RIBA Stage 2
Basis of Structural Design

J5423 City House

Ref: J5423-S-BD-0001

Revision: 01

Status: S2

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CONTENTS

DOCUMENT CONTROL

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Reviewer:	M.Day	**Signature:**	
Approver:	M.Day	**Signature**	

REVISION HISTORY

Date	Status	Revision
21.12.2023	S9	00

1. EXECUTIVE SUMMARY

The following items have been highlighted during the structural design works.

Item	Commentary
Ground Conditions	No site-specific ground investigations have been undertaken to date. These will be required in order to progress the design to the next stage.
Unexploded Ordnance	A UXO desk study should be undertaken to determine the likelihood of the presence of UXO.
Buried Services	A site survey should be undertaken to locate any buried services within or directly adjacent to the site boundary.
Inter-discipline considerations	As the design progresses, development and co-ordinations of elements will be required in order to firm up the structural sizing including but not limited to façade support, inset balconies, risers, access and maintenance requirements, dire design requirements and exposed structure.
Foundation Design	The proposed foundation strategy and design will need to be reviewed and updated after receipt of the site investigation.

2. PROJECT OVERVIEW

Webb Yates Engineers have been appointed by Macar Living (City House) Ltd. to undertake the structural and civil engineering design of a new development in Sutton, South London. The site, which is on the corner of Cheam Road and Sutton Park Road, is currently occupied by a three-storey office building that is due to be demolished as part of the proposals.

Plans for the proposed scheme involve the construction of a conjoined 5 and 13 storey residential building with commercial space at ground floor level.

The purpose of this document is to outline the structural design parameters which have been used to develop the design. This document will be updated throughout the design stages to record the design parameters used and to provide a record for any future developments or modifications.

3. SITE INFORMATION

3.1. Site Conditions

The site sits on the corner of Cheam Road and Sutton Park Road in Sutton, located in the London Borough of Sutton. The development area currently contains an office building located in the centre of the site with a car park located in the south and eastern sides with vehicular access obtained from the south through the neighbouring property. From visual inspection the topography of the site falls from South to North. Details of the site location are included below

Description	Site Location
Nearest post code	SM1 2AE
Lead Local Flood Authority	London Borough of Sutton
Lat, Long	51.361021 , -0.19492015
Nat Grid	TQ257639
OS X (Eastings)	525772
OS Y (Northings)	163985

3.2. Ground Conditions

No site-specific ground investigations have taken place. Nearby borehole records show the underlying soil to be predominantly chalk with localised patches of surface clay. The chalk extends beyond 10+m. Ground water is typically found at 5m BGL within the chalk layer, with the potential for perched water on the clay layer. Site specific ground investigations will be required to develop the scheme beyond Stage 2.

3.3. Existing Buildings on Site

An existing three storey masonry clad office building exists on site and is due to be demolished prior to construction of the new development. The exact construction typology is unknown but based on the scale and assumed age of the property, it expected that it is likely to be either a steel or concrete framed structure. Existing foundations are also unknown but given the anticipated loads and ground conditions are expected to be shallow.

3.4. Unexploded Ordnance

An Unexploded Ordnance Desktop study should be undertaken.

3.5. Buried Services

It is not known if there are any buried services on site. This remains a risk and a site specific survey should be undertaken to located all below ground services within the site boundary, including where they enter and exit site.

4. PROPOSAL

4.1. Substructure

Foundations are required below stability cores and all columns. No site investigations have been undertaken, however based on our understanding of the ground conditions and the massing of the building the foundations are likely to consist of ground beams, reinforced concrete piles and pile caps.

4.2. Superstructure

The super structure is formed with a regular 6x6m grid, with RC flat slab construction. Slab thicknesses vary in accordance with use class and the column sizes vary from ground to roof level to minimise material use and maximise space.

Slab Thickness:

- Residential Areas: 225mm
- Office Areas & Terrace Areas: 250mm
- Plant Areas: 275mm

Columns:

- Ground Floor – 5th Floor:
  - Internal: 650x650mm or 400x1050mm
  - Edge: 525x525mm or 400x700mm
  - Corner: 450x450mm or 400x525mm
- 6th Floor – Roof:
  - Internal: 450x450mm or 250x800mm
  - Edge: 400x400mm or 250x650mm
  - Corner: 350x350mm or 250x500mm.

4.3. Stability

Lateral stability is provided by reinforced concrete cores and shear walls from ground to roof level. These act as vertical cantilevers from their piled foundations. The stability walls are formed with 250mm thick reinforced concrete

Concrete floor plates provide diaphragm action transferring horizontal loads to the cores.

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4.4. Façade Works

The build-up of the proposed façade is subject to confirmation at the next stage. It is assumed the masonry façade is supported on each floor level and an edge load of 10kN/m has been assumed.

4.5. Inter-Discipline Considerations

Further development and co-ordination of the following elements is required to firm up the structural form including but not limited to: façade support, inset balconies, risers, access and maintenance requirements, fire design requirements, exposed structure.

5. SUSTAINABILITY

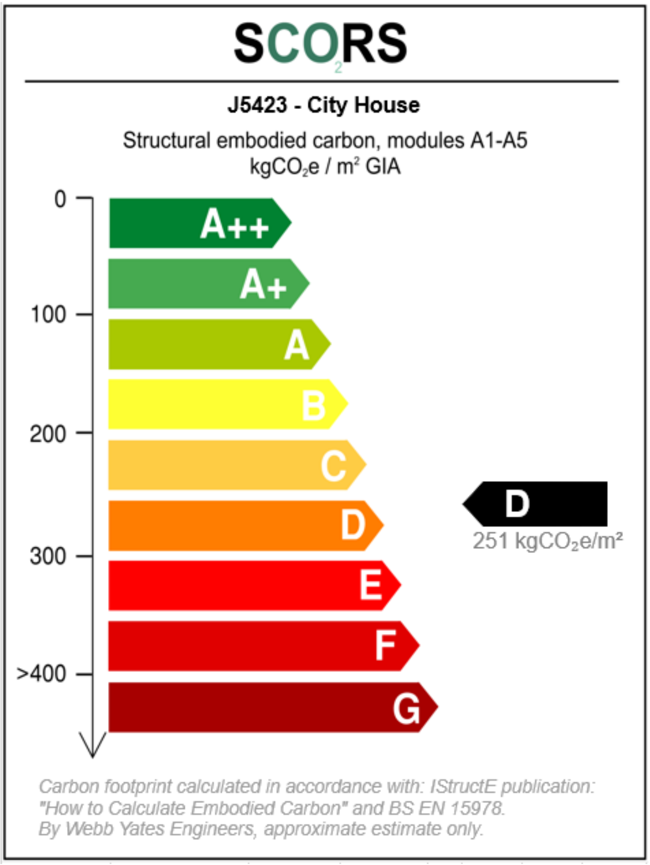
5.1. Aspirations and Proposals

An early stage feasibility study was undertaken on the proposed massing in order to estimate embodied carbon for different framing options and grid sizes. Whilst a flat slab option was taken forward due to structural zone constraints, architectural layouts were adjusted to 6m grid size which was optimum for the scale and loads of the building.

Transfer structures and basements have been designed out of the building, keeping embodied carbon to a minimum,

5.2. Embodied Carbon Estimate

The embodied carbon of the structural works has been estimated as 250 $kgCO_2e/m^2$ for modules A1-A5 and based on the proposed scheme provided by Wimshurst Pelleriti. Gross internal floor area for the project has been estimated as 7191 m^2. It should be noted that this calculation is an estimate and should be used for information only.



5.3. Opportunities

The following options should be considered at the next design stage to further reduce the embodied carbon of the project:

- Maximum percentage of cement replacement to be reviewed.
- Potential of shallow foundations (e.g. raft) to be investigated following receipt of ground investigations.
- Design for higher utilisations in detailed design.

6. DESIGN REQUIREMENTS

6.1. Design Standards

The design has been carried out in accordance with the following design standards and technical guides. Where a Eurocode has been referenced it includes the relevant UK National Annex.

- BS EN 1990 Eurocode 1: Basis of structural design
- BS EN 1991-1-1 Eurocode 1: Actions on structures. General actions – Densities, self-weight, imposed loads for buildings
- BS EN 1991-1-3 Eurocode 1: Actions on structures. General actions – Snow actions
- BS EN 1991-1-4 Eurocode 1: Actions on structures. General actions – Wind actions
- BS EN 1991-1-5 Eurocode 1: Actions on structures. General actions – Thermal actions
- BS EN 1992-1-1 Eurocode 2: Design of concrete structures. General rules and rules for buildings
- BS EN 1997-1 Eurocode 7 Geotechnical Design

All subsequent parts and the relevant national annex will be referred to where not explicitly listed above.

6.2. Design life

In accordance with BS EN 1990 all structural elements are to be designed and specified in accordance with design working life category 4 with an indicative structural design life of 50 years.

For the purposes of the whole life embodied carbon assessment of the building (undertaken by others) the building is assumed to have a 60-year design life.

6.3. Loads

6.3.1. Dead (Permanent) Loads

Dead loads are calculated in accordance with BS EN 1991-1-1 and the selected form of construction. These will include permanent walls, floors, roofs, finishes, services and all other permanent construction items. The design dead loads of the structure are outlined below.

- Reinforced Concrete - 25 kN/m^3
- Finishes, services + ceilings - 1.0 kN/m^2
- Roof Finishes - 1.0 kN/m^2
- Terrace Finishes (Green Roof) - 2.5 kN/m^2
- Masonry Cladding - 10 kN/m per floor

6.3.2. Imposed Loads

Imposed loads are calculated in accordance with BS EN 1991-1-1 and the UK National Annex. The following categories and values of imposed loads are allowed for in the design.

- Office Areas 2.5 kN/m^2 + 1.0 kN/m^2 Partition load
- Residential Areas - 1.5kN/m^2 + 1.0 kN/m^2 Partition load
- Roof Terrace - 5.0 kN/m^2
- Plant Deck - 7.5 kN/m^2
- Roof - 0.6 kN/m^2

6.3.3. Wind Loads

Wind loads are calculated in accordance with BS EN 1991-1-4 and the UK National Annex

6.3.4. Snow Loads

Snow loads are calculated in accordance with BS EN 1991-1-3 and the UK National Annex.

6.3.5. Accidental Loads

No specific allowance has been made for accidental loads to the structure.

6.3.6. Thermal Actions

Calculation of thermal actions on structures, will be designed to the requirements of BS EN 1991-1-5. This includes but is not limited to the effects due to season(s) environment changes during the build execution activities and phasing, occupancy operational range temperatures during service and exceptional lower internal temperature in the event of the building being unheated, vacant without heating or heating systems being turned off for a period or during refurbishment.

6.3.7. Imposed Load Reduction

Imposed load reduction has been applied in accordance with EC 1991.

6.4. Stability and Robustness

The building class in accordance with The Building Regulations (2013) Part A the structure is class 2B, Upper Risk Group. The structure will be designed to provide effective anchorage of floors and provision of horizontal and vertical ties in accordance with the relevant Eurocodes.

6.5. Fire Protection

Fire protection is not yet defined and will be developed in accordance with Architect’s specification: at this stage 90 minutes protection has been assumed for all primary structural elements and suitable cover will be provided to meet this requirement.

6.6. Durability

The concrete structures will be designed in accordance with EC2 to ensure adequate cover, considering bond quality and environmental conditions.

7. BASEMENT REQUIREMENTS

It is currently assumed there is no basement on site

8. ANALYSIS

8.1. Method of Analysis

Structures have been analysed using a mixture of hand calculations and FE analysis in accordance with the stated Eurocodes.

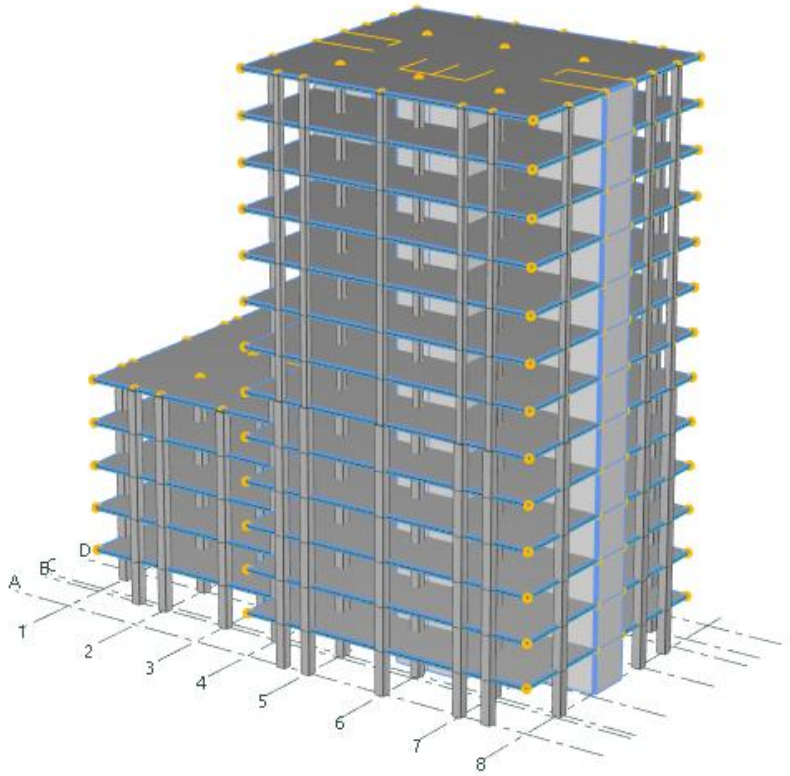


Figure 8.1: Screenshot of FE Model

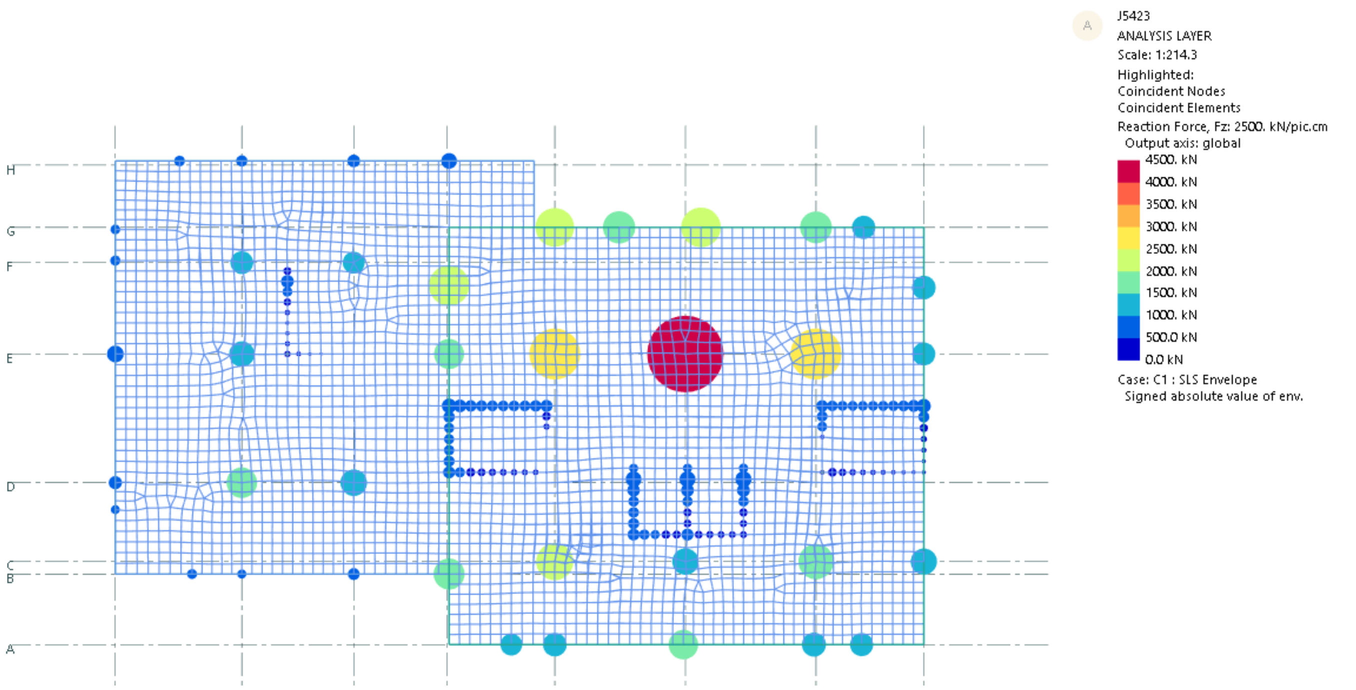


Figure 8.2: Base reactions (unfactored)

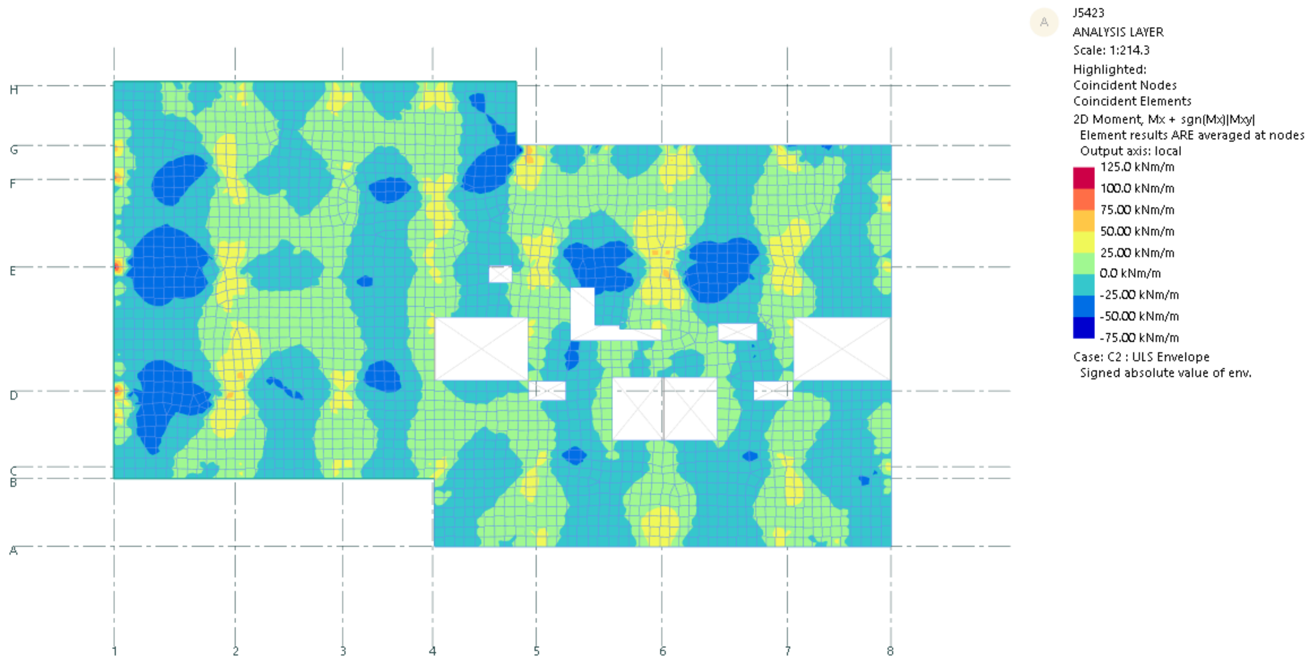


Figure 8.2: Typical slab bending moment plots (x-direction)

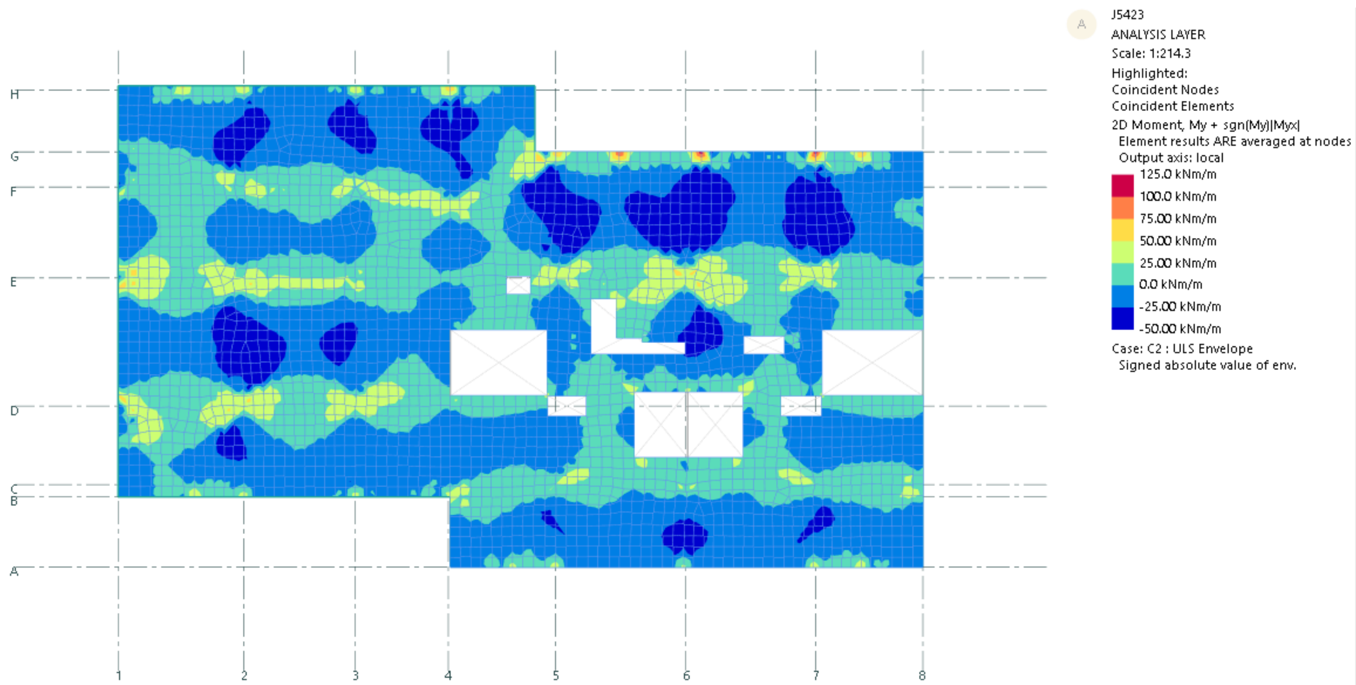


Figure 8.3: Typical slab bending moment plots (y-direction)

9. DESIGN CONSIDERATIONS

9.1. Effect of Concrete Creep and Cracking

If the concrete reaches a bending moment causing the first cracks to appear (cracking moment) its stiffness reduces. This reduced stiffness will then have an effect on the deflections and settlements of the structure. The effect of concrete creep and cracking is taken into account by undertaking a full cracked analysis of the structure. Analysis is undertaken to ensure any cracks will not be visible to the naked eye.

9.2. Effect of Early Age Thermal Cracking

Early-age thermal cracking occurs when the tensile strain, arising from either restrained thermal contraction or a temperature differential within the concrete section, exceeds the tensile strain capacity of the concrete. The final reinforcement design for the frame will take into consideration the pour sizes and sequence in order to ensure the tensile strains do not lead to excessive cracking of the concrete.

9.3. Natural Frequency and Vibrations

Dynamic design criteria is to be reviewed and agreed with the client and design team.

10. MOVEMENT AND TOLERANCES

The structure will be designed to control deflections to acceptable limits according to Eurocodes.

The structure is an insitu concrete frame and as such will be subject to both short term instantaneous deflections and long term creep deflections. Follow on trades are to allow for this by site measure. The structure will continue to deflect elastically in future due to additional dead and imposed loadings, which needs to be allowed for in the design of the façade, and internal finishes.

10.1. Combination of movements and tolerances

When considering the present and future position of a structural element it may be necessary to consider initial construction tolerances in combination with structural movements. Therefore the total positional variation of an element can be considered as a sum of the following three categories:

1. Tolerance (Δ0) : the allowable inaccuracy in the original construction of the frame.
2. Short term movement (Δ1) : the movement that has occurred prior to installation of the item in consideration. This movement is made up of the following components:
    - Instantaneous vertical deflection due to self-weight of the structure
    - Any creep or shrinkage effects that are predicted to have occurred prior to installation of the item in consideration
    - Vertical deflection of the structure due to other structural elements, finishes or other fit-out items already installed
    - Foundation settlement
3. Long term movement (Δ2) : the movement that will occur after the relevant item has been installed. This movement is made up of the following components:
    - Vertical deflection of the structure due to construction of the remaining structural elements, finishes and other fit-out items
    - Vertical deflection of the structure due to imposed loads
    - Movements due to wind loads
    - Concrete creep and shrinkage effects that are predicted to occur after installation of the item in consideration
    - Movements due to temperature changes (thermal loads)
    - Foundation movements

Figures for each of these components are given directly or in the sources quoted in the subsequent sections.

10.2. Anticipated Vertical Movements

The vertical movements can be split into two categories. The first are the vertical deflections of the floor slabs and beams between supports. Second is the global movement of the building due to axial shortening of the columns and settlement/heave of the foundations.

10.2.1. Slab and beam deflections generally

The total vertical deflections between supports are limited to the values stated below. The supports may also have their own settlements.

The deflections at each stage depend on the construction sequence and the stage at which each element is installed.
The following percentages of the vertical movements should be adopted to calculate Δ1, Δ2 and in use values (imposed loads only) after construction completion. The deflection due to superimposed dead load has been included in the percentages of the total deflection Δ2. It should be noted that these deflections do not occur concurrently at each level and are the maximum values which are likely to occur.

In-situ concrete slabs and beams are generally designed to satisfy the deflection limits set out in EC2, which are summarised as follows:

- Total deflection (Δ1+Δ2): span/250
- Imposed load deflection: span/360
- Dead load deflections: Max TBC, to limit natural frequency.
- Members supporting brittle elements: (Δ1+Δ2): span/500

Maximum deflections for elements supporting the masonry façade

- Total deflection (Δ1+Δ2): span/360 or 20mm whichever is smaller
- Imposed load deflection: span/750 or 10mm whichever is smaller
- Deflections cause by façade self-weight span/1000 or 7mm whichever is smaller

These values are to be accommodated within cladding specialists and suppliers design.

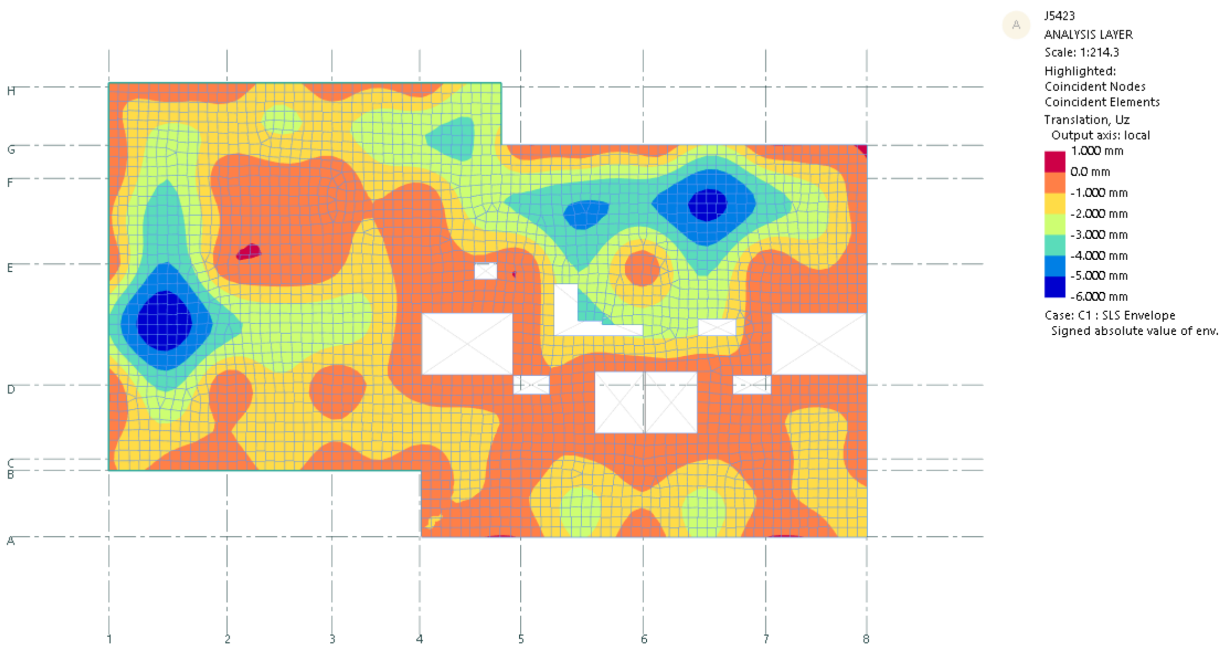


Figure 10.1: Typical short-term deflection plot of a lower level slab.

10.2.2. Axial shortening of columns

Total axial shortening of columns is expected to be 1-2mm per storey.

10.2.3. Settlement/heave of foundations

Settlement of the piled foundations will be in accordance with BS EN 1997-1 Annex H and will typically be limited to approximately 10mm. TBC following completion of piling specification and site investigation works .

10.3. Anticipated Horizontal Movements

The horizontal movements can be split into two categories. The first are the horizontal movements of the floor slabs due to thermal expansion/contraction. Second is the global movement of the building due to wind load acting on the building.

10.3.1. Thermal movements

Thermal movements are expected to be within typical allowances. No structural movement joints are required to accommodate thermal expansion and contraction. An assessment will need to be made by the façade engineer to confirm any movement joints required in the cladding.

10.3.2. Movements due to wind load

Deflections of each storey are limited to storey height/300

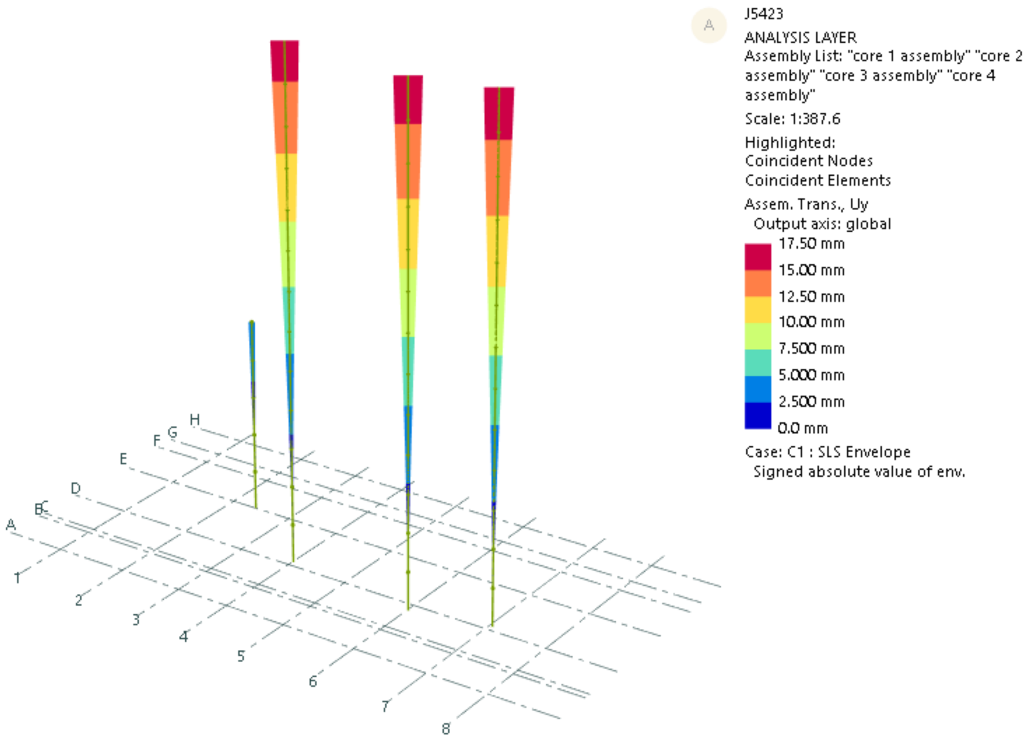


Figure 10.1: Total displacement of core walls under wind loading. Maximum 17.5mm ~ h/2500

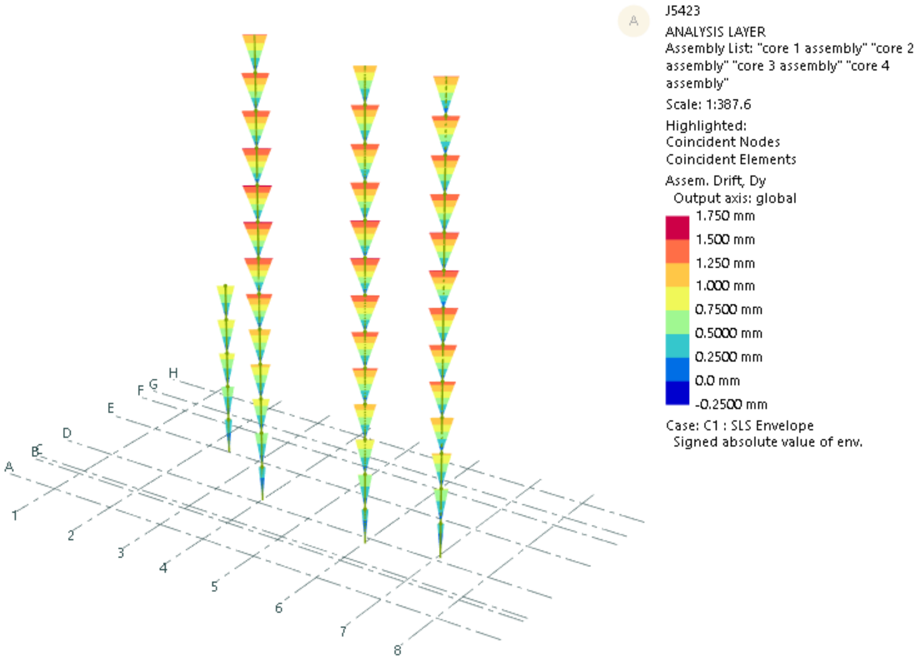


Figure 10.2: Inter-storey drift of core walls. Maximum 1.75mm ~h/1830

10.4. Construction Tolerances

Construction tolerances for the concrete works will be in accordance with BS EN 13670, Tolerance Class 1.

Tolerance precedence shall be as follows:

- The overall tolerance of the structure
- Positional tolerance of all parts of elements of the structure within the overall tolerance
- Dimensional tolerance of the individual elements within their positional tolerance
- The position tolerance of reinforcement and fixings within the individual elements dimensional tolerance

Refer to the specification for lift shaft tolerances as these are outside the recommendations of BS EN 13670.

11. EXCLUSIONS AND ASSUMPITIONS

11.1. Waterproofing

The details and design for waterproofing is outside WYE scope of works. Refer to Architect's details.

11.2. Non-structural Items

WYE are not responsible for the design of non-structural items, such as partitions, screeds, glazing, secondary steels and façade supports.

11.3. Contractor Responsibilities

The contractor is responsible for determining the order of work and method, requirements and design for temporary works or any other works necessary for the safe execution of the project and the protection and prevention of damage to adjacent structures.

11.4. Glazing and Façade Works

The primary frame will be designed to support the weight of the cladding to the agreed deflection limits. All secondary support elements and the cladding itself will need to be designed by a specialist subcontractor.

11.5. Design of piled foundations

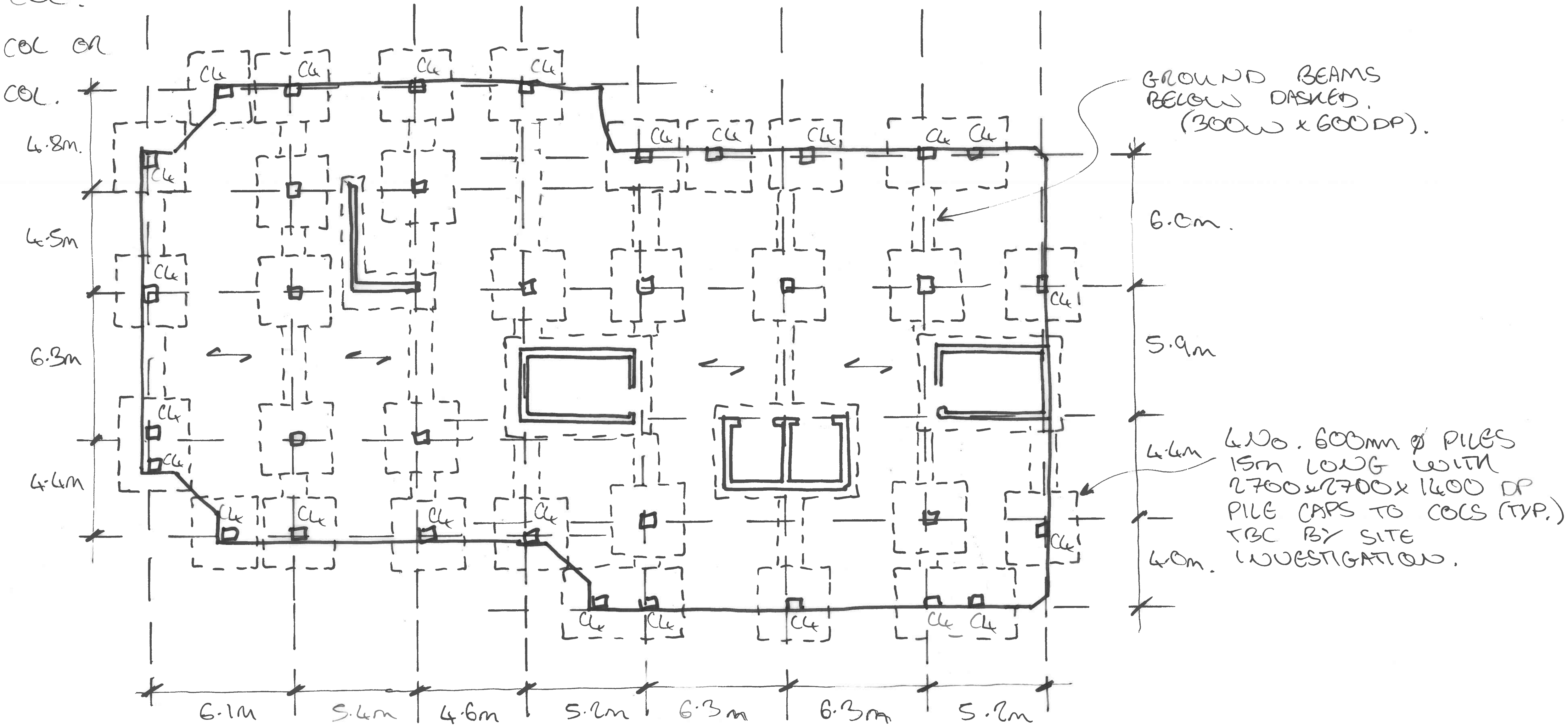
Piles to be designed by a specialist in accordance with the design loads and specification provided by WYE.

APPENDIX A – STRUCTURAL SCHEME SKETCHES

← 250mm SUSPENDED RC SLAB

C2 650x650 RC COL OR
400x1050 RC COL.

C4 525x525 RC COL OR
400x700 RC COL.



GROUND FLOOR PLAN

- ALL COLS C2 U.N.O.
- ALL WALLS 250mm U.N.O.
- ALL STRUCTURE TO ALIGN AT EACH LEVEL.

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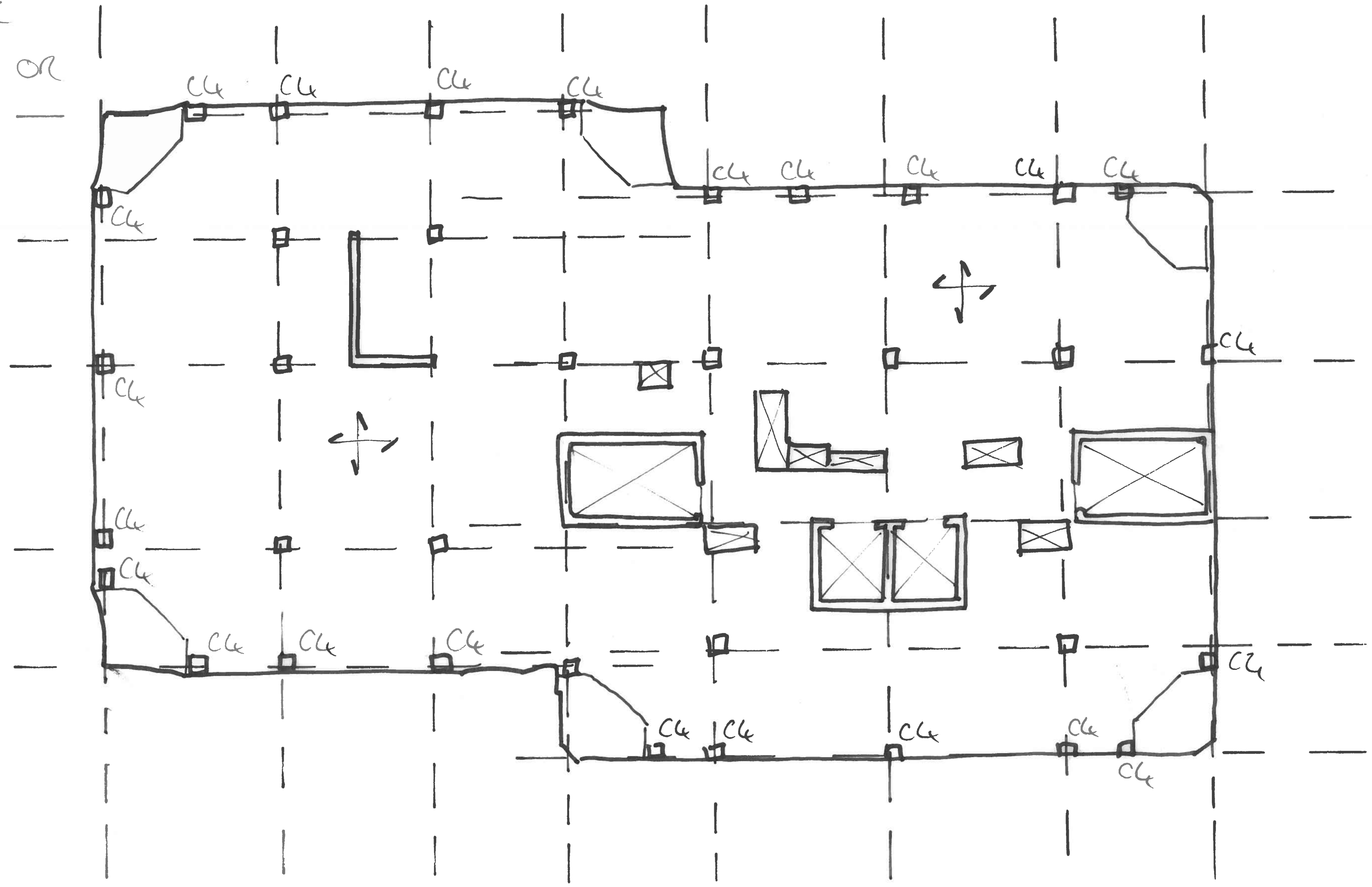
Drawing No			
JS423-S-SK-0006			
Project: CITY HOUSE		Status: S2	
Drawing Title: GROUND FLOOR PLAN			
Date: JAN'24	Drawn by: D.COLE	Scale: NTS	Revision: 00

225mm RC SLAB

C2 650x650 RC COL OR 400x1050 RC COL

C4 525x525 RC COL OR 400x700 RC COL



LEVEL 1-3 PLAN

- ALL COLS C2 U.N.O.
- ALL WALLS 250mm.
- ALL STRUCTURE TO ALIGN EACH LEVEL.

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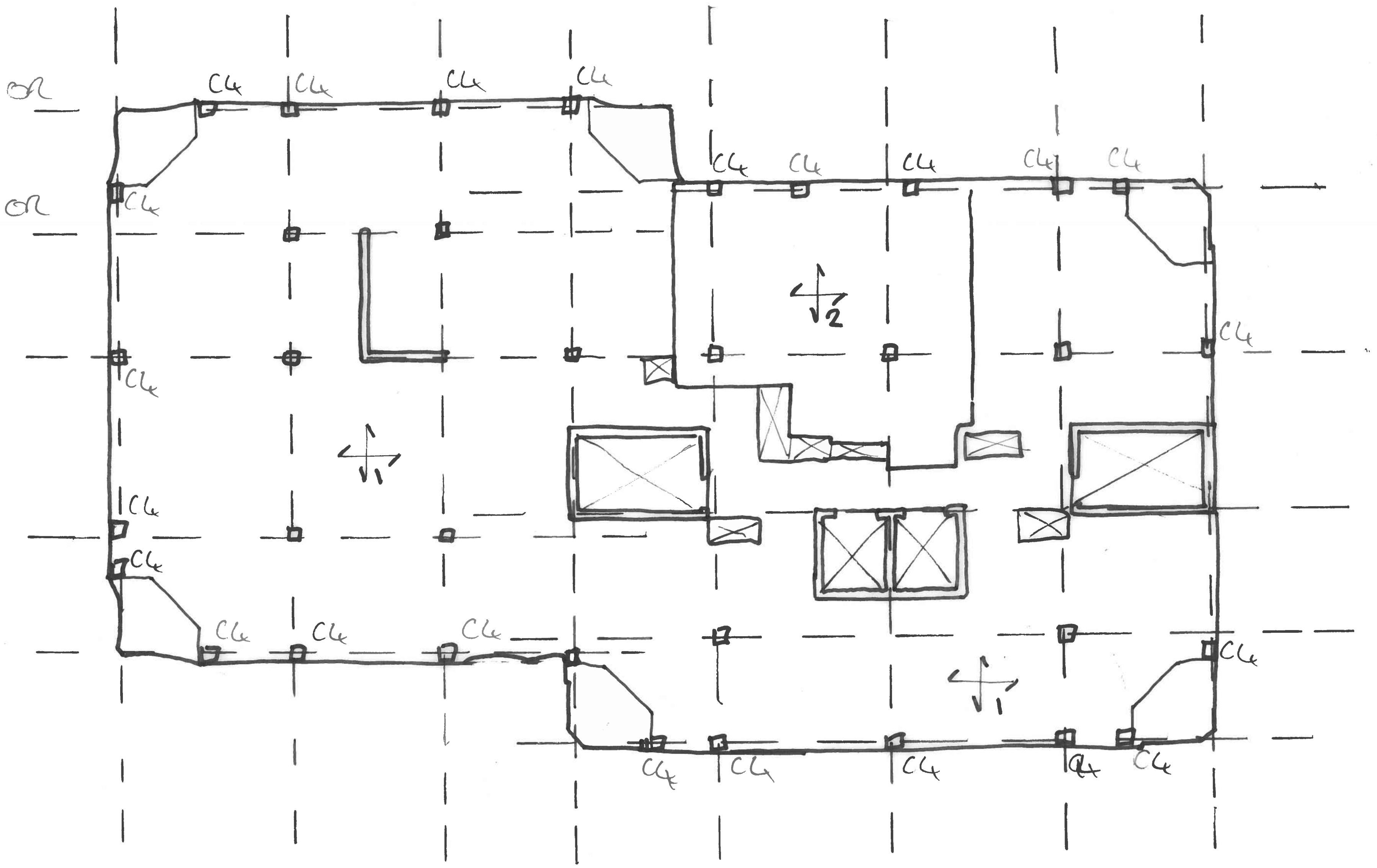
Drawing Title: LEVEL 1-3			
Date: JAN'24	Drawn by: D.COLE	Scale: NTS	Revision: 00

1 — 225mm RC SLAB

2 — 275mm RC SLAB

C2 650x650 RC COL OR 400x1050 RC COL

C4 525x525 RC COL OR 400x700 RC COL.



LEVEL 4 PLAN

- ALL COLS C2 U.N.O.
- ALL WALLS 250MM.
- ALL STRUCTURE TO ALIGN EACH LEVEL.

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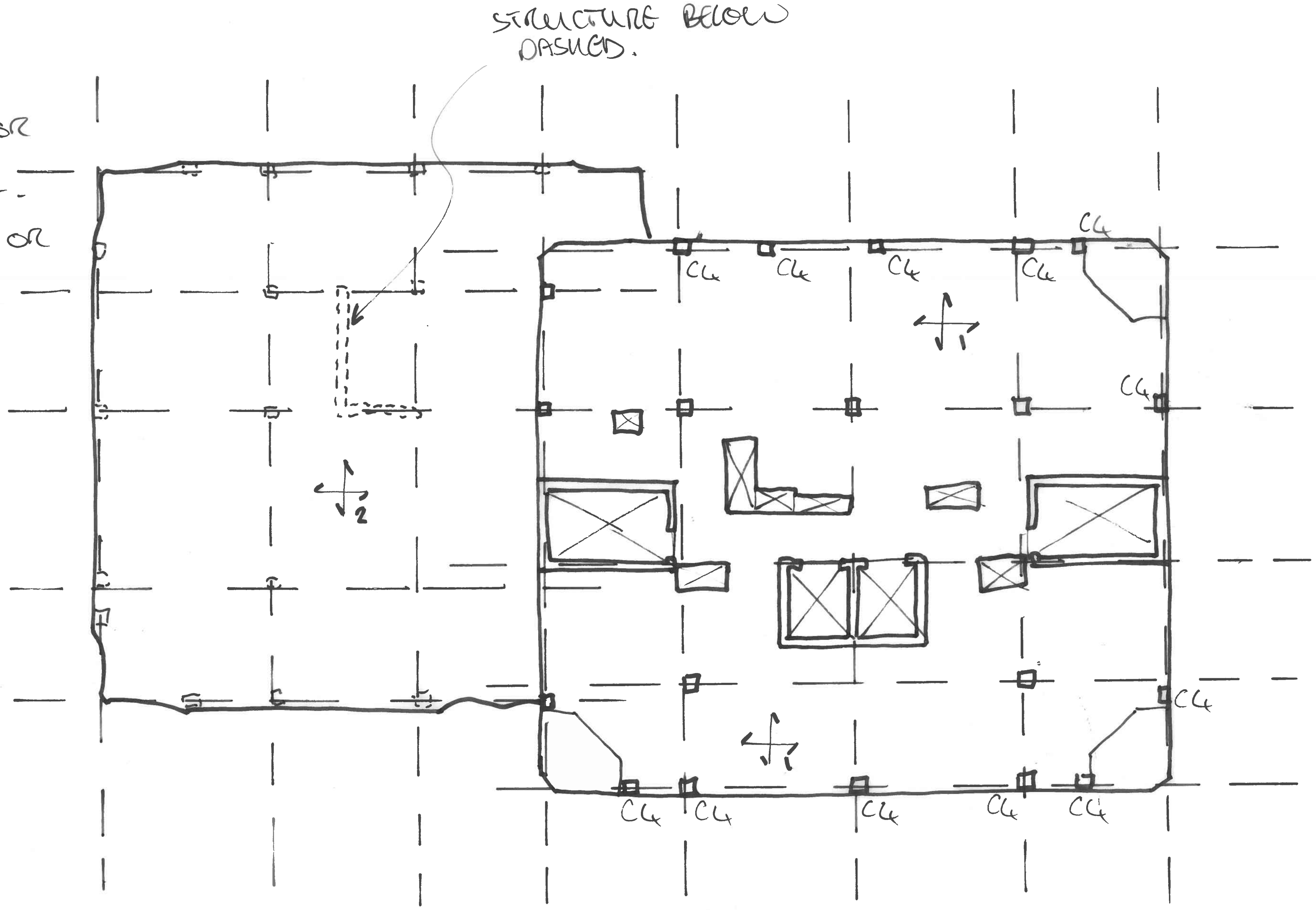
Drawing Title: LEVEL 4 PLAN			
Date	Drawn by	Scale	Revision
JAN'24	D.COLE	NTS	00

1 — 225mm RC SLAB

2 — 250mm RC SLAB

C2 — 650x650 RC COL OR 400x1050 RC COL

C4 — 525x525 RC COL OR 400x700 RC COL



LEVEL 5 PLAN

- ALL COLS C2 U.N.O.
- ALL WALLS 250 MM U.N.O.
- GREEN ROOF ALLOWANCE – 2.5kN/m²
- ALL STRUCTURE TO ALIGN EACH LEVEL.

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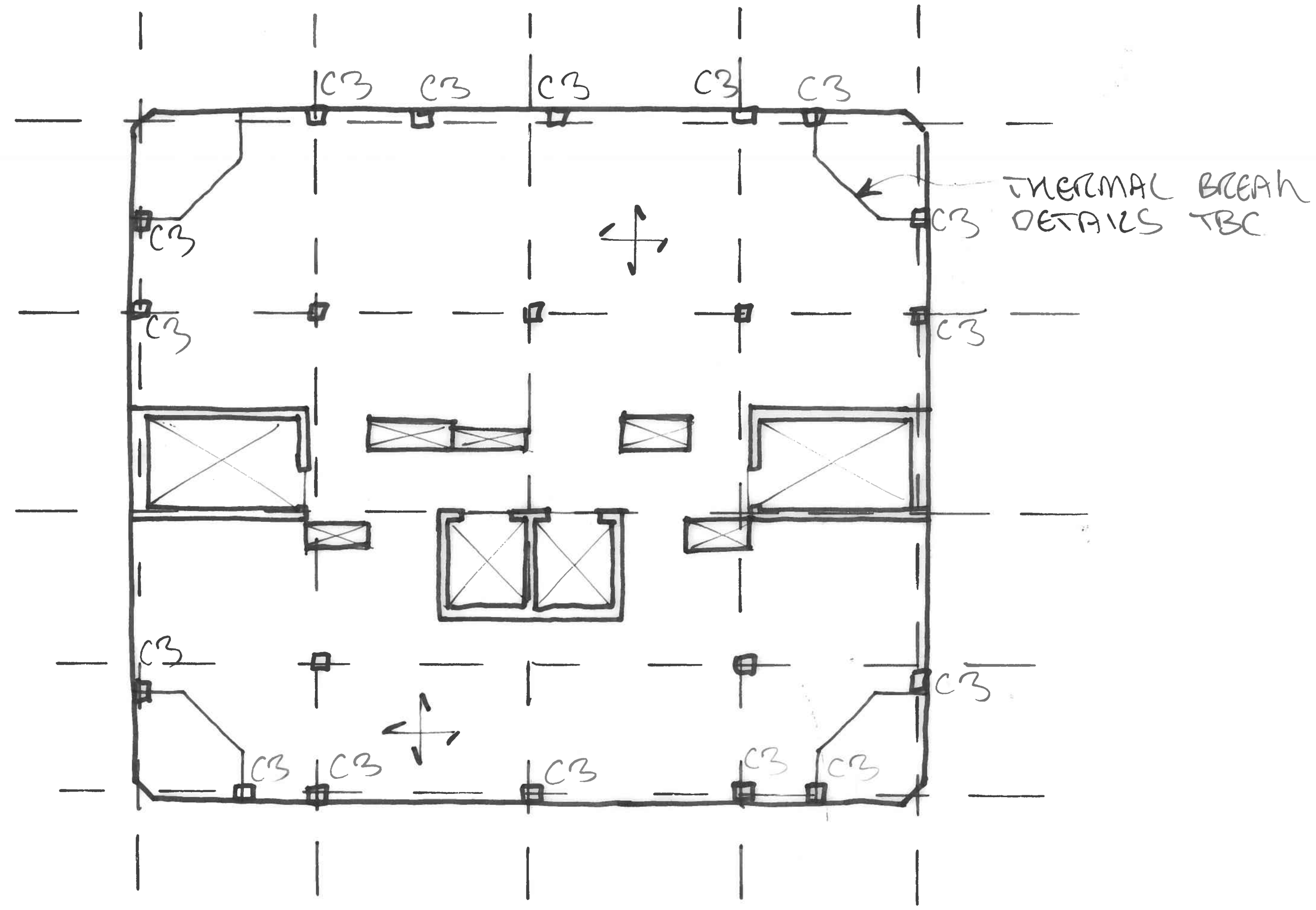
Drawing Title: LEVEL 5 PLAN			
Date: JAN'24	Drawn by: D. COLE	Scale: NTS	Revision: 00

225mm THK
RC SLAB

C1 450x450 RC COL OR
250x800 RC COL.

C3 400x400 RC COL OR
250x600 RC COL.



LEVEL 6-12 PLAN

- ALL COLS C1 U.N.O.
- ALL WALLS 250mm U.N.O.
- ALL STRUCTURE TO ALIGN EACH LEVEL.

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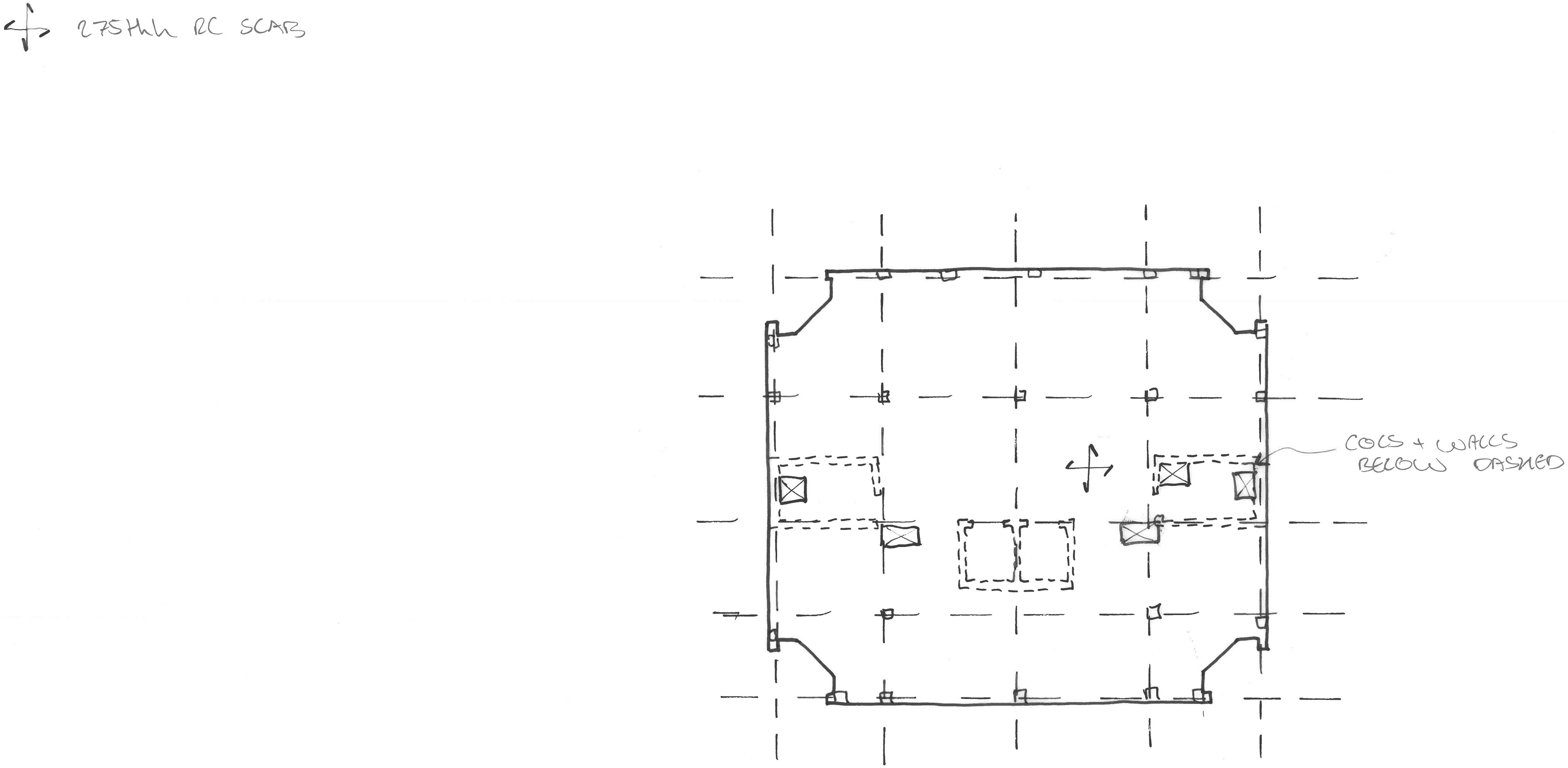
Project: CITY HOUSE			Status: S2
Drawing Title: LEVEL 6-12 PLAN			
Date: JAN'24	Drawn by: D.COLE	Scale: NTS	Revision: 00



ROOF PLAN

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Drawing No			
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Project: CITY HOUSE		Status: S2	
Drawing Title: ROOF PLAN			
Date: JAN '24	Drawn by: D.COLE	Scale: NTS	Revision: 00