{ N/mm}^2)^{0.5} / 1000$ = **0.0057**

Required tension reinforcement ratio $\rho = \max(0.0035, A_{sp1\_m} / (b \times d_{p1}))$ = **0.0035**

Required compression reinforcement ratio $\rho' = A_{scp1\_req} / (b \times d_{p1})$ = **0.0000**

Structural system factor (Table 7.4N) K_δ = **1.0**

Basic span-to-depth ratio limit $ratio_{lim1\_bas} = K_\delta \times [11 + 1.5 \times (f_{ck}/1 \text{ N/mm}^2)^{0.5} \times \rho_0/\rho + 3.2 \times (f_{ck}/1 \text{ N/mm}^2)^{0.5} \times (\rho_0/\rho - 1)^{1.5}]$

(Exp. 7.16a) $ratio_{lim1\_bas}$ = **33.47**

Modified span-to-depth ratio limit

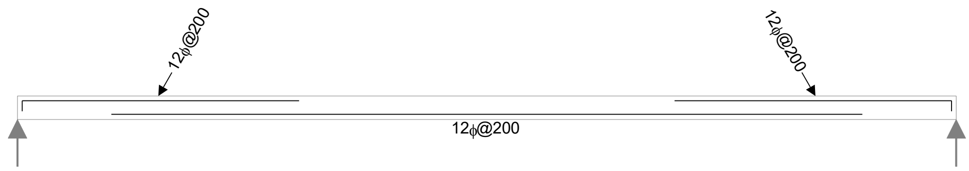
$ratio_{lim1} = \min(40 \times K_\delta, \min(1.5, (500 \text{ N/mm}^2 / f_{yk}) \times (A_{sp1} / A_{sp1\_m})) \times ratio_{lim1\_bas})$ = **40.00**

Actual span-to-depth ratio $ratio_{act1} = l_1 / d_{p1}$ = **20.09**

PASS - Span-to-depth ratio is acceptable (0.502)

Reinforcement sketch

The following sketch is indicative only. Note that additional reinforcement may be required in accordance with clauses 9.2.1.2, 9.2.1.4 and 9.2.1.5 of EN 1992-1-1:2004 to meet detailing rules.



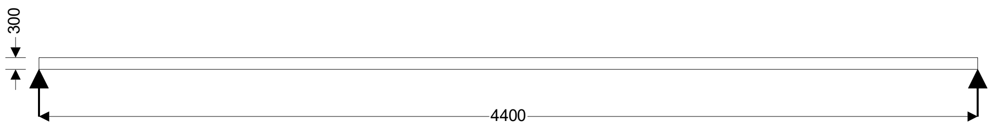
RC SLAB DESIGN

In accordance with EN1992-1-1:2004 incorporating corrigendum January 2008 and the UK national annex

Tedds calculation version 1.0.22

Design summary

Description	Unit	Provided	Required	Utilisation	Result
Support 1					
Tension reinf.	mm²/m	565	415	0.734	PASS
Tension bar spacing	mm	200	300	0.667	PASS
Shear	kN/m	118.6	22.5	0.190	PASS
Span 1					
Tension reinf.	mm²/m	565	344	0.609	PASS
Tension bar spacing	mm	200	300	0.667	PASS
Allow. span-to-depth ratio		20.09	40.00	0.502	PASS
Support 2					
Tension reinf.	mm²/m	565	415	0.734	PASS
Tension bar spacing	mm	200	300	0.667	PASS
Shear	kN/m	118.6	22.5	0.190	PASS
Cover					
Min cover bottom	mm	75	22	0.293	PASS



Slab definition

Slab reference name **basement slab**

Overall slab depth $h = \mathbf{300}$ mm

Number of spans $N_{spans} = \mathbf{1}$

First support **Simple**

Last support **Simple**

Nominal cover to bottom reinforcement $c_{nom\_b} = \mathbf{75}$ mm

Loading

Ratio of quasi-permanent to ultimate load $r_q = \mathbf{0.620}$

Concrete properties

Concrete strength class C32/40

Characteristic cylinder strength $f_{ck} = \mathbf{32}$ N/mm^2

Partial factor (Table 2.1N) $\gamma_C = \mathbf{1.50}$

Compressive strength factor (cl. 3.1.6) $\alpha_{cc} = \mathbf{0.85}$

Design compressive strength (cl. 3.1.6) $f_{cd} = \mathbf{18.1}$ N/mm^2

Mean axial tensile strength (Table 3.1) $f_{ctm} = 0.30$ N/mm$^2 \times (f_{ck} / 1$ N/mm$^2)^{2/3} = \mathbf{3.0}$ N/mm^2

Maximum aggregate size $d_g = \mathbf{20}$ mm

Reinforcement properties

Characteristic yield strength $f_{yk} = \mathbf{500}$ N/mm^2

Partial factor (Table 2.1N) $\gamma_S = \mathbf{1.15}$

Design yield strength (fig. 3.8) $f_{yd} = f_{yk} / \gamma_S = \mathbf{434.8}$ N/mm^2

Concrete cover to reinforcement

Nominal cover to bottom reinforcement $c_{nom\_b} = \mathbf{75}$ mm

Fire resistance period to bottom of slab R_{btm} = **30** min
Axis distance to bottom reinft (Table 5.8) a_{fi_b} = **10** mm
Max bar diameter in bottom ϕ_{max_b} = **12** mm
Min. btm cover requirement with regard to bond $c_{min,b\_b} = \phi_{max\_b}$ = **12** mm
Reinforcement fabrication **Not subject to QA system**
Cover allowance for deviation Δc_{dev} = **10** mm
Min. required nominal cover to bottom reinft $c_{nom\_b\_min} = \max(a_{fi\_b} - \phi_{max\_b} / 2, c_{min,b\_b} + \Delta c_{dev})$ = **22.0** mm

PASS - There is sufficient cover to the bottom reinforcement

Bending design checks

Redistribution ratio δ = **1.0**
Limiting value of K $K' = 0.598 \times \delta - 0.18 \times \delta^2 - 0.21$ = **0.208**

Reinforcement design at midspan of span 1 (cl.6.1)

Length of span 1 l_1 = **4400** mm
Design bending moment M_{p1} = **24.8** kNm/m
Reinforcement provided **12 mm dia. bars at 200 mm centres**
Area provided A_{sp1} = **565** mm²/m
Effective depth to tension reinforcement $d_{p1} = h - c_{nom\_b} - \phi_{p1} / 2$ = **219.0** mm
K factor $K = M_{p1} / (b \times d_{p1}^2 \times f_{ck})$ = **0.016**

K < K' - Compression reinforcement is not required

Lever arm $z = \min(0.95 \times d_{p1}, d_{p1} / 2 \times (1 + \sqrt{(1 - 3.53 \times K)}))$
z = **208.0** mm
Area of reinforcement required for bending $A_{sp1\_m} = M_{p1} / (f_{yd} \times z)$ = **274** mm²/m
Minimum area required $A_{sp1\_min} = \max(0.26 \times (f_{ctm}/f_{yk}), 0.0013) \times b \times d_{p1}$ = **344** mm²/m
Area of reinforcement required $A_{sp1\_req} = \max(A_{sp1\_m}, A_{sp1\_min})$ = **344** mm²/m

PASS - Area of tension reinforcement provided is adequate (0.609)

Check reinforcement spacing

Reinforcement service stress $\sigma_s = (f_{yk} / \gamma_S) \times \min((A_{sp1\_m}/A_{sp1}), 1.0) \times r_q$ = **130.4** N/mm²
Maximum allowable spacing (Table 7.3N) s_{max_p1} = **300** mm
Actual bar spacing s_{p1} = **200** mm

PASS - The reinforcement spacing is acceptable

Shear design checks

Shear resistance constant (cl. 6.2.2) $C_{Rd,c} = 0.18\ N/mm^2 / \gamma_C$ = **0.12** N/mm²

Shear capacity check at support 1

Shear force V_1 = **22.5** kN/m
Reinforcement provided **12 mm dia. bars at 200 mm centres**
Area provided A_{sd1} = **565** mm²/m
Effective depth $d_{d1} = h - c_{nom\_b} - \phi_{d1} / 2$ = **219.0** mm
Effective depth factor (cl. 6.2.2) $k = \min(2.0, 1 + (200\ mm / d_{d1})^{0.5})$ = **1.956**
Reinforcement ratio $\rho_l = \min(0.02, A_{sd1} / (b \times d_{d1}))$ = **0.0026**
Minimum shear resistance (Exp. 6.3N) $V_{Rd,c\_min} = 0.035\ N/mm^2 \times k^{1.5} \times (f_{ck} / 1\ N/mm^2)^{0.5} \times b \times d_{d1}$
V_{Rd,c_min} = **118.6** kN/m
Shear resistance (Exp. 6.2a) $V_{Rd,c1} = \max(V_{Rd,c\_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck}/1\ N/mm^2))^{0.333} \times b \times d_{d1})$
$V_{Rd,c1}$ = **118.6** kN/m

PASS - Shear capacity is adequate (0.190)

Shear capacity check at support 2

Shear force V_2 = **22.5** kN/m

Reinforcement provided **12 mm dia. bars at 200 mm centres**

Area provided A_{sd2} = **565** mm^2/m

Effective depth $d_{d2} = h - c_{nom\_b} - \phi_{d2} / 2$ = **219.0** mm

Effective depth factor (cl. 6.2.2) $k = \min(2.0, 1 + (200 \text{ mm} / d_{d2})^{0.5})$ = **1.956**

Reinforcement ratio $\rho_l = \min(0.02, A_{sd2} / (b \times d_{d2}))$ = **0.0026**

Minimum shear resistance (Exp. 6.3N) $V_{Rd,c\_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{d2}$

V_{Rd,c_min} = **118.6** kN/m

Shear resistance (Exp. 6.2a) $V_{Rd,c2} = \max(V_{Rd,c\_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck}/1 \text{ N/mm}^2))^{0.333} \times b \times d_{d2})$

$V_{Rd,c2}$ = **118.6** kN/m

PASS - Shear capacity is adequate (0.190)

Deflection checks

Basic span-to-depth ratio deflection check span 1 (cl. 7.4.2)

Reference reinforcement ratio $\rho_0 = (f_{ck} / 1 \text{ N/mm}^2)^{0.5} / 1000$ = **0.0057**

Required tension reinforcement ratio $\rho = \max(0.0035, A_{sp1\_m} / (b \times d_{p1}))$ = **0.0035**

Required compression reinforcement ratio $\rho' = A_{scp1\_req} / (b \times d_{p1})$ = **0.0000**

Structural system factor (Table 7.4N) K_δ = **1.0**

Basic span-to-depth ratio limit (Exp. 7.16a) $ratio_{lim1\_bas} = K_\delta \times [11 + 1.5 \times (f_{ck}/1 \text{ N/mm}^2)^{0.5} \times \rho_0/\rho + 3.2 \times (f_{ck}/1 \text{ N/mm}^2)^{0.5} \times (\rho_0/\rho - 1)^{1.5}]$

$ratio_{lim1\_bas}$ = **33.47**

Modified span-to-depth ratio limit

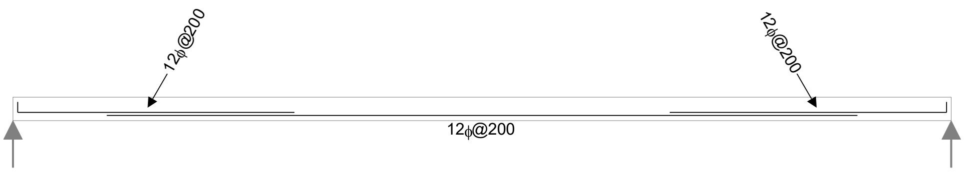
$ratio_{lim1} = \min(40 \times K_\delta, \min(1.5, (500 \text{ N/mm}^2/ f_{yk}) \times (A_{sp1} / A_{sp1\_m})) \times ratio_{lim1\_bas})$ = **40.00**

Actual span-to-depth ratio $ratio_{act1} = l_1 / d_{p1}$ = **20.09**

PASS - Span-to-depth ratio is acceptable (0.502)

Reinforcement sketch

The following sketch is indicative only. Note that additional reinforcement may be required in accordance with clauses 9.2.1.2, 9.2.1.4 and 9.2.1.5 of EN 1992-1-1:2004 to meet detailing rules.



RC MEMBER ANALYSIS & DESIGN (EN1992-1-1:2004)

In accordance with EN1992-1-1:2004 incorporating Corrigenda January 2008 and the UK national annex

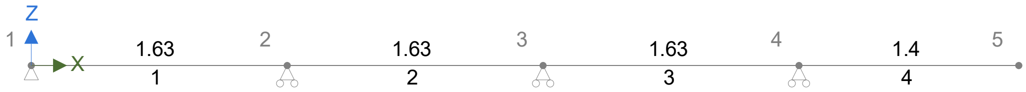
Tedds calculation version 3.3.08

ANALYSIS

Tedds calculation version 1.0.37

Geometry

Geometry (m) - Concrete (C32 2500 Quartzite) - R 200x475

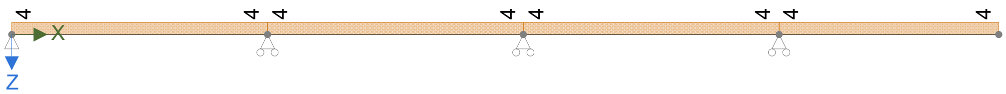


Span	Length (m)	Section	Start Support	End Support
1	1.63	R 200x475	Pinned	Roller Pin X
2	1.63	R 200x475	Roller Pin X	Roller Pin X
3	1.63	R 200x475	Roller Pin X	Roller Pin X
4	1.4	R 200x475	Roller Pin X	Free
R 200x475: Area 950 cm^2, Inertia Major 178620 cm^4, Inertia Minor 31667 cm^4, Shear area parallel to Minor 792 cm^2, Shear area parallel to Major = 792 cm^2				
Concrete (C32 2500 Quartzite): Density 2500 kg/m^3, Youngs 33.3457645 kN/mm^2, Shear 13.8940685 kN/mm^2, Thermal 0.00001 °C^{-1}				

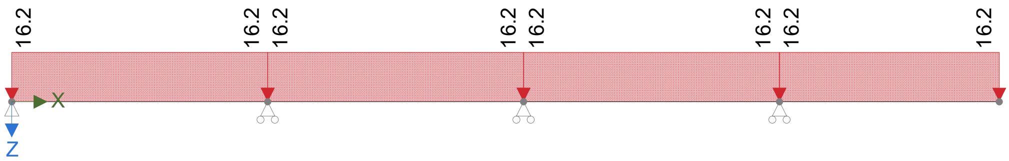
Loading

Self weight included

Permanent - Loading (kN/m)



Imposed - Loading (kN/m)



Load combination factors

Load combination	Self Weight	Permanent	Imposed
1.35G + 1.5Q + 1.5RQ (Strength)	1.35	1.35	1.50
1.0G + 1.0Q + 1.0RQ (Service)	1.00	1.00	1.00
1.0G + 1.0ψ_2Q (Quasi)	1.00	1.00	0.30

Member Loads

Member	Load case	Load Type	Orientation	Description
Beam	Permanent	UDL	GlobalZ	4 kN/m

Member	Load case	Load Type	Orientation	Description
Beam	Imposed	UDL	GlobalZ	16.2 kN/m

Results

Reactions

Load case: Self Weight

Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	1.5	0
2	0	4.6	0
3	0	2.1	0
4	0	6.5	0

Load case: Permanent

Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	2.5	0
2	0	7.9	0
3	0	3.6	0
4	0	11.1	0

Load case: Imposed

Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	10.2	0
2	0	32	0
3	0	14.6	0
4	0	45.1	0

Load combination: 1.35G + 1.5Q + 1.5RQ (Strength)

Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	20.7	0
2	0	64.8	0
3	0	29.6	0
4	0	91.5	0

Load combination: 1.0G + 1.0Q + 1.0RQ (Service)

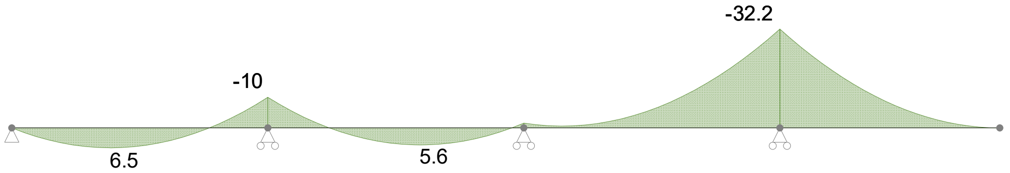
Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	14.2	0
2	0	44.4	0
3	0	20.3	0
4	0	62.8	0

Load combination: 1.0G + 1.0ψ_2Q (Quasi)

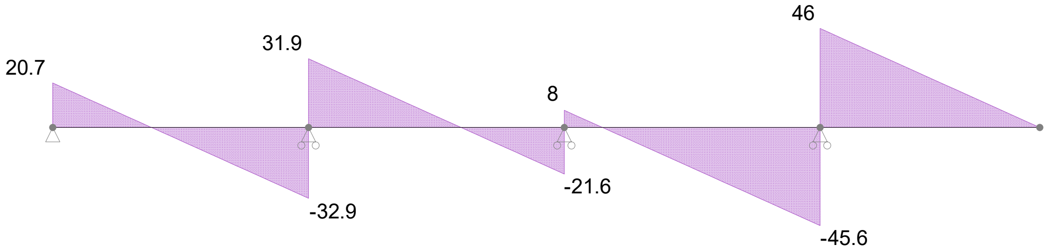
Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	7	0
2	0	22.1	0
3	0	10.1	0
4	0	31.2	0

Forces

Strength combinations - Moment envelope (kNm)



Strength combinations - Shear envelope (kN)



Concrete details (Table 3.1 - Strength and deformation characteristics for concrete)

Concrete strength class C32/40

Char. comp. cylinder strength f_{ck} = **32** N/mm^2

Design comp conc. strength f_{cwd} = **21.3** N/mm^2

Maximum aggregate size h_{agg} = **20** mm

Reinforcement details

Char. yield strength of rinf. f_{yk} = **500** N/mm^2

Partial factor for reinf. steel γ_S = **1.15**

Design yield strength of reinf. f_{yd} = **435** N/mm^2

Nominal cover to reinforcement

Nominal cover to top reinf c_{nom_t} = **25** mm

Nominal cover to bottom reinf c_{nom_b} = **50** mm

Nominal cover to side reinf c_{nom_s} = **35** mm

Fire resistance

Standard fire resistance period R = **60** min

No. sides exposed to fire 3

Minimum width of beam b_{min} = **120** mm

Beam - Span 1

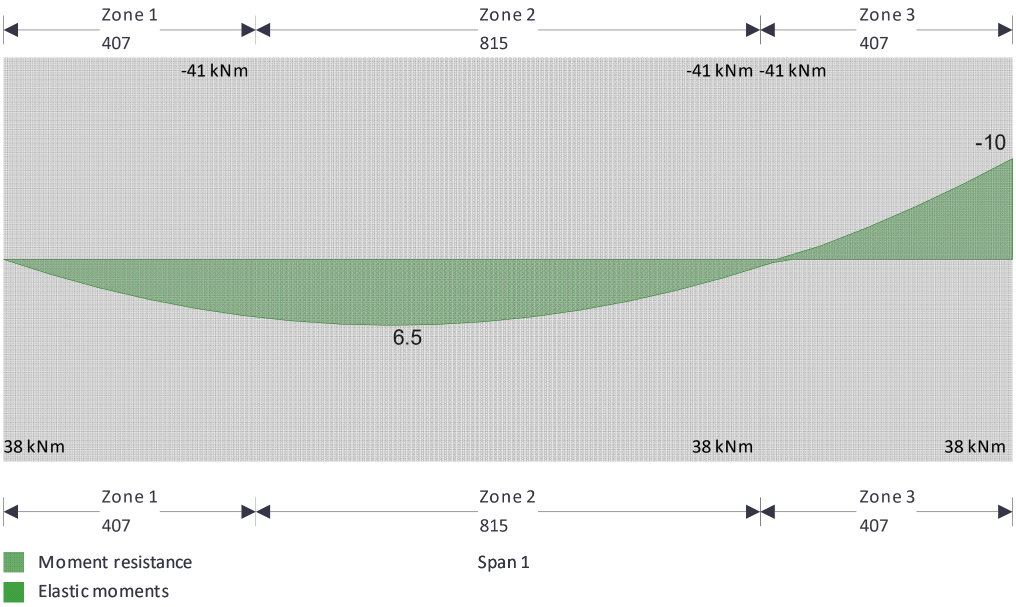
Rectangular section details

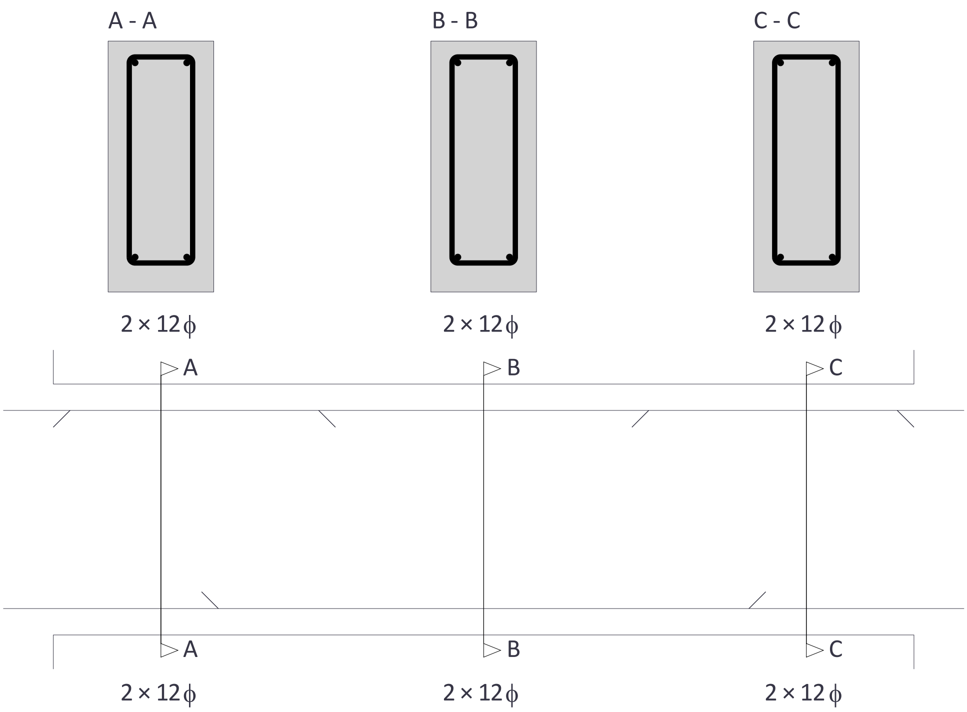
Section width b = **200** mm

Section depth h = **475** mm

PASS - Minimum dimensions for fire resistance met

Moment design





Zone 1 (0 mm - 407 mm) Positive moment - section 6.1

Design bending moment	M = **5.7** kNm	Effective depth tension reinf.	d = **409** mm
Area of tension reinf. req'd	$A_{s,req}$ = **34** mm^2	Area of tension reinf. prov	$A_{s,prov}$ = **226** mm^2
Min area of reinf. (exp.9.1N)	$A_{s,min}$ = **129** mm^2	Max area reinf. (cl.9.2.1.1(3))	$A_{s,max}$ = **3800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width	w_k = **0.30** mm	Min area reinf req'd (exp.7.1)	$A_{sc,min}$ = **177** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **1.9**kNm

Actual tension bar spacing s_{bar} = **98** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Zone 1 (0 mm - 407 mm) Negative moment - section 6.1

Design bending moment M = **1.6** kNm Effective depth tension reinf. d = **434** mm

Area of tension reinf. req'd $A_{s,req}$ = **9** mm^2 Area of tension reinf. prov $A_{s,prov}$ = **226** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **136** mm^2 Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **0.0**kNm

Actual tension bar spacing s_{bar} = **98** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

Top bar spacing s_{top} = **86.0** mm Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **86.0** mm Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Zone 2 (407 mm - 1223 mm) Positive moment - section 6.1

Design bending moment M = **6.5** kNm Effective depth tension reinf. d = **409** mm

Area of tension reinf. req'd $A_{s,req}$ = **38** mm^2 Area of tension reinf. prov $A_{s,prov}$ = **226** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **129** mm^2 Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **2.2**kNm

Actual tension bar spacing s_{bar} = **98** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio $span\_to\_depth_{allow}$ = **52.000** Actual span to depth ratio $span\_to\_depth_{actual}$ = **3.985**

PASS - Actual span to depth ratio is within the allowable limit

Minimum bar spacing (Section 8.2)

Top bar spacing s_{top} = **86.0** mm Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **86.0** mm Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Zone 3 (1223 mm - 1630 mm) Positive moment - section 6.1

Design bending moment M = **0.7** kNm Effective depth tension reinf. d = **409** mm

Area of tension reinf. req'd $A_{s,req}$ = **4** mm^2 Area of tension reinf. prov $A_{s,prov}$ = **226** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **129** mm^2 Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **0.2**kNm

Actual tension bar spacing s_{bar} = **98** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Zone 3 (1223 mm - 1630 mm) Negative moment - section 6.1

Design bending moment M = **10.0** kNm Effective depth tension reinf. d = **434** mm

Area of tension reinf. req'd $A_{s,req}$ = **56** mm^2 Area of tension reinf. prov $A_{s,prov}$ = **226** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **136** mm^2 Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **3.4**kNm

Actual tension bar spacing s_{bar} = **98** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

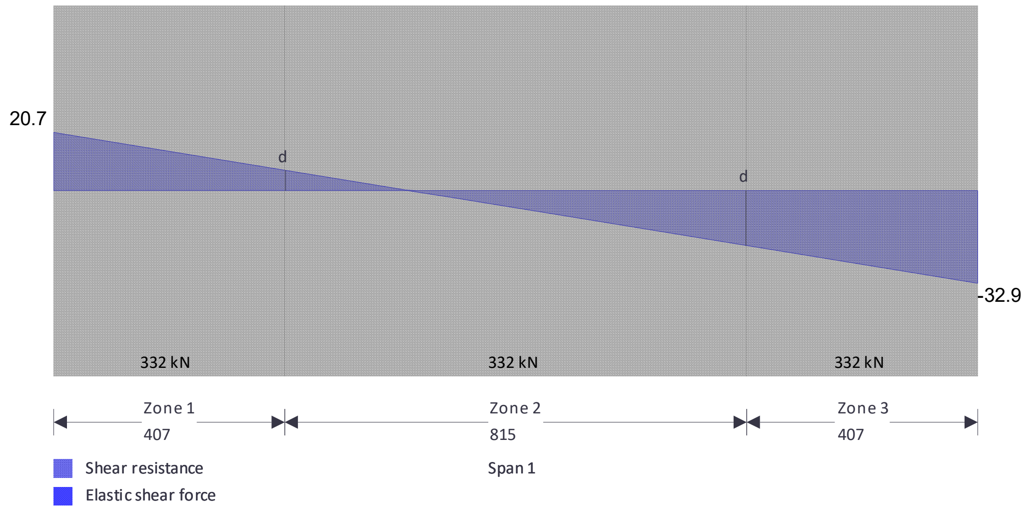
Top bar spacing s_{top} = **86.0** mm Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

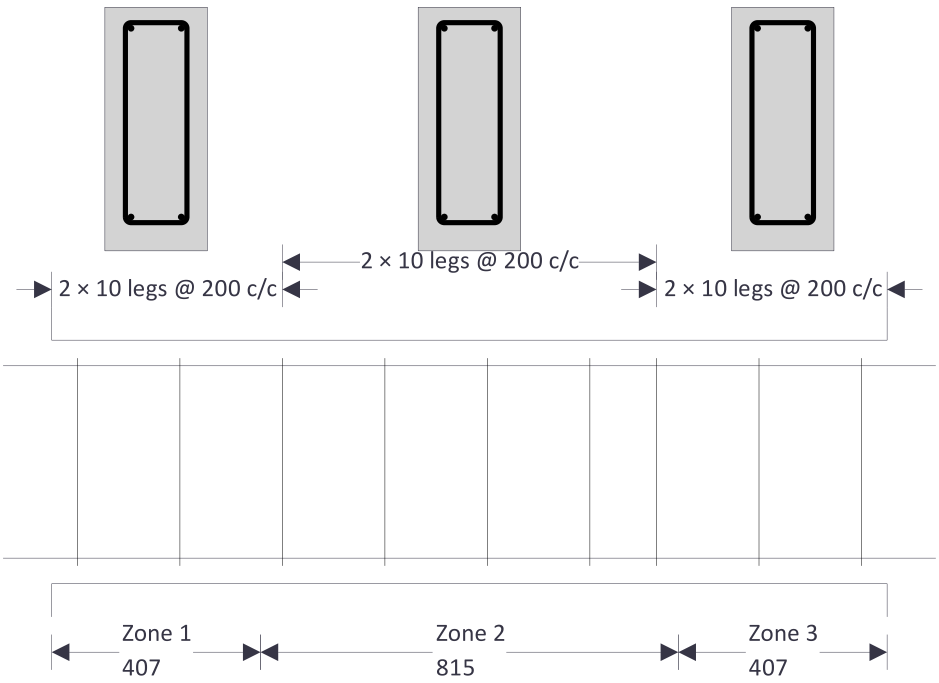
PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **86.0** mm Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Shear design





Angle of comp. shear strut θ_{max} = 45 deg
Strength reduction factor v_1 = **0.523**
Compression chord coefficient α_{cw} = **1.00**
Minimum area of shear reinf. $A_{sv,min}$ = **181** mm^2/m

Zone 1 (0 mm - 407 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **21** kN
Max design shear resistance $V_{Rd,max}$ = **434** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **7** kN
Area shear reinf. req'd $A_{sv,req}$ = **181** mm^2/m
Area of shear reinf prov. $A_{sv,prov}$ = **785** mm^2/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **307** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Zone 2 (407 mm - 1223 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **19** kN
Max design shear resistance $V_{Rd,max}$ = **434** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **19** kN
Area shear reinf. req'd $A_{sv,req}$ = **181** mm^2/m
Area of shear reinf prov. $A_{sv,prov}$ = **785** mm^2/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **307** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Zone 3 (1223 mm - 1630 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **33** kN
Max design shear resistance $V_{Rd,max}$ = **434** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **19** kN
Area shear reinf. req'd $A_{sv,req}$ = **181** mm^2/m
Area of shear reinf prov. $A_{sv,prov}$ = **785** mm^2/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **307** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Beam - Span 2

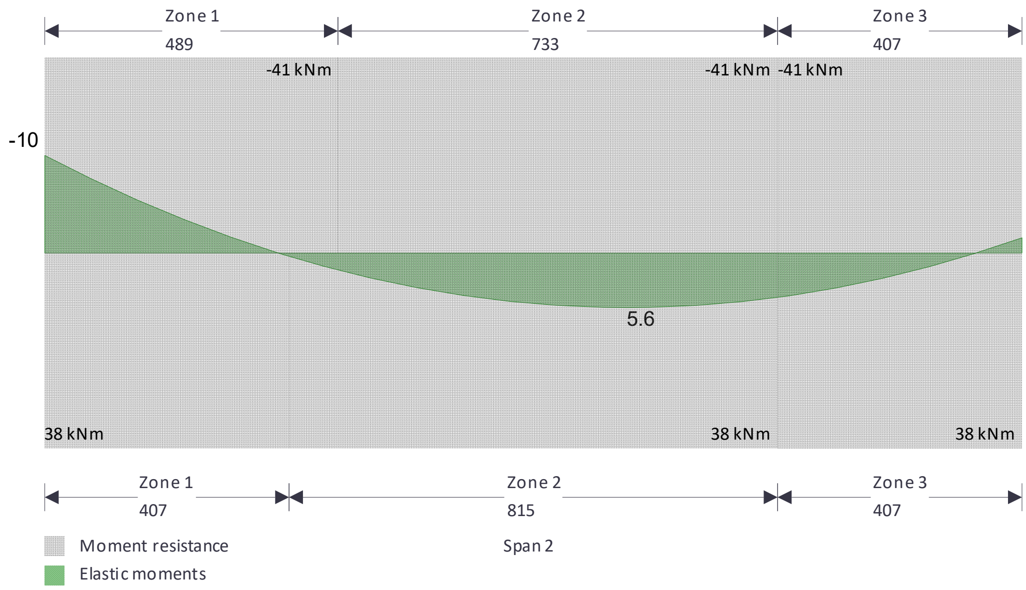
Rectangular section details

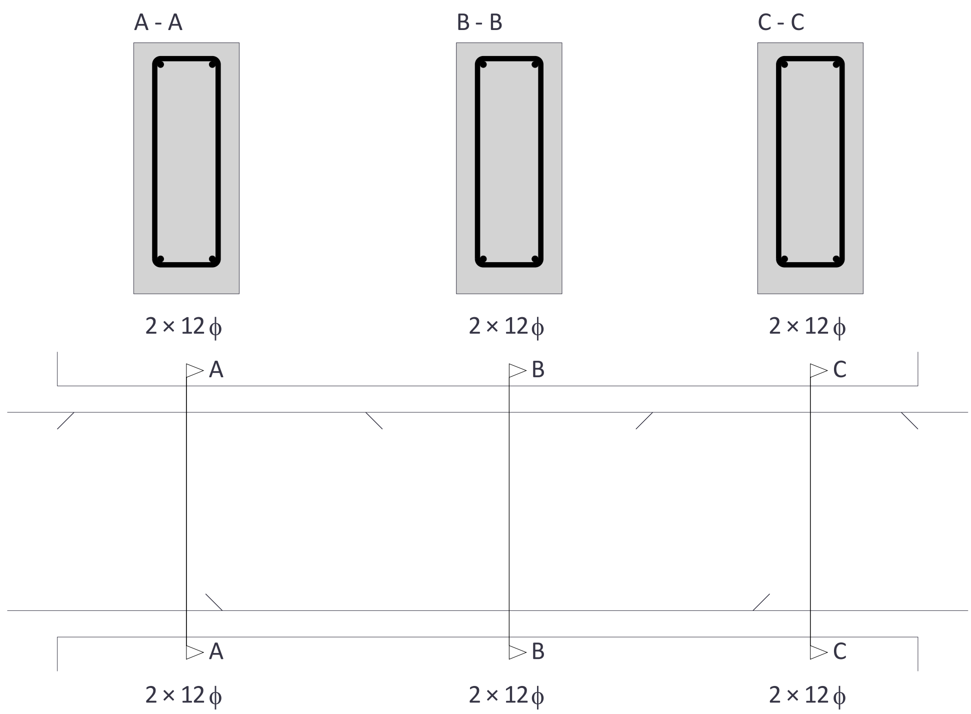
Section width b = **200** mm

Section depth h = **475** mm

PASS - Minimum dimensions for fire resistance met

Moment design





Zone 1 (0 mm - 407 mm) Positive moment - section 6.1

Design bending moment M = **0.3** kNm

Effective depth tension reinf. d = **409** mm

Area of tension reinf. req'd $A_{s,req}$ = **2** mm^2

Area of tension reinf. prov $A_{s,prov}$ = **226** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **129** mm^2

Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm   Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **0.1**kNm

Actual tension bar spacing s_{bar} = **98** mm   Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Zone 1 (0 mm - 489 mm) Negative moment - section 6.1

Design bending moment M = **10.0** kNm   Effective depth tension reinf. d = **434** mm

Area of tension reinf. req'd $A_{s,req}$ = **56** mm^2 Area of tension reinf. prov $A_{s,prov}$ = **226** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **136** mm^2 Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm   Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **3.4**kNm

Actual tension bar spacing s_{bar} = **98** mm   Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

Top bar spacing s_{top} = **86.0** mm   Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **86.0** mm   Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Zone 2 (407 mm - 1223 mm) Positive moment - section 6.1

Design bending moment M = **5.6** kNm   Effective depth tension reinf. d = **409** mm

Area of tension reinf. req'd $A_{s,req}$ = **33** mm^2 Area of tension reinf. prov $A_{s,prov}$ = **226** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **129** mm^2 Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm   Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **1.9**kNm

Actual tension bar spacing s_{bar} = **98** mm   Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio $span\_to\_depth_{allow}$ = **60.000**   Actual span to depth ratio $span\_to\_depth_{actual}$ = **3.985**

PASS - Actual span to depth ratio is within the allowable limit

Minimum bar spacing (Section 8.2)

Top bar spacing s_{top} = **86.0** mm   Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **86.0** mm   Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Zone 3 (1223 mm - 1630 mm) Positive moment - section 6.1

Design bending moment M = **4.5** kNm   Effective depth tension reinf. d = **409** mm

Area of tension reinf. req'd $A_{s,req}$ = **27** mm^2 Area of tension reinf. prov $A_{s,prov}$ = **226** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **129** mm² Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm²

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm²

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **1.5**kNm

Actual tension bar spacing s_{bar} = **98** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Zone 3 (1223 mm - 1630 mm) Negative moment - section 6.1

Design bending moment M = **1.6** kNm Effective depth tension reinf. d = **434** mm

Area of tension reinf. req'd $A_{s,req}$ = **9** mm² Area of tension reinf. prov $A_{s,prov}$ = **226** mm²

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **136** mm² Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm²

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm²

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **0.5**kNm

Actual tension bar spacing s_{bar} = **98** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

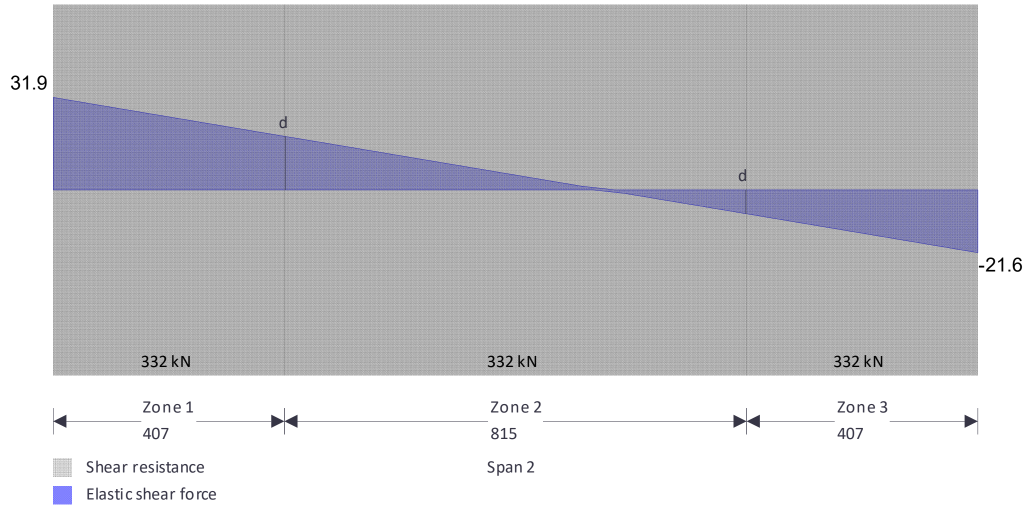
Top bar spacing s_{top} = **86.0** mm Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

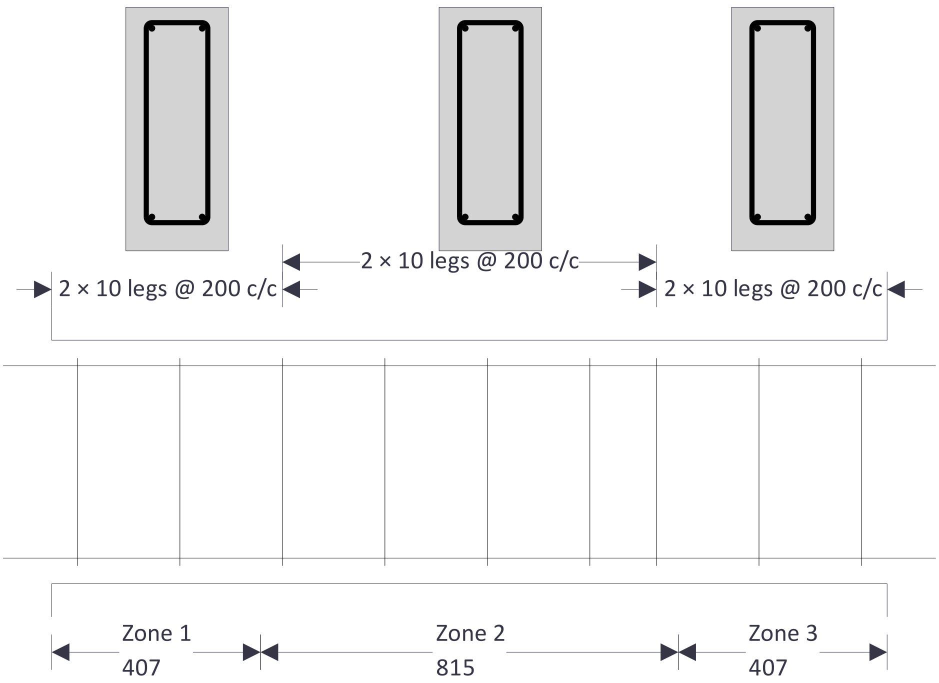
PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **86.0** mm Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Shear design





Angle of comp. shear strut θ_{max} = 45 deg Strength reduction factor v_1 = **0.523**

Compression chord coefficient α_{cw} = **1.00** Minimum area of shear reinf. $A_{sv,min}$ = **181** mm²/m

Zone 1 (0 mm - 407 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **32** kN Max design shear resistance $V_{Rd,max}$ = **434** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **18** kN Area shear reinf. req'd $A_{sv,req}$ = **181** mm²/m

Area of shear reinf prov. $A_{sv,prov}$ = **785** mm²/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **307** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Zone 2 (407 mm - 1223 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **19** kN Max design shear resistance $V_{Rd,max}$ = **434** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **18** kN Area shear reinf. req'd $A_{sv,req}$ = **181** mm²/m

Area of shear reinf prov. $A_{sv,prov}$ = **785** mm²/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **307** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Zone 3 (1223 mm - 1630 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **22** kN Max design shear resistance $V_{Rd,max}$ = **434** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **8** kN Area shear reinf. req'd $A_{sv,req}$ = **181** mm²/m

Area of shear reinf prov. $A_{sv,prov}$ = **785** mm²/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **307** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Tekla Tedds	Project 28 Charlotte Street				Job no. 1964	
Rodrigues Associates 1 Amwell Street, London EC1R 1UL	Calcs for GF Rc beam to restrain top of retaining wall				Start page no./Revision C7. 12	
	Calcs by ab	Calcs date 26/10/2022	Checked by	Checked date	Approved by	Approved date

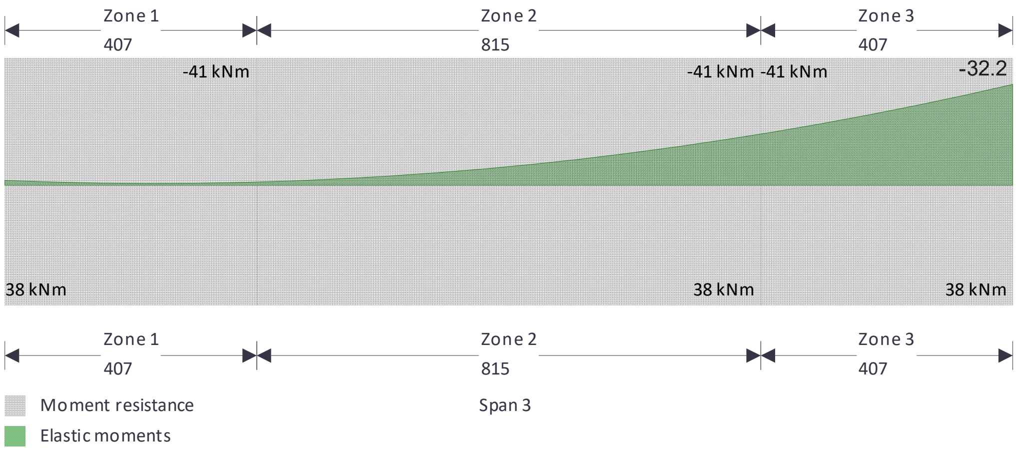
Beam - Span 3

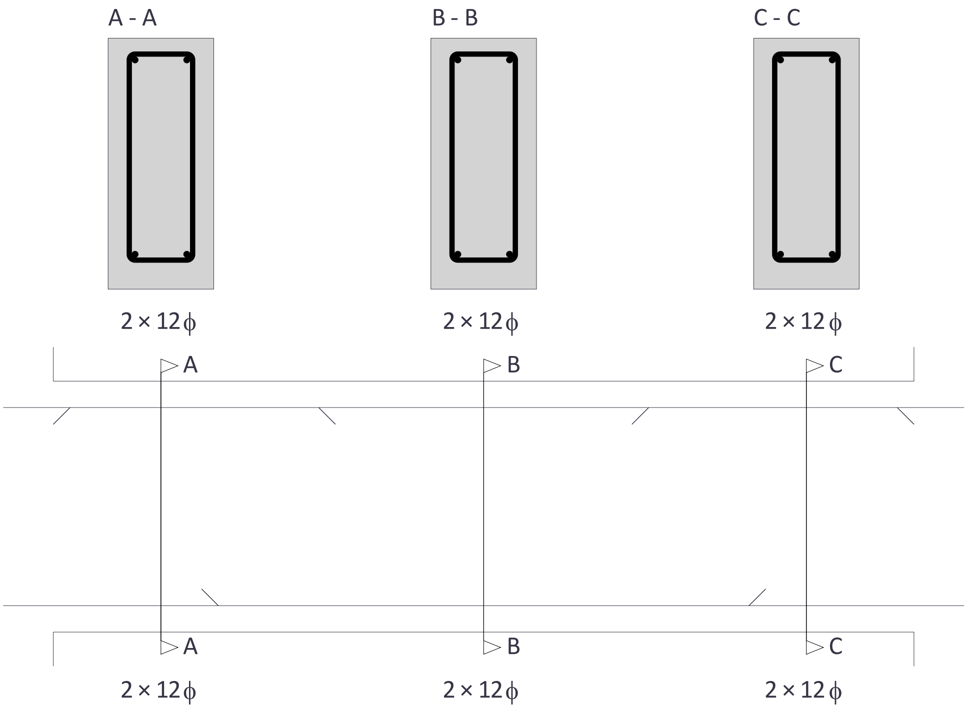
Rectangular section details

Section width b = **200** mm Section depth h = **475** mm

PASS - Minimum dimensions for fire resistance met

Moment design





Zone 1 (0 mm - 407 mm) Negative moment - section 6.1

Design bending moment M = **1.6** kNm Effective depth tension reinf. d = **434** mm

Area of tension reinf. req'd $A_{s,req}$ = **9** mm^2 Area of tension reinf. prov $A_{s,prov}$ = **226** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **136** mm^2 Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **0.5**kNm

Actual tension bar spacing s_{bar} = **98** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

Top bar spacing s_{top} = **86.0** mm Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **86.0** mm Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Zone 2 (407 mm - 1223 mm) Negative moment - section 6.1

Design bending moment M = **16.4** kNm Effective depth tension reinf. d = **434** mm

Area of tension reinf. req'd $A_{s,req}$ = **91** mm^2 Area of tension reinf. prov $A_{s,prov}$ = **226** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **136** mm^2 Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **5.6**kNm

Actual tension bar spacing s_{bar} = **98** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio span_to_depth$_{allow}$ = **60.000** Actual span to depth ratio span_to_depth$_{actual}$ = **3.756**

PASS - Actual span to depth ratio is within the allowable limit

Minimum bar spacing (Section 8.2)

Top bar spacing s_{top} = **86.0** mm Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **86.0** mm Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Zone 3 (1223 mm - 1630 mm) Negative moment - section 6.1

Design bending moment M = **32.2** kNm Effective depth tension reinf. d = **434** mm

Area of tension reinf. req'd $A_{s,req}$ = **180** mm^2 Area of tension reinf. prov $A_{s,prov}$ = **226** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **136** mm^2 Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **11.0**kNm

Actual tension bar spacing s_{bar} = **98** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

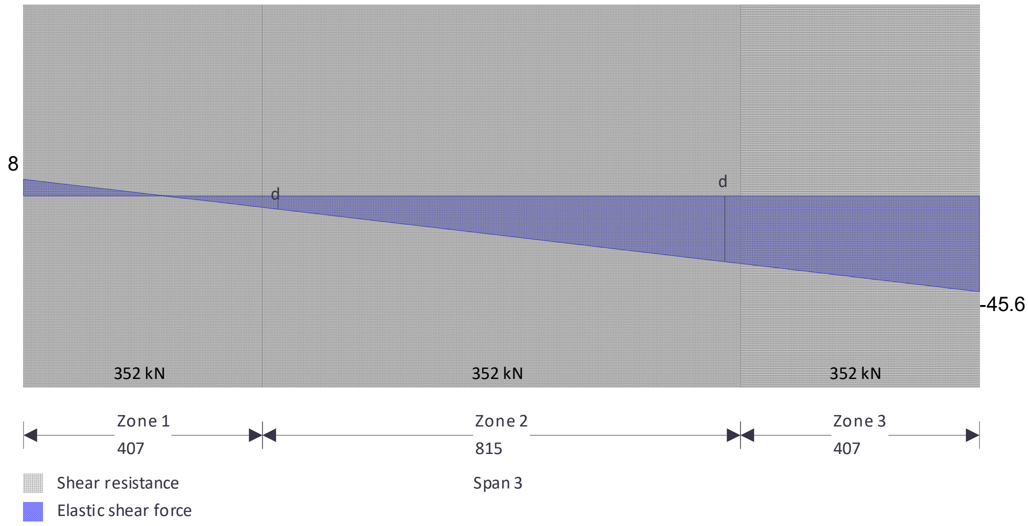
Top bar spacing s_{top} = **86.0** mm Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

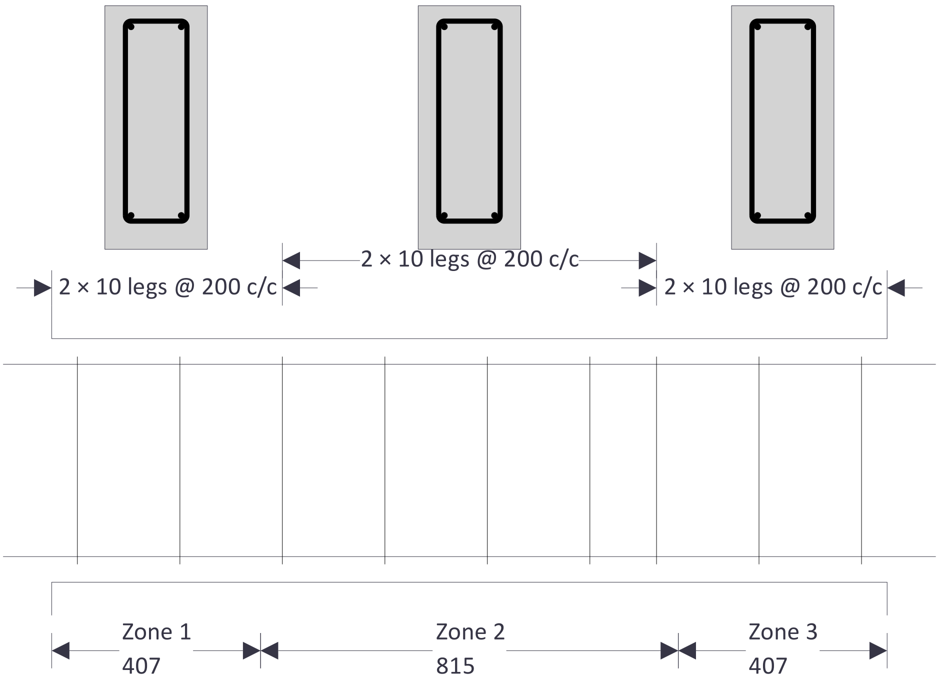
PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **86.0** mm Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Shear design





Angle of comp. shear strut θ_{max} = 45 deg

Strength reduction factor v_1 = **0.523**

Compression chord coefficient α_{cw} = **1.00**

Minimum area of shear reinf. $A_{sv,min}$ = **181** mm^2/m

Zone 1 (0 mm - 407 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **8** kN

Max design shear resistance $V_{Rd,max}$ = **460** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **6** kN

Area shear reinf. req'd $A_{sv,req}$ = **181** mm^2/m

Area of shear reinf prov. $A_{sv,prov}$ = **785** mm^2/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **326** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Zone 2 (407 mm - 1223 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **31** kN Max design shear resistance $V_{Rd,max}$ = **460** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **31** kN Area shear reinf. req'd $A_{sv,req}$ = **181** mm^2/m

Area of shear reinf prov. $A_{sv,prov}$ = **785** mm^2/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **326** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Zone 3 (1223 mm - 1630 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **46** kN Max design shear resistance $V_{Rd,max}$ = **460** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **31** kN Area shear reinf. req'd $A_{sv,req}$ = **181** mm^2/m

Area of shear reinf prov. $A_{sv,prov}$ = **785** mm^2/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **326** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

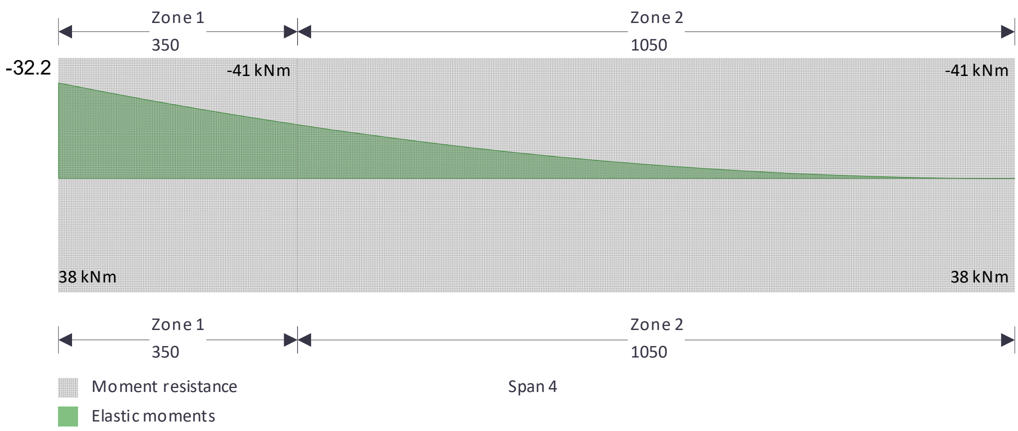
Beam - Span 4

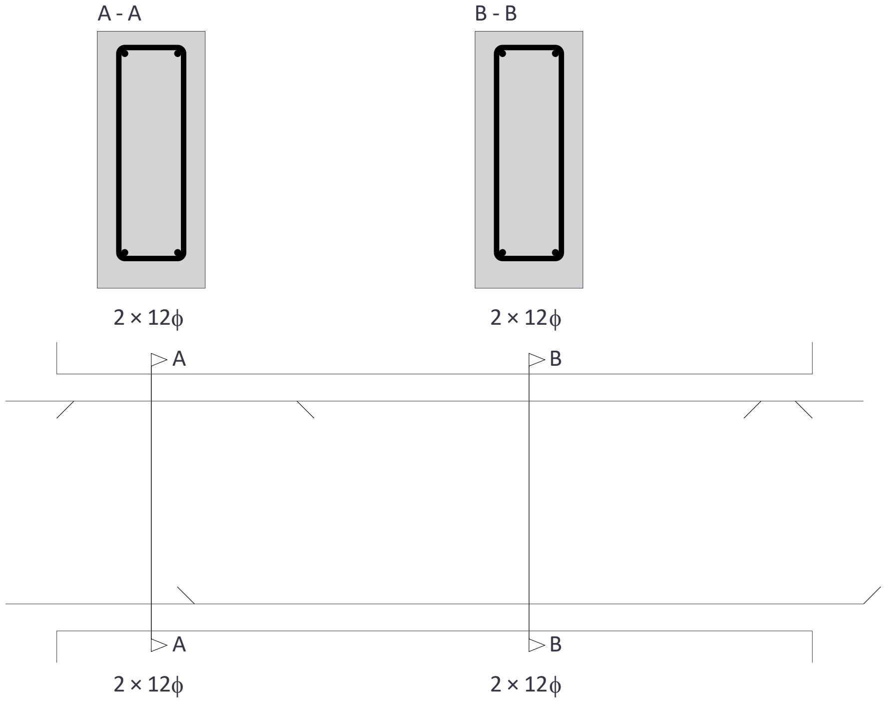
Rectangular section details

Section width b = **200** mm Section depth h = **475** mm

PASS - Minimum dimensions for fire resistance met

Moment design





Zone 1 (0 mm - 350 mm) Negative moment - section 6.1

Design bending moment M = **32.2** kNm Effective depth tension reinf. d = **434** mm

Area of tension reinf. req'd $A_{s,req}$ = **180** mm² Area of tension reinf. prov $A_{s,prov}$ = **226** mm²

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **136** mm² Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm²

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm²

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **11.0**kNm

Actual tension bar spacing s_{bar} = **98** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio $span\_to\_depth_{allow}$ = **16.000** Actual span to depth ratio $span\_to\_depth_{actual}$ = **3.226**

PASS - Actual span to depth ratio is within the allowable limit

Minimum bar spacing (Section 8.2)

Top bar spacing s_{top} = **86.0** mm Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **86.0** mm Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Zone 2 (350 mm - 1400 mm) Negative moment - section 6.1

Design bending moment M = **18.1** kNm Effective depth tension reinf. d = **434** mm

Area of tension reinf. req'd $A_{s,req}$ = **101** mm² Area of tension reinf. prov $A_{s,prov}$ = **226** mm²

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **136** mm² Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **3800** mm²

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **177** mm²

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **6.2**kNm

Actual tension bar spacing s_{bar} = **98** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

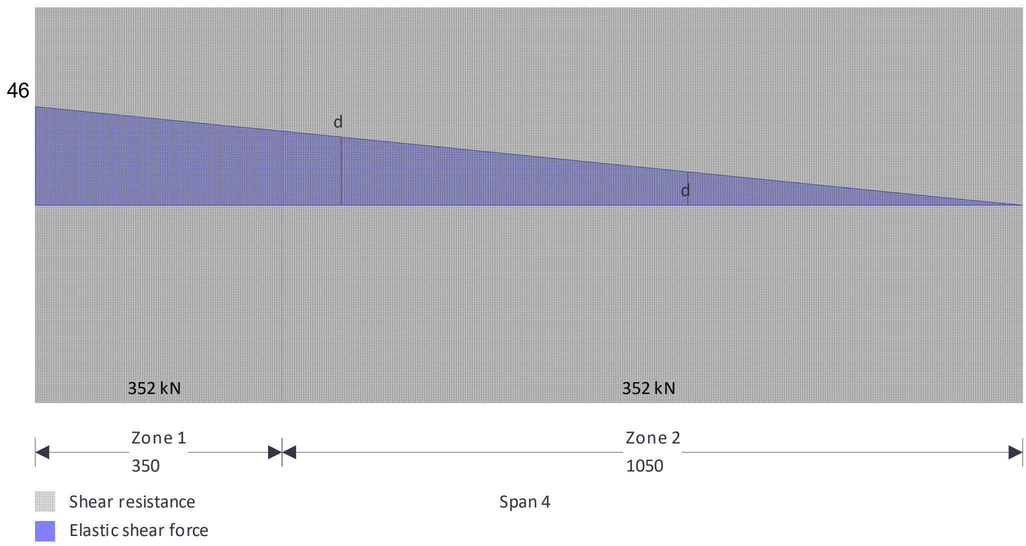
Top bar spacing s_{top} = **86.0** mm Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

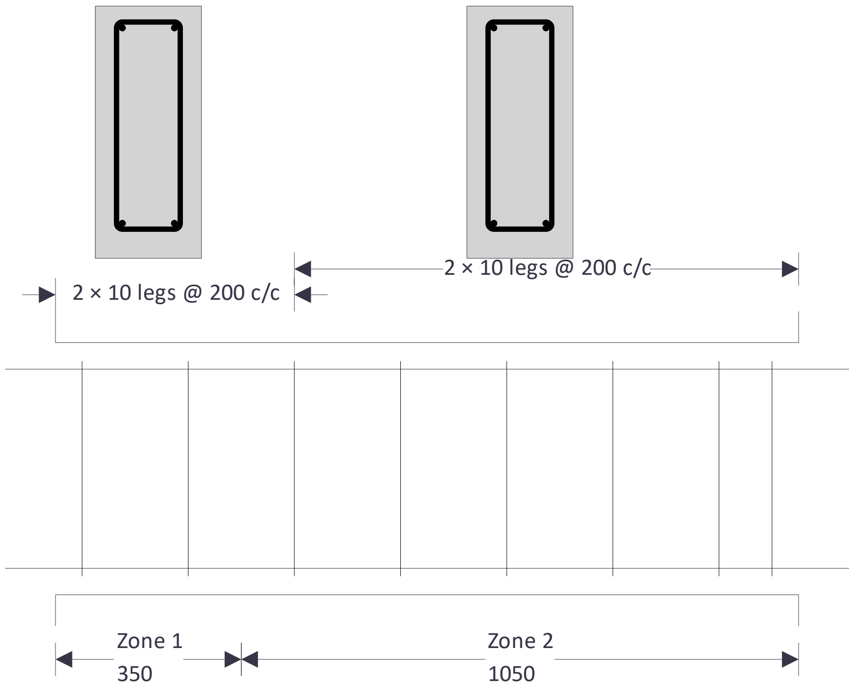
PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **86.0** mm Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Shear design





Angle of comp. shear strut θ_{max} = 45 deg Strength reduction factor v_1 = **0.523**

Compression chord coefficient α_{cw} = **1.00** Minimum area of shear reinf. $A_{sv,min}$ = **181** mm^2/m

Zone 1 (0 mm - 350 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **46** kN Max design shear resistance $V_{Rd,max}$ = **460** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **32** kN Area shear reinf. req'd $A_{sv,req}$ = **181** mm^2/m

Area of shear reinf prov. $A_{sv,prov}$ = **785** mm^2/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **326** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Zone 2 (350 mm - 1400 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **32** kN Max design shear resistance $V_{Rd,max}$ = **460** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **32** kN Area shear reinf. req'd $A_{sv,req}$ = **181** mm^2/m

Area of shear reinf prov. $A_{sv,prov}$ = **785** mm^2/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **326** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

RC MEMBER ANALYSIS & DESIGN (EN1992-1-1:2004)

In accordance with EN1992-1-1:2004 incorporating Corrigenda January 2008 and the UK national annex

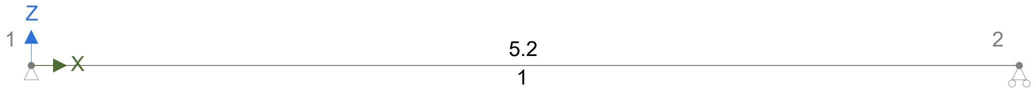
Tedds calculation version 3.3.08

ANALYSIS

Tedds calculation version 1.0.37

Geometry

Geometry (m) - Concrete (C32 2500 Quartzite) - R 200x850

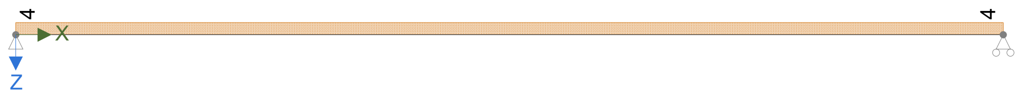


Span	Length (m)	Section	Start Support	End Support
1	5.2	R 200x850	Pinned	Roller Pin X
R 200x850: Area 1700 cm², Inertia Major 1023542 cm⁴, Inertia Minor 56667 cm⁴, Shear area parallel to Minor 1417 cm², Shear area parallel to Major = 1417 cm²				
Concrete (C32 2500 Quartzite): Density 2500 kg/m³, Youngs 33.3457645 kN/mm², Shear 13.8940685 kN/mm², Thermal 0.00001 °C⁻¹				

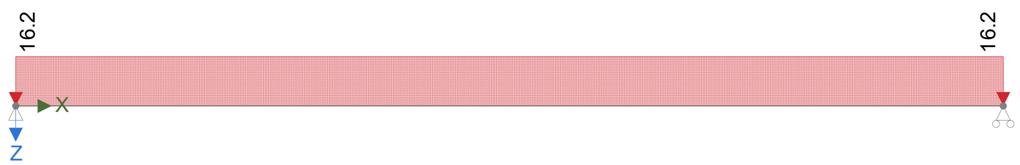
Loading

Self weight included

Permanent - Loading (kN/m)



Imposed - Loading (kN/m)



Load combination factors

Load combination	Self Weight	Permanent	Imposed
1.35G + 1.5Q + 1.5RQ (Strength)	1.35	1.35	1.50
1.0G + 1.0Q + 1.0RQ (Service)	1.00	1.00	1.00
1.0G + 1.0ψ_2Q (Quasi)	1.00	1.00	0.30

Member Loads

Member	Load case	Load Type	Orientation	Description
Beam	Permanent	UDL	GlobalZ	4 kN/m
Beam	Imposed	UDL	GlobalZ	16.2 kN/m

Results

Reactions

Load case: Self Weight

Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	10.8	0
2	0	10.8	0

Load case: Permanent

Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	10.4	0
2	0	10.4	0

Load case: Imposed

Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	42.1	0
2	0	42.1	0

Load combination: 1.35G + 1.5Q + 1.5RQ (Strength)

Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	91.8	0
2	0	91.8	0

Load combination: 1.0G + 1.0Q + 1.0RQ (Service)

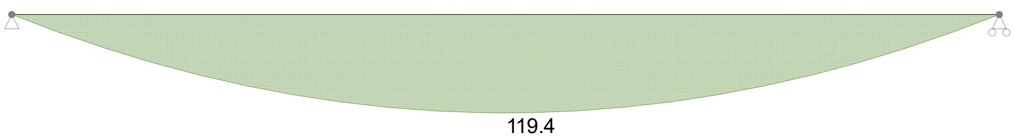
Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	63.4	0
2	0	63.4	0

Load combination: 1.0G + 1.0ψ_2Q (Quasi)

Node	Force		Moment
	Fx (kN)	Fz (kN)	My (kNm)
1	0	33.9	0
2	0	33.9	0

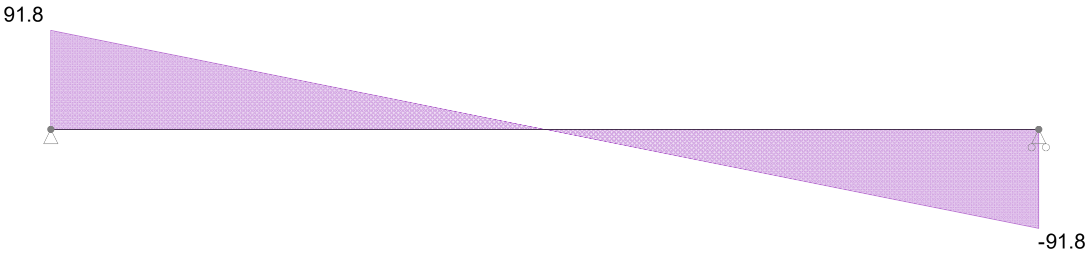
Forces

Strength combinations - Moment envelope (kNm)



Tekla Tedds Rodrigues Associates 1 Amwell Street, London EC1R 1UL	Project 28 Charlotte Street				Job no. 1964	
	Calcs for GF RC beam to restrain top of rear retaining wall				Start page no./Revision C8. 3	
	Calcs by ab	Calcs date 26/10/2022	Checked by	Checked date	Approved by	Approved date

Strength combinations - Shear envelope (kN)



Concrete details (Table 3.1 - Strength and deformation characteristics for concrete)

Concrete strength class C32/40 | Char. comp. cylinder strength f_{ck} = **32** N/mm^2

Design comp conc. strength f_{cwd} = **21.3** N/mm^2 | Maximum aggregate size h_{agg} = **20** mm

Reinforcement details

Char. yield strength of rinf. f_{yk} = **500** N/mm^2 | Partial factor for reinf. steel γ_S = **1.15**

Design yield strength of reinf. f_{yd} = **435** N/mm^2

Nominal cover to reinforcement

Nominal cover to top reinf c_{nom_t} = **25** mm | Nominal cover to bottom reinf c_{nom_b} = **50** mm

Nominal cover to side reinf c_{nom_s} = **35** mm

Fire resistance

Standard fire resistance period R = **60** min | No. sides exposed to fire 3

Minimum width of beam b_{min} = **120** mm

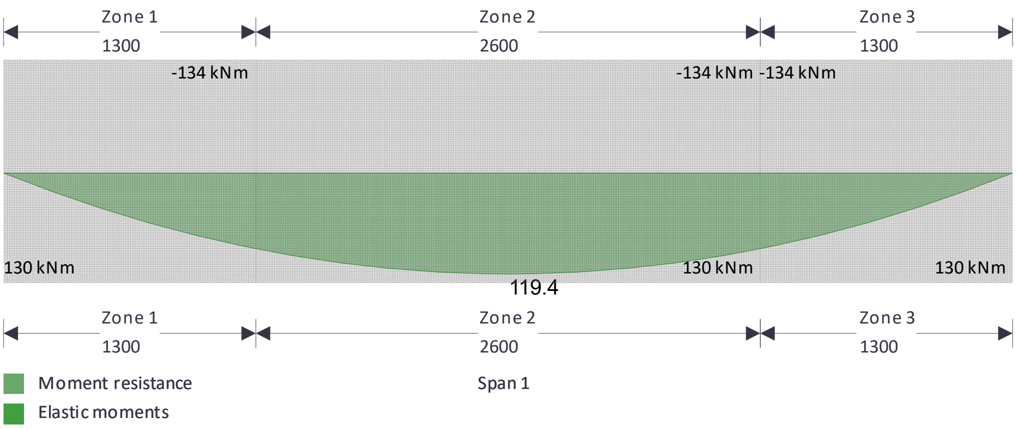
Beam - Span 1

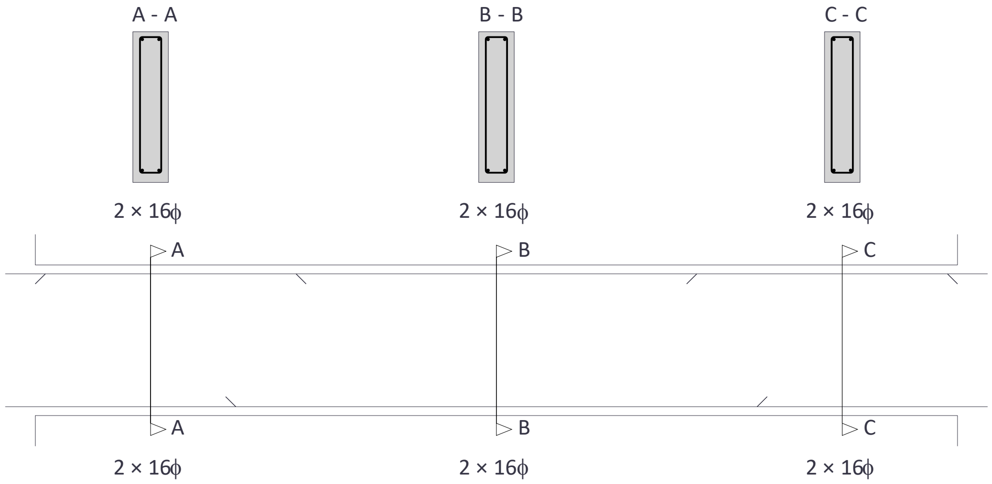
Rectangular section details

Section width b = **200** mm | Section depth h = **850** mm

PASS - Minimum dimensions for fire resistance met

Moment design





Zone 1 (0 mm - 1300 mm) Positive moment - section 6.1

Design bending moment	M = **89.6** kNm	Effective depth tension reinf.	d = **782** mm
Area of tension reinf. req'd	$A_{s,req}$ = **277** mm^2	Area of tension reinf. prov	$A_{s,prov}$ = **402** mm^2
Min area of reinf. (exp.9.1N)	$A_{s,min}$ = **246** mm^2	Max area reinf. (cl.9.2.1.1(3))	$A_{s,max}$ = **6800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width	w_k = **0.30** mm	Min area reinf req'd (exp.7.1)	$A_{sc,min}$ = **313** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment	M_{QP} = **33.0**kNm		
Actual tension bar spacing	s_{bar} = **94** mm	Max bar spacing (Table 7.3N)	$s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Zone 1 (0 mm - 1300 mm) Negative moment - section 6.1

Design bending moment	M = **29.9** kNm	Effective depth tension reinf.	d = **807** mm
Area of tension reinf. req'd	$A_{s,req}$ = **90** mm^2	Area of tension reinf. prov	$A_{s,prov}$ = **402** mm^2
Min area of reinf. (exp.9.1N)	$A_{s,min}$ = **254** mm^2	Max area reinf. (cl.9.2.1.1(3))	$A_{s,max}$ = **6800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width	w_k = **0.30** mm	Min area reinf req'd (exp.7.1)	$A_{sc,min}$ = **313** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment	M_{QP} = **0.0**kNm		
Actual tension bar spacing	s_{bar} = **94** mm	Max bar spacing (Table 7.3N)	$s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

Top bar spacing	s_{top} = **78.0** mm	Min allow. top bar spacing	$s_{top,min}$ = **25.0** mm
		PASS - Actual bar spacing exceeds minimum allowable	
Bottom bar spacing	s_{bot} = **78.0** mm	Min allow. bottom bar spacing	$s_{bot,min}$ = **25.0** mm
		PASS - Actual bar spacing exceeds minimum allowable	

Zone 2 (1300 mm - 3900 mm) Positive moment - section 6.1

Design bending moment	M = **119.4** kNm	Effective depth tension reinf.	d = **782** mm
Area of tension reinf. req'd	$A_{s,req}$ = **370** mm^2	Area of tension reinf. prov	$A_{s,prov}$ = **402** mm^2
Min area of reinf. (exp.9.1N)	$A_{s,min}$ = **246** mm^2	Max area reinf. (cl.9.2.1.1(3))	$A_{s,max}$ = **6800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **313** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **44.0**kNm

Actual tension bar spacing s_{bar} = **94** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Deflection control - Section 7.4

Allow. span to depth ratio $span\_to\_depth_{allow}$ = **52.000** Actual span to depth ratio $span\_to\_depth_{actual}$ = **6.650**

PASS - Actual span to depth ratio is within the allowable limit

Minimum bar spacing (Section 8.2)

Top bar spacing s_{top} = **78.0** mm Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **78.0** mm Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Zone 3 (3900 mm - 5200 mm) Positive moment - section 6.1

Design bending moment M = **89.6** kNm Effective depth tension reinf. d = **782** mm

Area of tension reinf. req'd $A_{s,req}$ = **277** mm^2 Area of tension reinf. prov $A_{s,prov}$ = **402** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **246** mm^2 Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **6800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **313** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **33.0**kNm

Actual tension bar spacing s_{bar} = **94** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Zone 3 (3900 mm - 5200 mm) Negative moment - section 6.1

Design bending moment M = **29.9** kNm Effective depth tension reinf. d = **807** mm

Area of tension reinf. req'd $A_{s,req}$ = **90** mm^2 Area of tension reinf. prov $A_{s,prov}$ = **402** mm^2

Min area of reinf. (exp.9.1N) $A_{s,min}$ = **254** mm^2 Max area reinf. (cl.9.2.1.1(3)) $A_{s,max}$ = **6800** mm^2

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3

Maximum crack width w_k = **0.30** mm Min area reinf req'd (exp.7.1) $A_{sc,min}$ = **313** mm^2

PASS - Area of tension reinforcement provided exceeds minimum required for crack control

Quasi-permanent moment M_{QP} = **0.0**kNm

Actual tension bar spacing s_{bar} = **94** mm Max bar spacing (Table 7.3N) $s_{bar,max}$ = **300** mm

PASS - Maximum bar spacing exceeds actual bar spacing for crack control

Minimum bar spacing (Section 8.2)

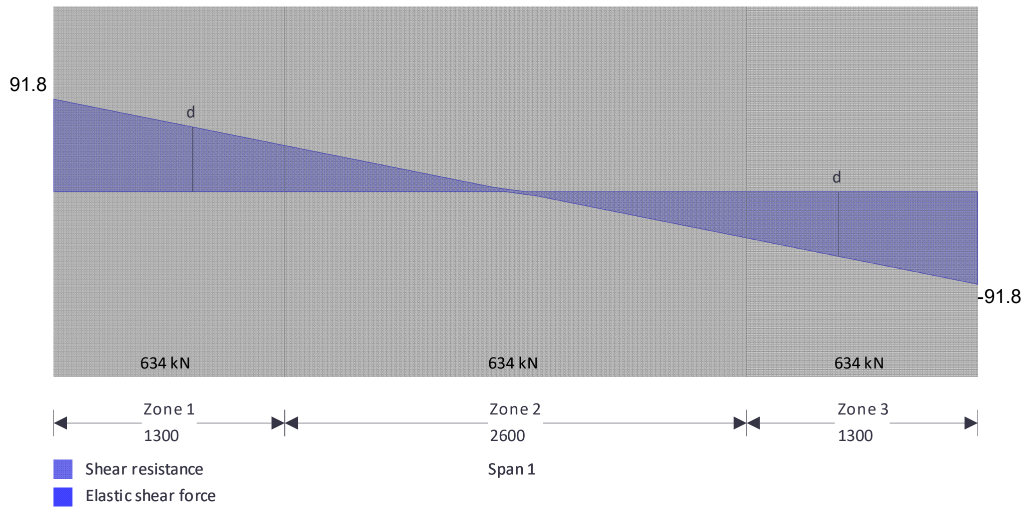
Top bar spacing s_{top} = **78.0** mm Min allow. top bar spacing $s_{top,min}$ = **25.0** mm

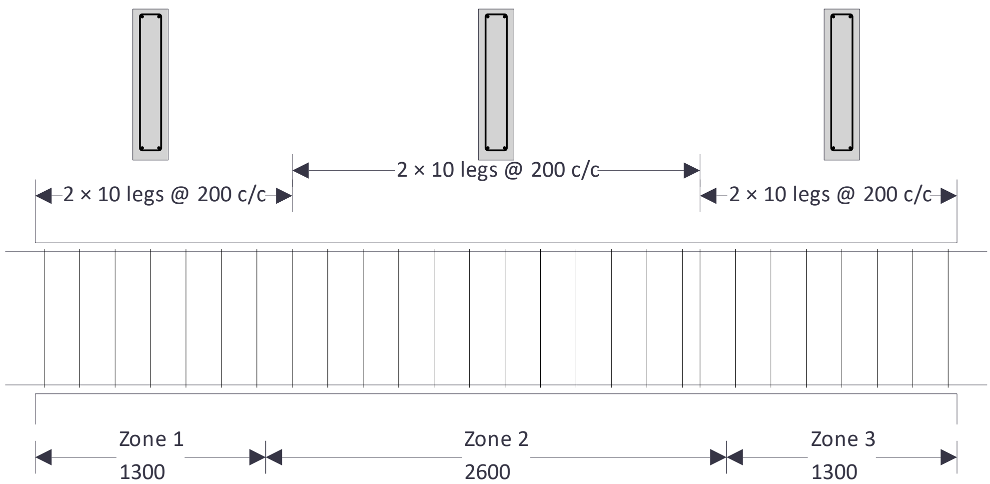
PASS - Actual bar spacing exceeds minimum allowable

Bottom bar spacing s_{bot} = **78.0** mm Min allow. bottom bar spacing $s_{bot,min}$ = **25.0** mm

PASS - Actual bar spacing exceeds minimum allowable

Shear design





Angle of comp. shear strut θ_{max} = 45 deg

Strength reduction factor v_1 = **0.523**

Compression chord coefficient α_{cw} = **1.00**

Minimum area of shear reinf. $A_{sv,min}$ = **181** mm²/m

Zone 1 (0 mm - 1300 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **92** kN

Max design shear resistance $V_{Rd,max}$ = **829** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **64** kN

Area shear reinf. req'd $A_{sv,req}$ = **181** mm²/m

Area of shear reinf prov. $A_{sv,prov}$ = **785** mm²/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **587** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Zone 2 (1300 mm - 3900 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **46** kN

Max design shear resistance $V_{Rd,max}$ = **829** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **46** kN

Area shear reinf. req'd $A_{sv,req}$ = **181** mm²/m

Area of shear reinf prov. $A_{sv,prov}$ = **785** mm²/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **587** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Zone 3 (3900 mm - 5200 mm) shear - section 6.2

Shear force at support $V_{Ed,max}$ = **92** kN Max design shear resistance $V_{Rd,max}$ = **829** kN

PASS - Design shear force at support is less than maximum design shear resistance

Design shear force V_{Ed} = **64** kN Area shear reinf. req'd $A_{sv,req}$ = **181** mm^2/m

Area of shear reinf prov. $A_{sv,prov}$ = **785** mm^2/m

PASS - Area of shear reinforcement provided exceeds minimum required

Max. long. spacing - exp.9.6N $s_{vl,max}$ = **587** mm

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Appendix D – Site investigation

For

28, Charlotte Street

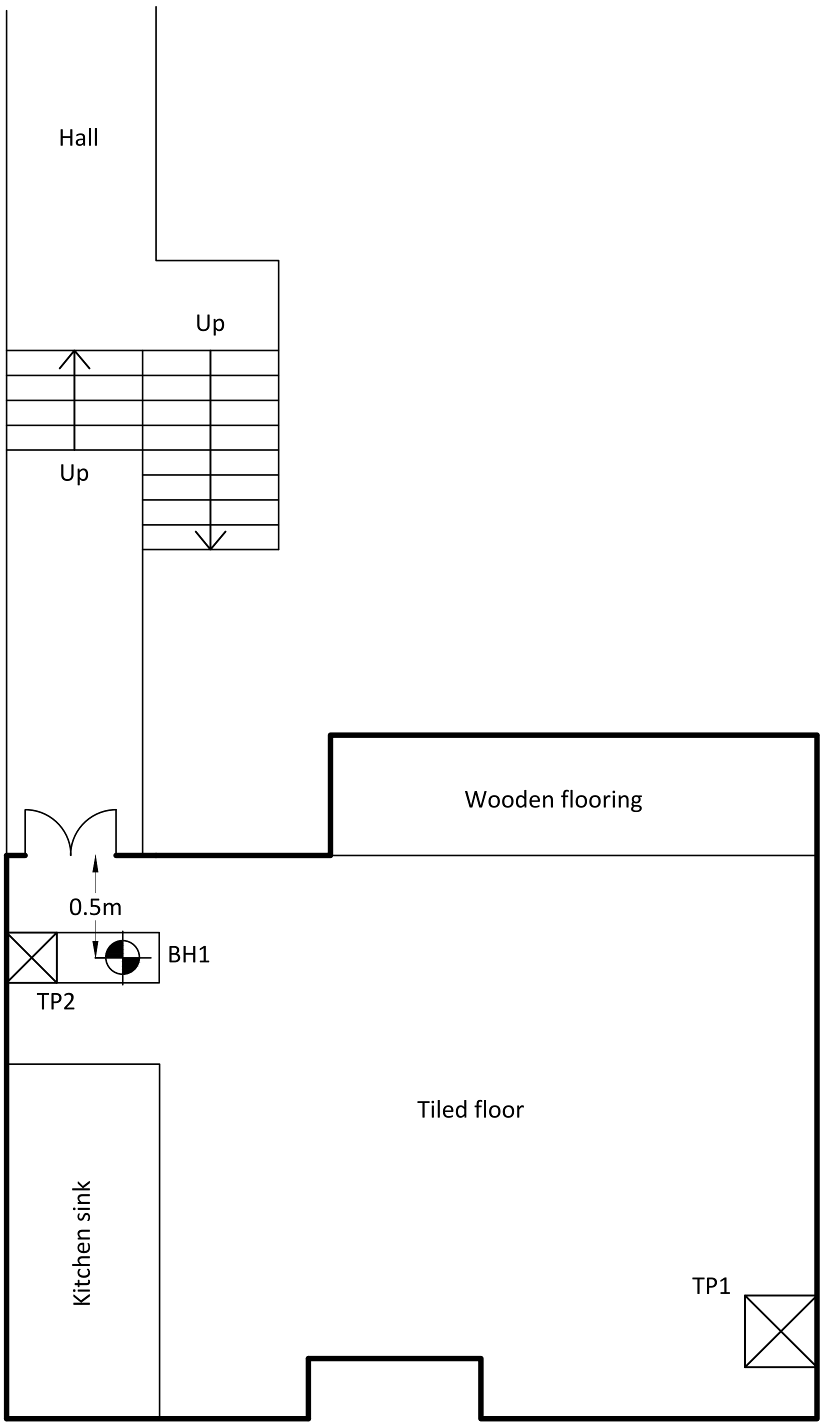
Fitzrovia

London W1T

rodriguesassociates
1 Amwell Street
London
EC1R 1UL
Telephone 020 7837 1133
www.rodriguesassociates.com
October 2022

Chelmer
Site Investigations
'Groundbreaking Services'

Client: Hammond & Hammond Ltd	**Scale:** NTS	**Sheet:** 1 of 1	**Date:** 04.01.16
Location: 28 Charlotte Street, London W1T 2NA	**Job No:** 6262	**Weather:** Internal	**Drawn by:** JP / **Checked by:** JH



Notes:

Key:

Borehole

Trial Pit

Chelmer Site Investigations
'Groundbreaking Services'

Client: Hammond & Hammond Ltd	**Scale:** N.T.S.	**Sheet No:** 1 of 1	**Weather:** Internal	**Date:** 11.01.16
Site: 28 Charlotte Street, London W1T 2NA	**Job No:** 6262	**Borehole No:** 1	**Boring method:** CFA 100mmØ Secondman	

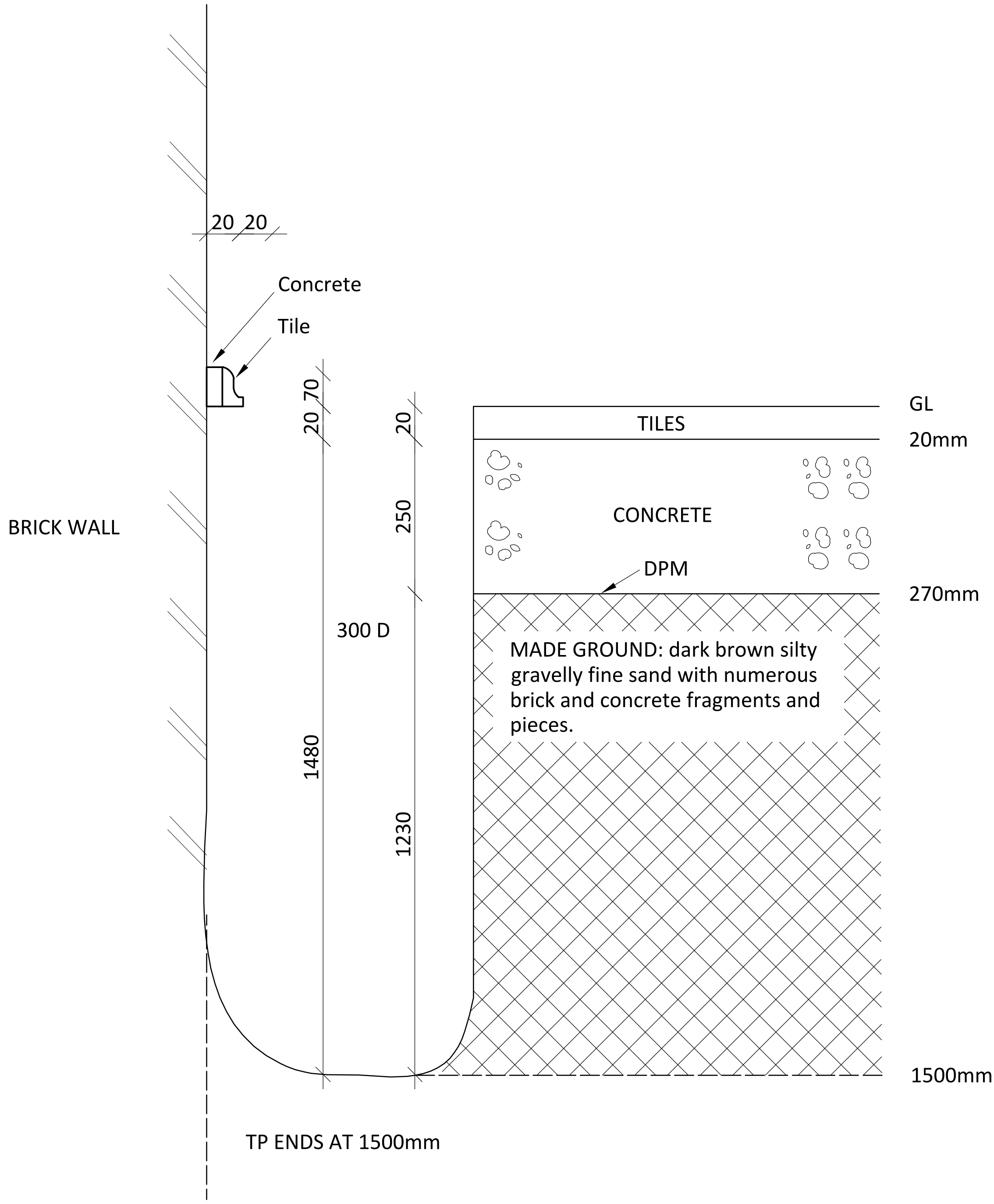
Depth Mtrs	Description of Strata	Thick-ness	Legend	Sample	Test Type	Test Result	Root Information	Depth to Water	Depth Mtrs
GL	TERRACOTTA TILES OVER CONCRETE	0.25		D			No roots observed.		0.25
0.25	MADE GROUND: medium compact dark brown silty gravelly sand sand with numerous brick concrete and slate pieces and fragments whole and half brick pieces.			D					0.5
				D	M	12 18 15 16			1.0
		2.55		D					1.5
1.8	Becoming slightly moist from 1.8m.			D	M	8 12 17 15			2.0
				D					2.5
2.8	MADE GROUND: medium compact moist dark brown sandy gravelly silt with occasional brick fragments.			D	M	13 15 15 15			3.0
				D					3.5
		2.5		D	M	12 15 17 17			4.0
				D					4.5
				D	M	13 11 18 12			5.0
5.3	SUSPECT NATURAL: wet medium dense mid grey silty gravelly SAND.			D				*5.3*	5.5
		2.4		D	M	21 18 28 28			6.0
				D	M	18 23 28 26			7.0
7.7	Very stiff mid grey silty CLAY with partings of grey and brown silt and fine sand.			D	V	130+ 130+			8.0
		2.3		D	V	130+ 130+			9.0
10.0	BOREHOLE ENDS AT 10.0m.			D	V	130+ 130+			10.0

Drawn by: DB **Approved by:** JH

Remarks: *Groundwater strike at 5.3m.*
Borehole wet and collapsed at 4.7m on completion.
Metal standpipe installed to 9.0m.

Key:
D Small disturbed sample
V Pilcon Vane (KPa)
M Mackintosh Probe

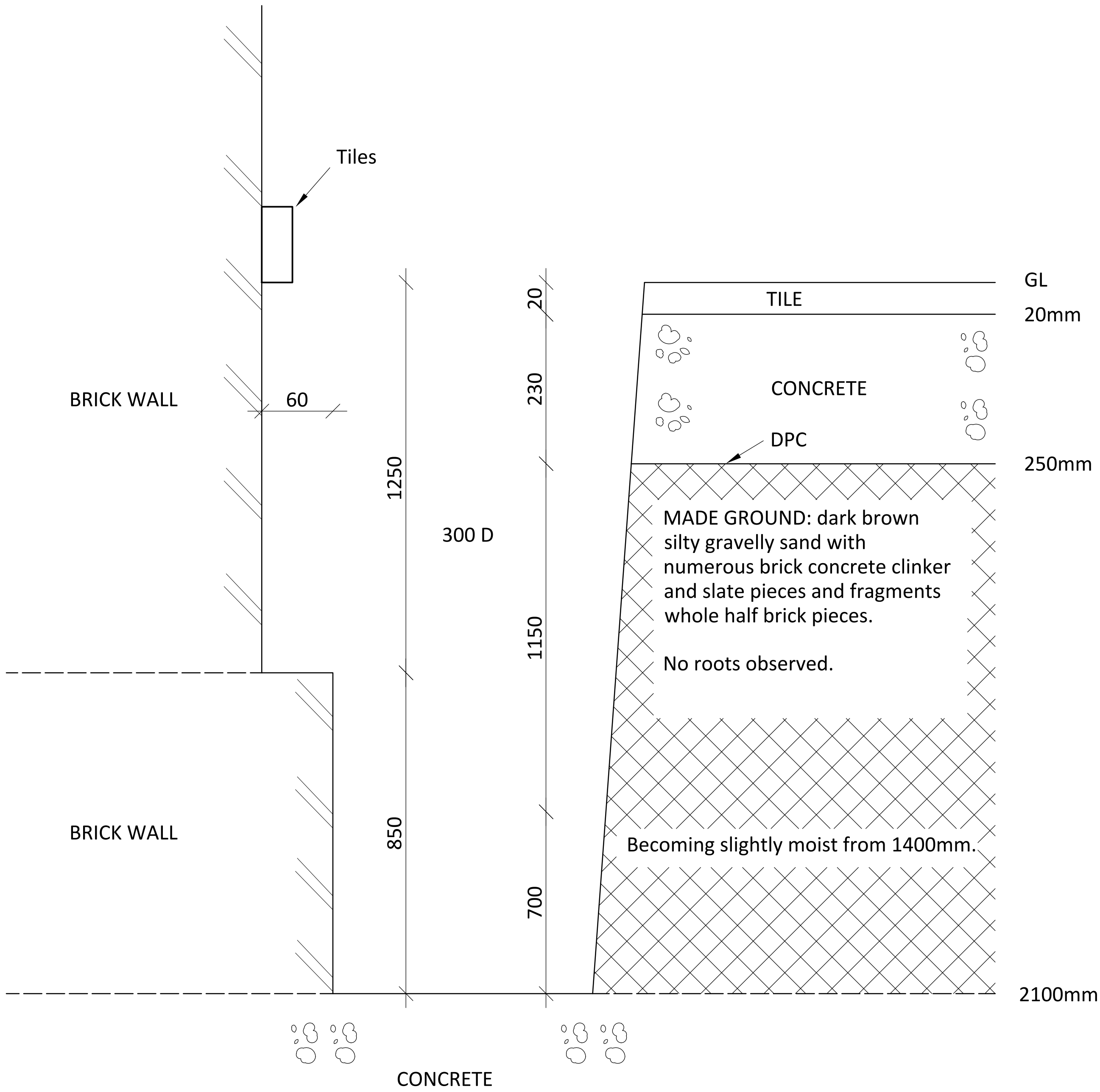
Client: Hammond & Hammond Ltd	**Scale:** NTS	**Sheet No:** 1 of 1	**Date:** 04.01.16
Location: 28 Charlotte Street, London W1T 2NA	**Job No:** 6262	**Trial Pit No:** 1	**Weather:** Internal
Excavation Method: Hand tools		**Drawn by:** JD	**Checked by:** JH



Remarks:

Key:
D Small disturbed sample

Client: Hammond & Hammond Ltd	**Scale:** NTS	**Sheet No:** 1 of 1	**Date:** 04.01.16
Location: 28 Charlotte Street, London W1T 2NA	**Job No:** 6262	**Trial Pit No:** 2	**Weather:** Internal
Excavation Method: Hand tools		**Drawn by:** JD	**Checked by:** JH



TRIAL PIT ENDS AT 2100mm
UNABLE TO LOCATE U/S.

Remarks:	**Key:**