EUSTON TOWER

Structural Statement

December 2023

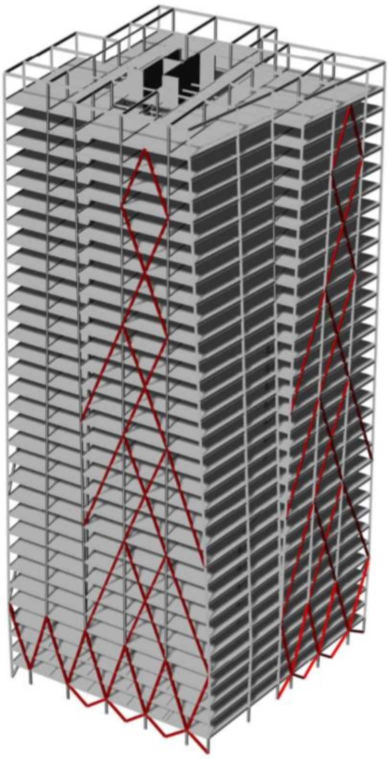
British Land

British Land Property Management Limited

Euston Tower, 286 Euston Road

Structural Report

01 | 30 November 2023



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1. Executive Summary

This Structural Report has been prepared by Ove Arup and Partners Limited (Arup) in support of an application for planning permission in relation to proposed development at Euston Tower, 286 Euston Road, London, NW1 3DP.

Euston Tower is an in-situ reinforced concrete framed building, which was designed and constructed in the late 1960s. The building has generally been in use since its completion, however, has been vacant since 2021. The building takes the form of a pinwheel on plan; a 45x80’ rectangle rotated and copied about its lower right corner at 90-degree increments. The structure has one central core housing passenger lifts and four satellite cores, one in each re-entrant corner. The north and south satellite cores contain escape stairs; the east and west each contain a fire/goods lift and an escape stair. There is a large single-story basement which is shared with the rest of the Regents Place estate and two levels of podium.

A series of structural surveys have been undertaken in 2020 and 2023 to understand the current condition and arrangement of the structure. These include condition surveys of structural elements, and destructive and non-destructive investigations to determine rebar and concrete strength, reinforcing bar layouts, and general arrangements of structural elements. A foundation investigation was conducted in 2022 to understand the geometry of foundation elements through a combination of mined headings and caisson sinking.

Generally, the existing structural system is a reinforced concrete frame infilled with a combination of ribbed and flat slabs. It is thought that lateral stability was intended to be provided by a central, reinforced concrete core, though in practice, it is likely the four satellite cores contribute.

The goal is to retain as much structure as practical, while delivering a building which provides fit-for purpose commercial floorspace. The existing floor-to-floor heights and existing column grid are undesirable and not fit for modern office use, but the core, pile cap and dense arrangement of foundation piles have potential to be reused. With the limited knowledge gained through site investigation of the retained structure, we believe there is very little scope for the new loading regime to exceed the previous loading regime. This means that new loads applied to the structure must be limited to being equal or less than the precedent established by the existing building. For instance, new column loads applied to the existing foundations must not exceed existing column loads.

The new building will attract more wind load, and alterations to the existing core to accommodate modern lifts means the capacity of the central core has decreased. As such, the stability system needs to be supplemented, which has been achieved with new steel perimeter bracing, which will be supported on a new piled raft. The current proposal allows for the retention of the existing foundations and basement.

2. Introduction

Photograph 1: Euston Tower from Tottenham Court Road

This statement has been prepared by Ove Arup & Partners Limited (Arup) to support the application for planning permission for the proposed redevelopment of Euston Tower.

The redevelopment proposals comprise:

Redevelopment of Euston Tower, including the partial retention (retention of existing core, foundations and basement), disassembly, reuse and extension of the existing building, to provide a 32-storey building for use as offices and research and development floorspace (Class E(g)) and office, retail, café and restaurant space (Class E) and learning and community space (Class F) at ground, first and second floors, and associated external terraces. Provision of public realm enhancements, including new landscaping, and provision of new publicly accessible steps and ramp. Provision of short and long stay cycle storage, servicing, refuse storage, plant, and other ancillary and associated works.

Euston Tower is the last largely unaltered building constructed as part of the Euston Centre estate for developer DE & J Levy between the years 1963-1970. The estate was designed by architect Sidney Kaye, Eric Firmin & Partners, and the structural engineer for the tower was John De Bremaeker & Partners who are believed to have designed both the sub and super-structure. The tower superstructure was constructed more than 50 years ago, between approximately 1965 and 1970, by contractor George Wimpey; it is unclear whether they also constructed the substructure. The podium was refurbished at the turn of the millennium by architects Sheppard Robson with structural engineers Arup. This refurbishment included wind mitigation measures for Euston Road which will also be implemented in the new scheme.

In broad terms, the proposed redevelopment will involve the deconstruction of the existing floorplates from the Ground Floor to the Roof, with the central core, foundations and basement being retained. A new steel structural frame and new floorplates will be constructed, with the foundations and central core being reused. New supplementary foundations will be constructed to support the new superstructure where it extends beyond the extent of the existing pilecap.

3. The Site and Surroundings

Euston Tower is a 36-storey tall building standing on the northern edge of central London, situated in the south-west of the London Borough of Camden.

Figure 1: Site Location

Located on the corner of Euston and Hampstead Road, at the top of Tottenham Court Road, the tower shares a busy intersection with the UCL Hospital campus and is directly opposite Warren Street Station. The current tower has a prominent presence, given its status as the second tallest building in the Borough after the nearby BT Tower, and as such acts as a physical landmark for London Euston, Euston Square and Warren Street stations as well as wayfinding for the wider neighbourhood.

Completed in 1970, Euston Tower is designed in the 'International Style'. Above a two-storey extruded glazed podium, the tower has a pinwheel plan clad in aluminium curtain walling with green reflective tinted glazing. It was designed as an office building to provide cellular office accommodation typical of the period, and formed part of a wider masterplan known as The Euston Centre. It now stands on the eastern edge of the pedestrianised Regent's Place Estate.

a) From North

b) From East

c) From South

d) From West

Figure 2: Arial views of the site

Since its completion, the tower has undergone a modest refurbishment, but beyond this its external form and façade remain as originally constructed. These elements of the building are in a generally poor condition, due to a combination of wear in use and the quality of the original detailing. Gradually it has been vacated, and since 2021, with the exception of the retail at grade level, the building is entirely disused. The land surrounding the Site consists of a range of uses. The Site is designated within the Knowledge Quarter Innovation District (‘KQID’), home to world-class clusters of scientific and knowledge-based institutions and companies specialising in life-sciences, data and technology and creative industries. The neighbouring Regent’s Place comprises commercial, office and cultural land uses, as well as pedestrianised streets and public realm incorporated into the space. The closest residential properties are located along Drummond Street (north) and Hampstead Road (east).

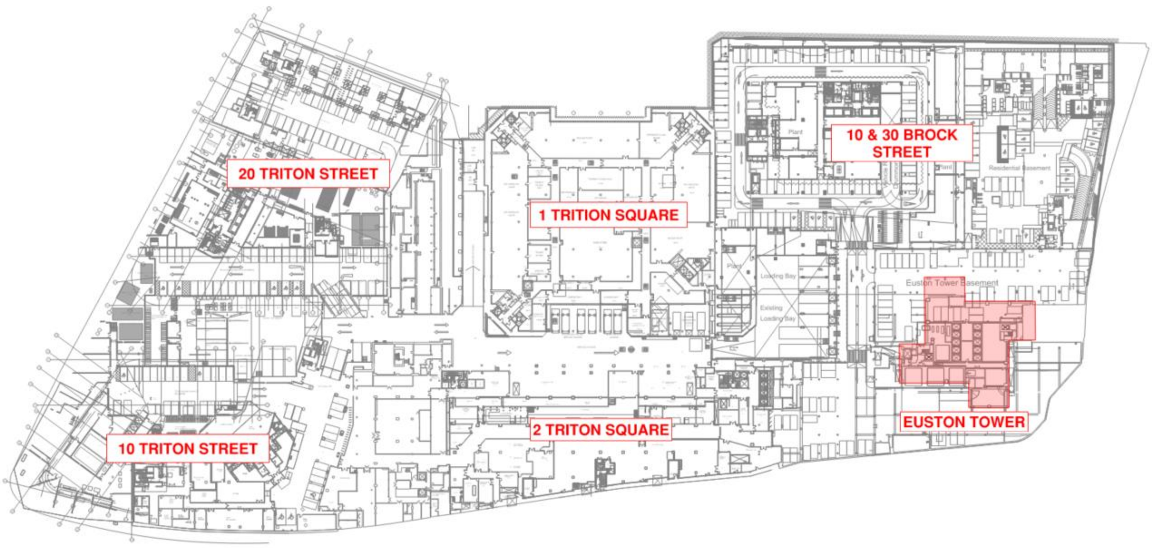


Figure 3: The shared basement at Regents Place

There is a large single-storey shared basement across the Regents place estate, which is bounded by Drummond Street to the north, Hampstead Road to the East, Euston Road to the South and all the way to Osnaburgh Street in the west. Euston Tower is located in the South-East Corner. The basement will be retained as part of the new works.

4. Existing Structure

4.1 General Description

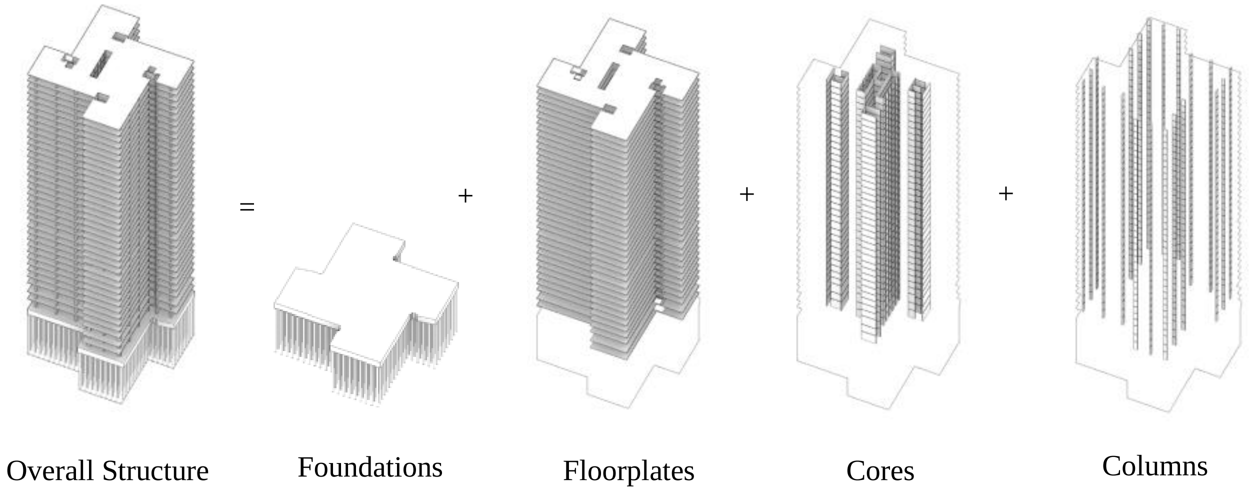
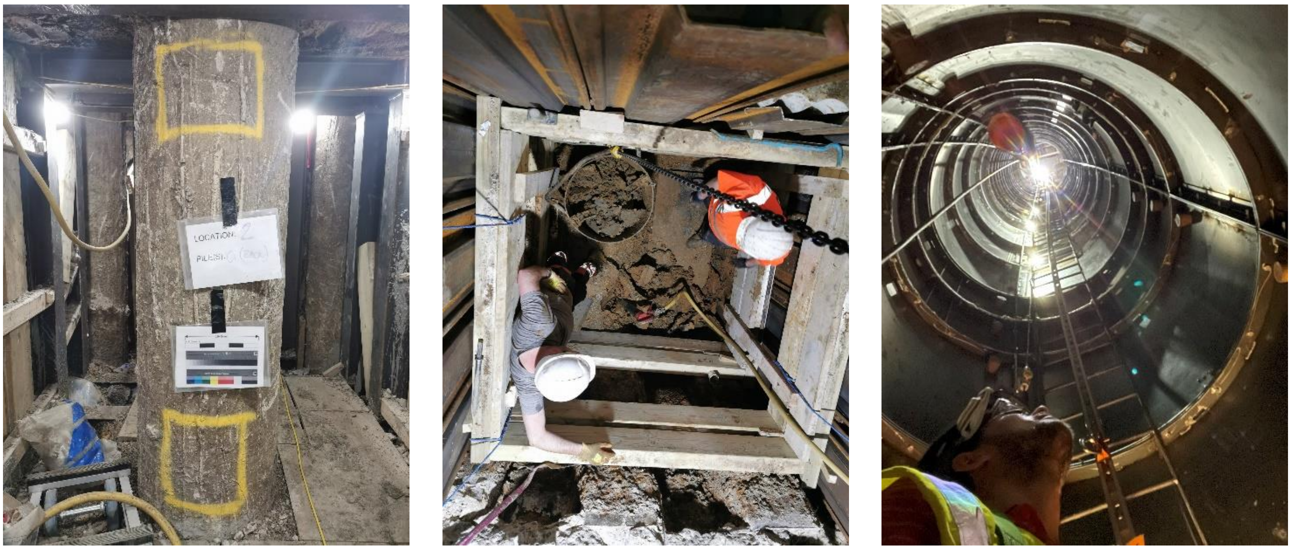


Figure 4: Euston Tower existing structural elements

Euston Tower is an in-situ concrete framed building, which was designed and constructed in the late 1960s. The building has generally been in use since its completion. The building takes the form of a pinwheel on plan; a 45x80’ rectangle rotated and copied about its lower right corner at 90-degree increments. The structure has one central core housing passenger lifts and a satellite core in each re-entrant corner. The north and south satellite cores contain escape stairs; the east and west each contain a combined fire/goods lift and an escape stair. There is a large single-storey basement shared with the rest of the Regents Place estate and two levels of podium.

Surviving original structural drawings for the building are sparse. An extensive search was conducted for records of the original structure including structural general arrangement drawings, reinforcement drawings and original calculations. The limited original design information obtained as of October 2023 comprises of a number of architectural drawings from firms Lewis Solomon, Kaye and Partners, and Sidney Kaye, Eric Firmin & Partners; a limited number of structural drawings from firm John De Bremaeker & Partners; and fragments of the original structural calculations submitted to building control.

A series of structural surveys have been undertaken in 2020 and 2023 to understand the current condition and arrangement of the structure. These include condition surveys of structural elements, and destructive and non-destructive investigations to determine rebar and concrete strength, reinforcing bar layouts, and general arrangements of structural elements, a 3D laser scan (to inform line/level drawings), and a pictorial survey of the building. A foundation investigation was conducted in 2022 to understand the geometry of foundation elements through a combination of mined headings and caisson sinking.



Photograph 2: Photos from foundations surveys. Exposed pile (left), Heading Excavation (centre), Sunk caisson to observe pile toe (right).

The findings suggest that the concrete and reinforcement is generally in good condition, and has a high strength in walls, columns, and beams. Accordingly, the existing structure satisfies strength and stability requirements in its present condition. These surveys confirmed the suitability of the existing foundations for continued use in the new building, and into the future.

The existing structural fire rating is generally understood to be between 60 and 90 minutes. Upgrades to existing structure, predominantly to specific areas of slab and select columns, would be needed to comply with contemporary fire performance requirements.

4.2 Structural Arrangement

4.2.1 Foundations and Basement

4.2.1.1 Foundations

Limited information has been located describing the foundation arrangement. The foundation investigation demonstrated that piles are arranged in groups beneath the columns and the structural cores (including the four satellite cores). Piles were discovered to be of 2ft (610mm) diameter; approx. 19m long shafted reinforced concrete sections. Intrusive investigations have found that they are reasonably well reinforced to full depth.

The raft/pile cap was found to be 2.8m thick, with a structural thickness of 2.4m. The cap extends over the full footprint of the existing tower and is used to spread the load from individual columns into the pile groups. The pile cap appears to be in good condition for its age, although is sparsely reinforced when compared to modern standards. The concrete appears to be of high compressive strength and no corrosion of the reinforcing steel has been observed.

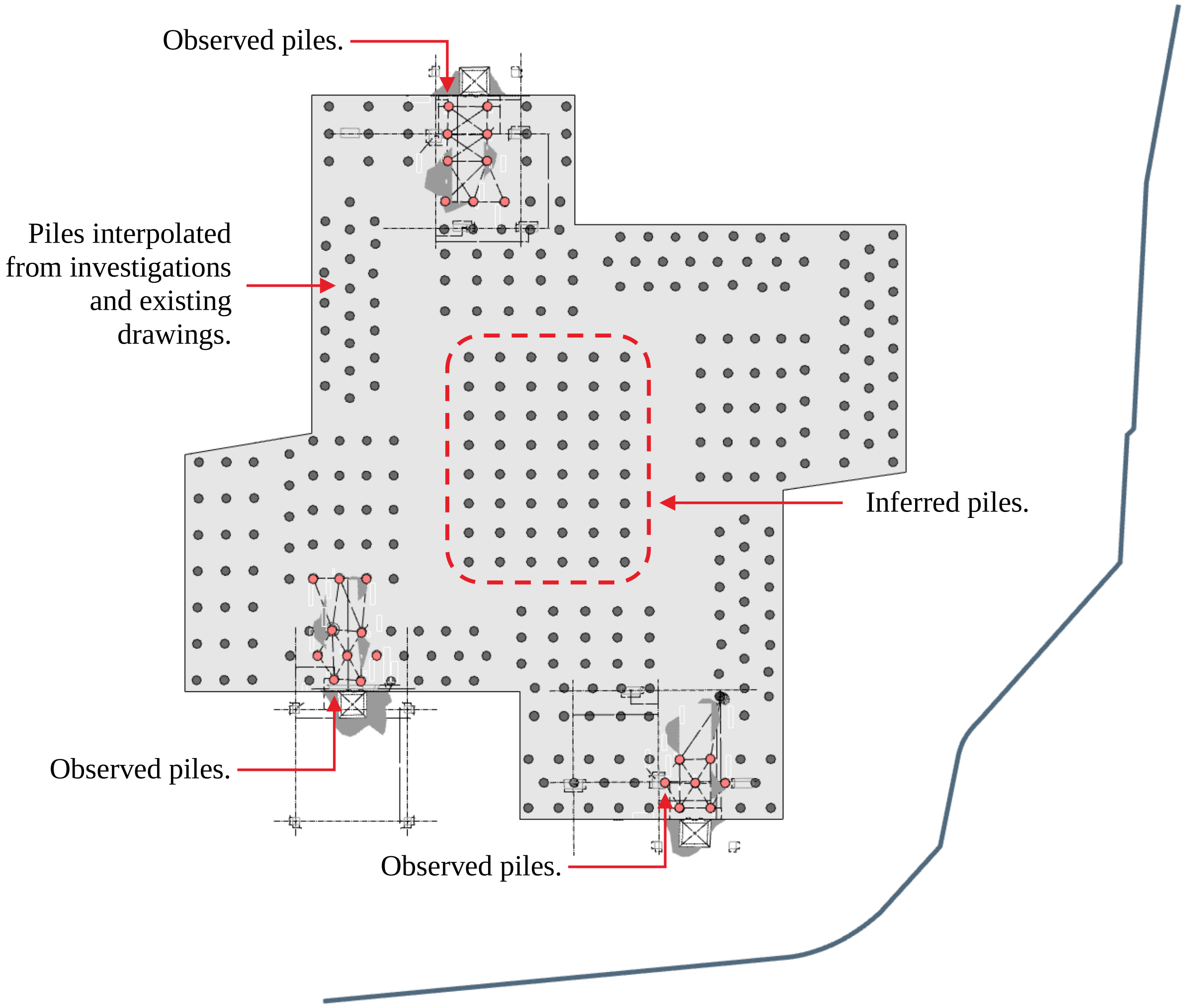


Figure 5: Understood arrangement of pile cap as of October 2023.

4.2.1.2 Basement

The basement of Euston Tower is shared across the majority of Regent's Place – it is currently used as delivery and loading access, car parking, mechanical plant and back of house use. A UKPN substation serving the tower is located to the east of the basement space. The basement structure is typically formed of in-situ concrete. Modifications are visible in the basement, including new penetrations and steel framing for tree pits and openings in the ground floor slab. Surveys are ongoing to understand the condition and waterproofing of the retaining wall.

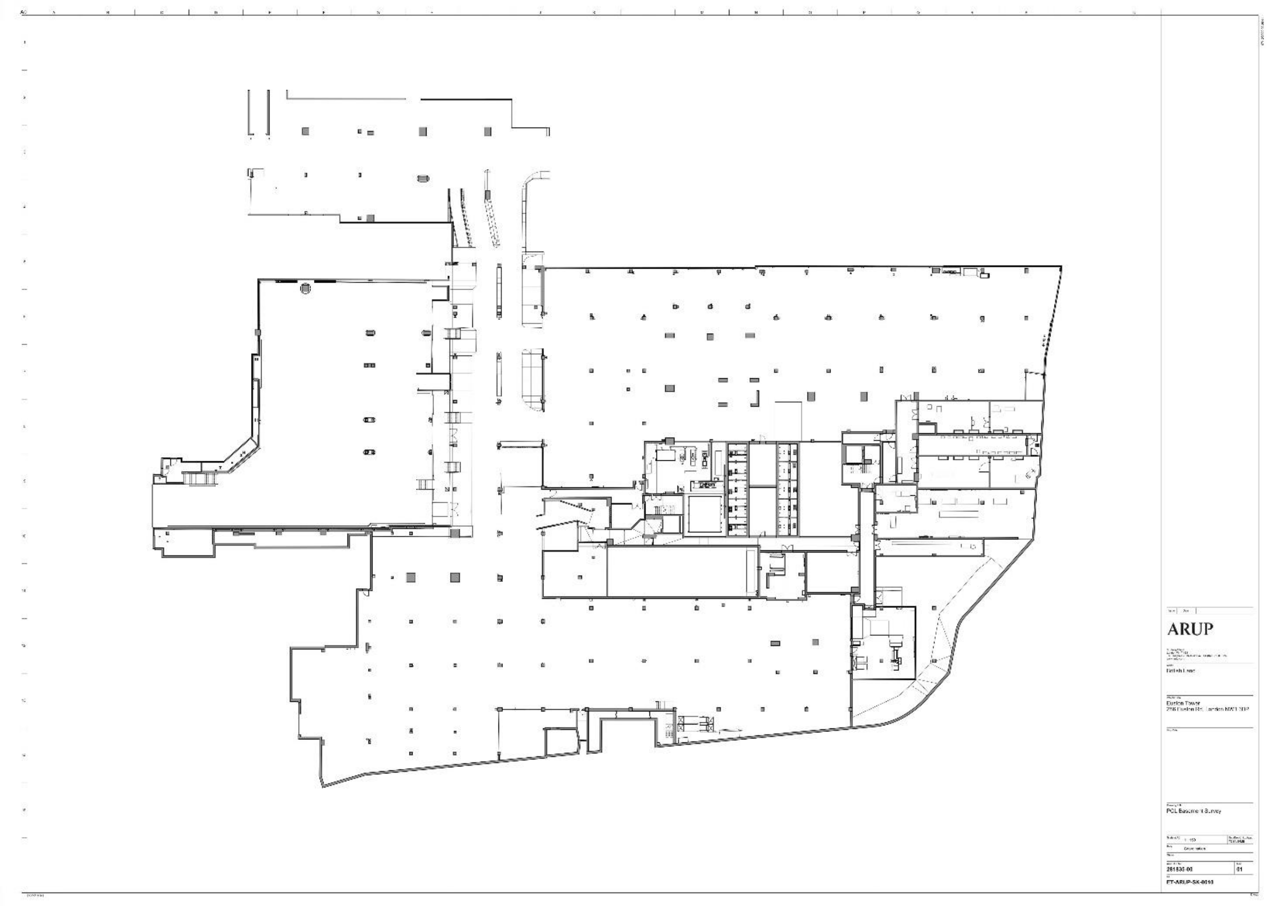


Figure 6: Structural basement plan

4.2.2 Typical office levels (02 to 34)

The existing tower is approximately 125m tall, comprising of 36 storeys with office accommodation over the 34 upper floors, and retail space at ground floor. Figure 7 provides an illustration of a typical office floorplate between levels 03 and 19. From level 20, the lifts in the East side of the central core drop off, and Level 35 and 36 are designed for plant space. The dimensions of the existing column grid can be read from Figure 7 and Figure 8. The grid is irregular and does not lend itself to a modular system.

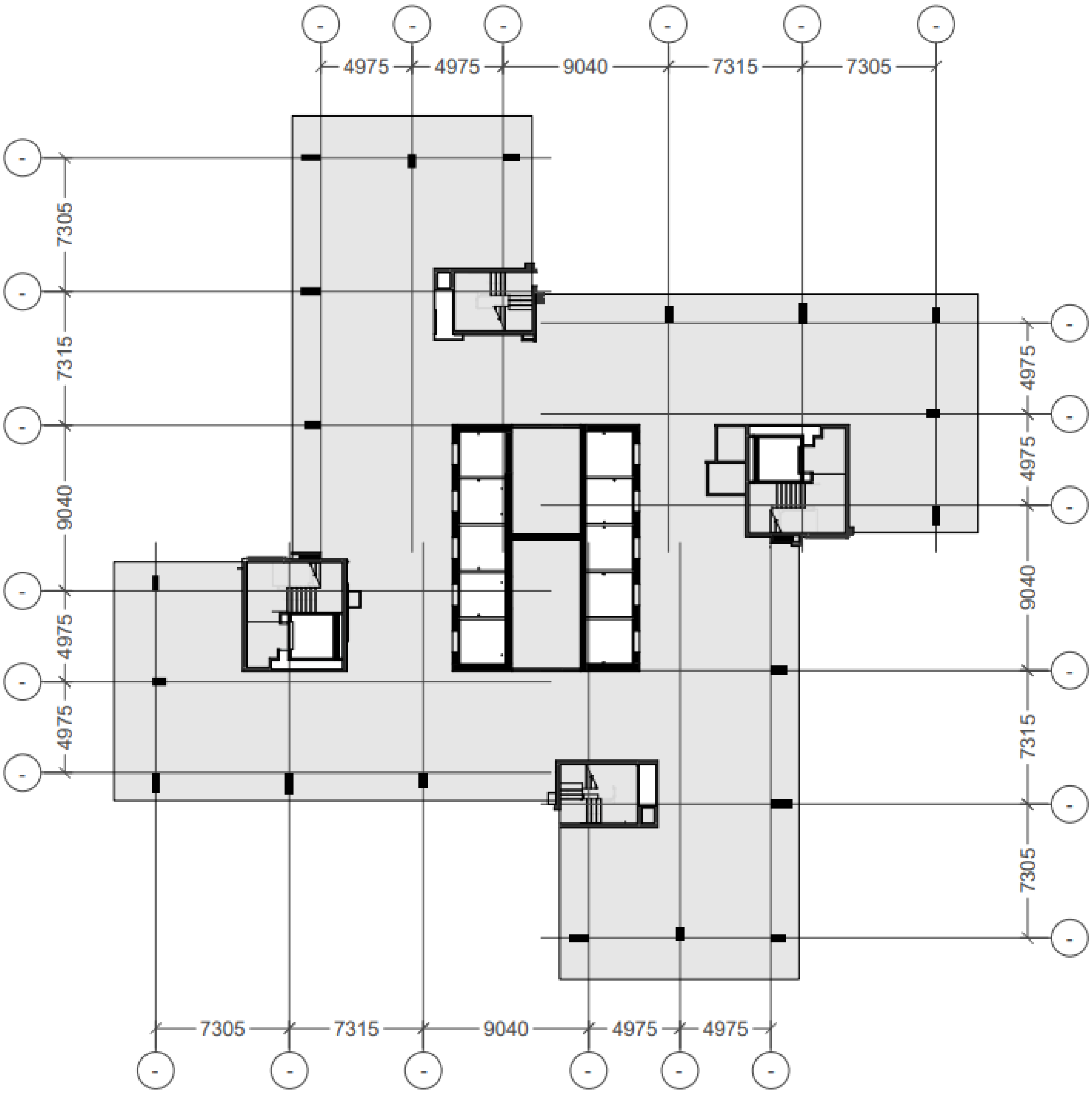


Figure 7: Typical existing office floorplates for tower Level 03 to 19

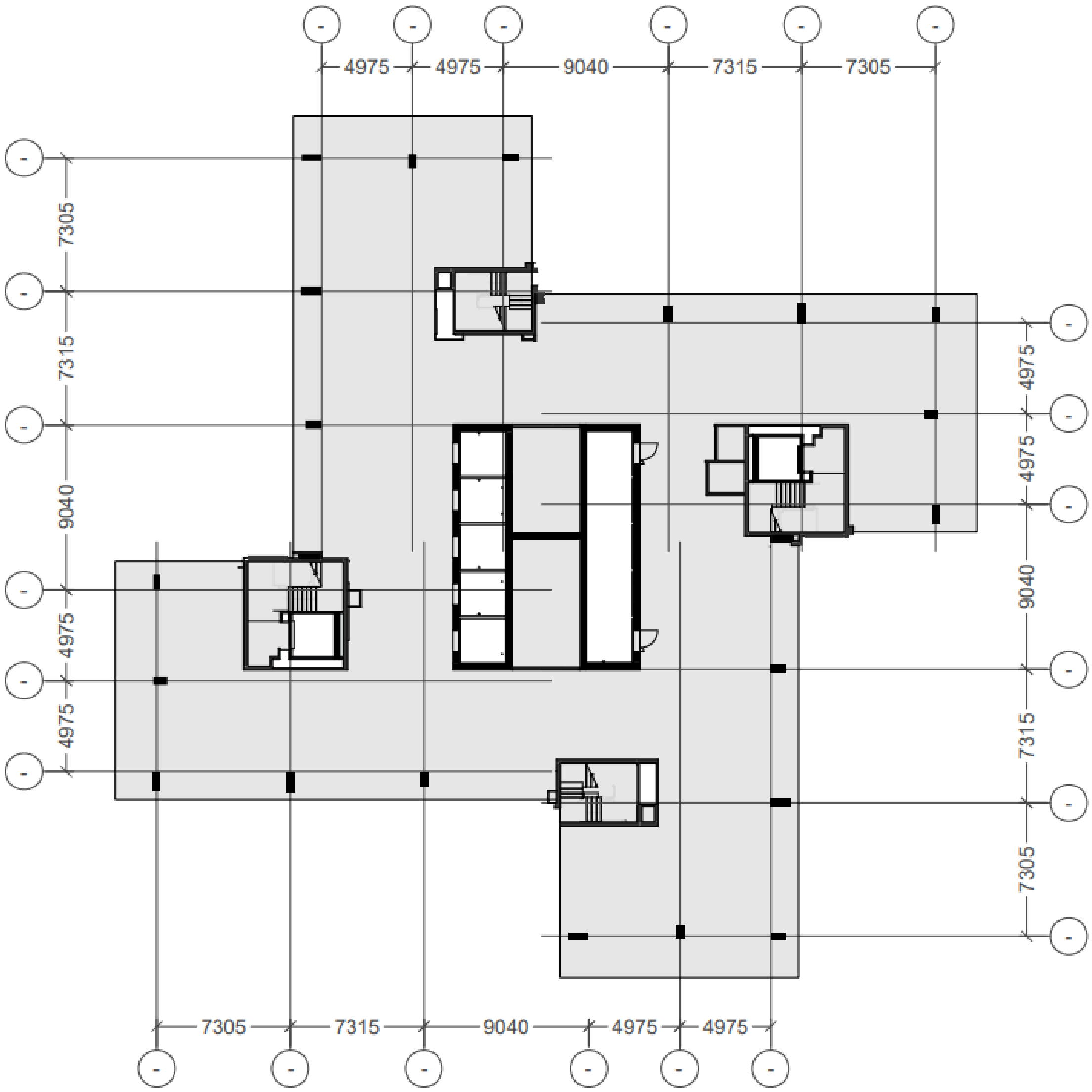


Figure 8: Typical existing office floorplates for tower Level 20 to 34

4.2.3 Podium levels (00 to 02)

Figure 9 provides an illustration of the Ground Level and the plaza. Retail space is provided at ground floor, where the floorplate is extended out to a square.

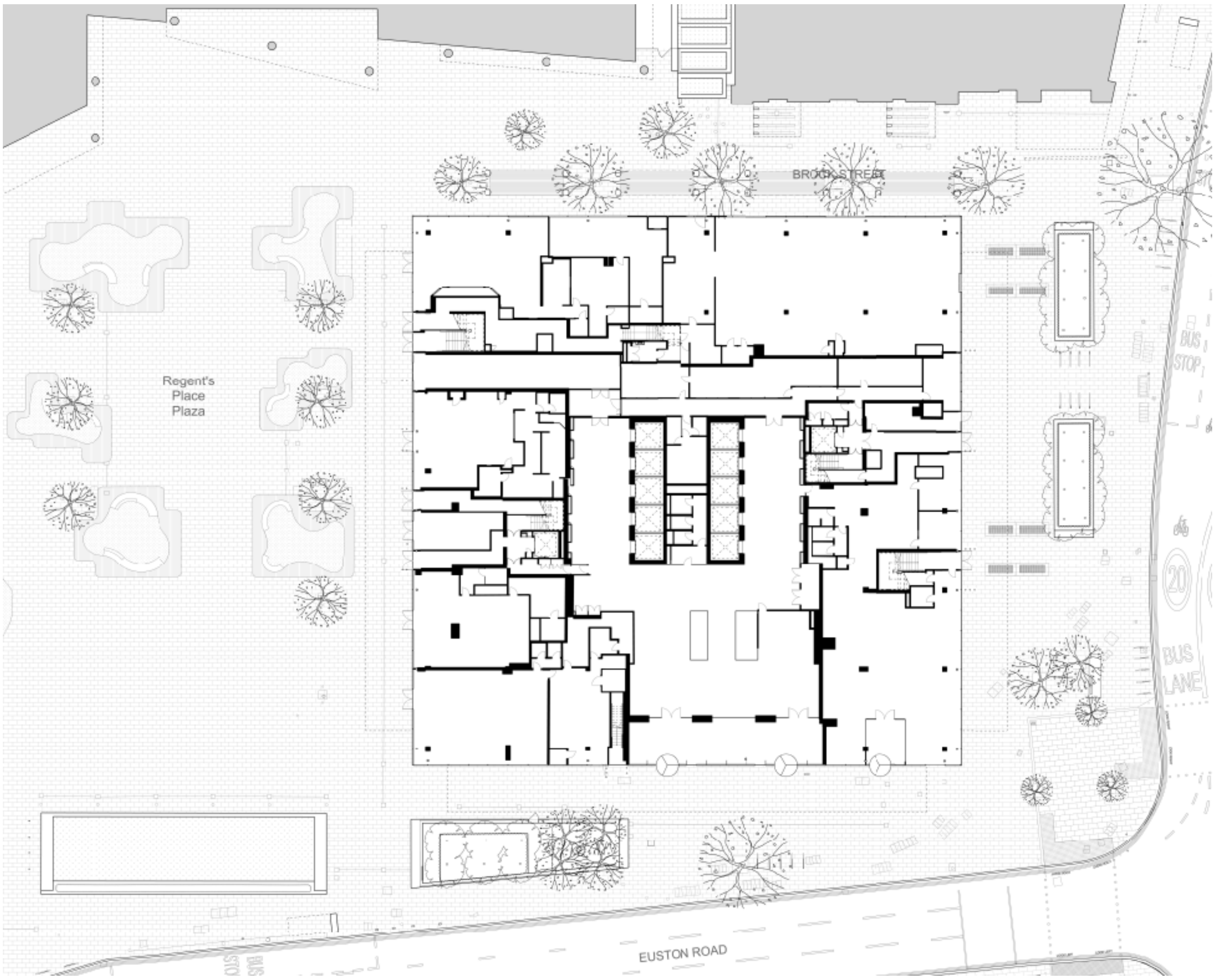


Figure 9: Ground floor floorplate

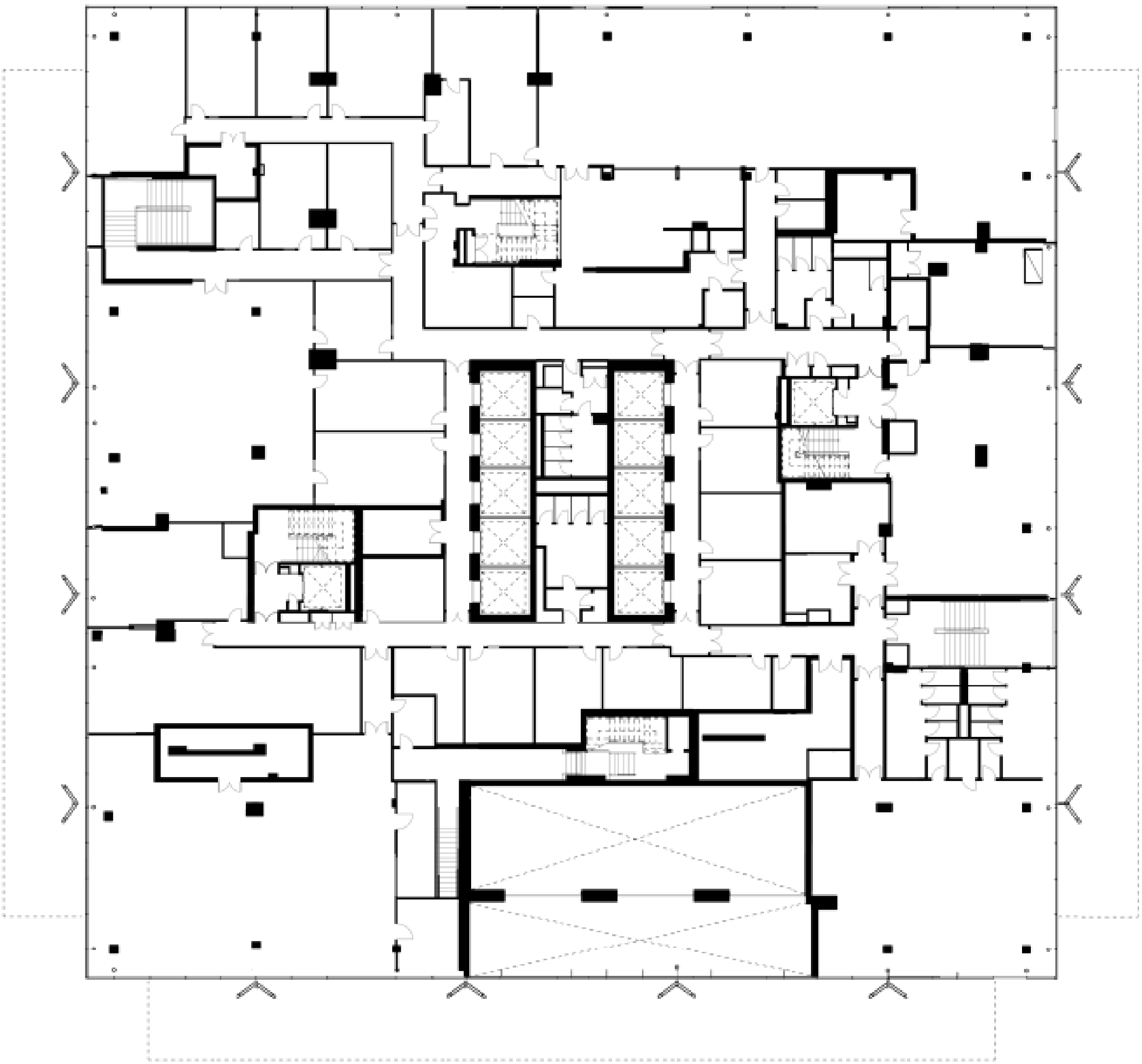


Figure 10: Existing floorplate level for podium level 01.

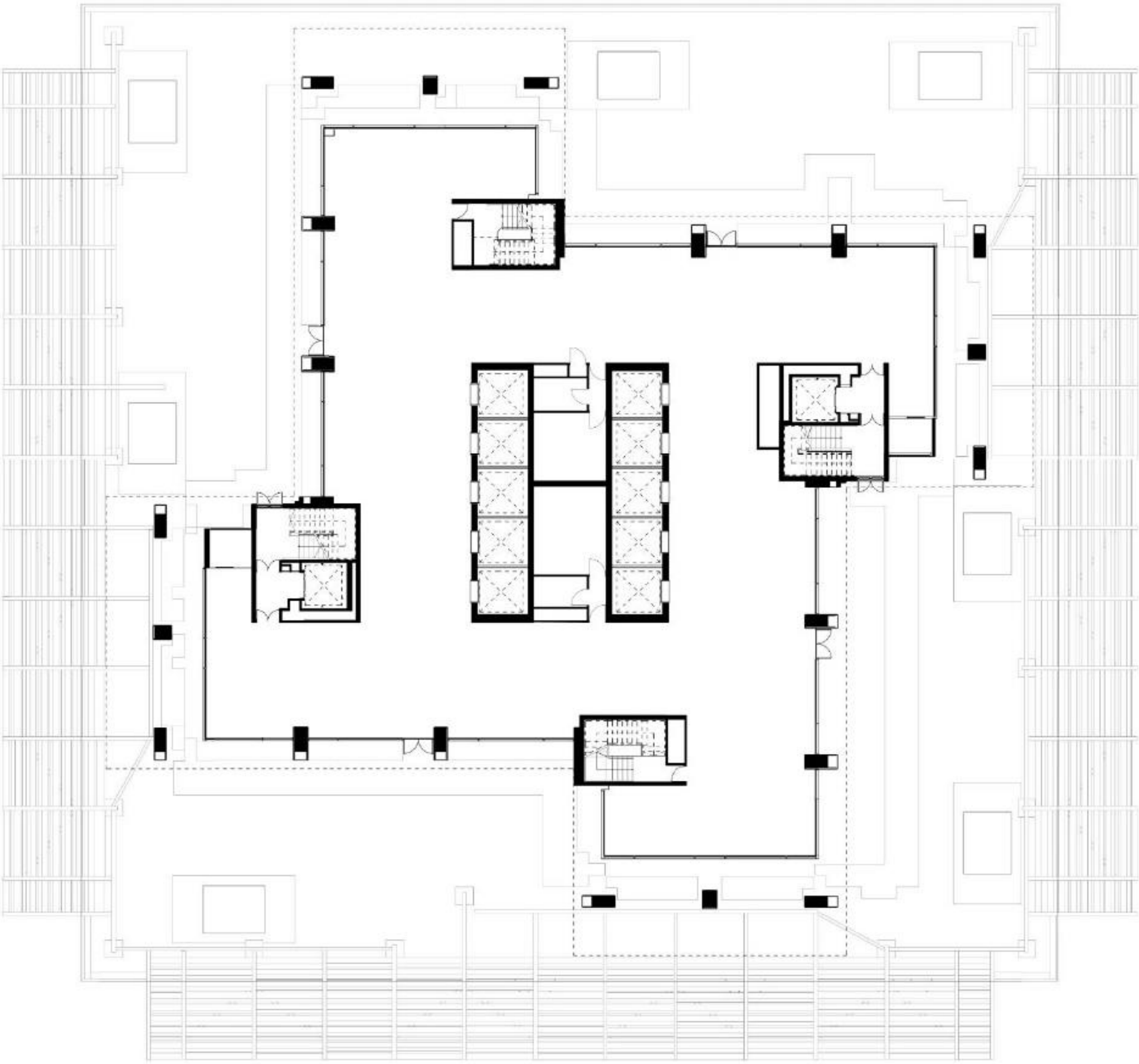


Figure 11: Existing floorplate level for podium level 02.

4.2.4 Stability system

It is thought that lateral stability was designed to be provided by a central reinforced concrete core, but in practice it is likely that there is some contribution from the satellite cores and sway-frame action of the concrete frame. Structural walls are arranged around the central lift shafts and the four perimeter “satellite” cores. They are typically formed of 300-400mm thick in-situ reinforced concrete walls .

Figure 12: Typical existing structural floorplate with stability system highlighted.

4.2.5 Other elements

4.2.5.1 Columns

Columns are arranged around the perimeter of the structure and are constructed of in-situ reinforced concrete. They form part of the gravity system, but do not form part of the lateral stability system. They appear to be in good condition for their age, are densely reinforced, and have a high design strength. The columns do not appear to have been modified.

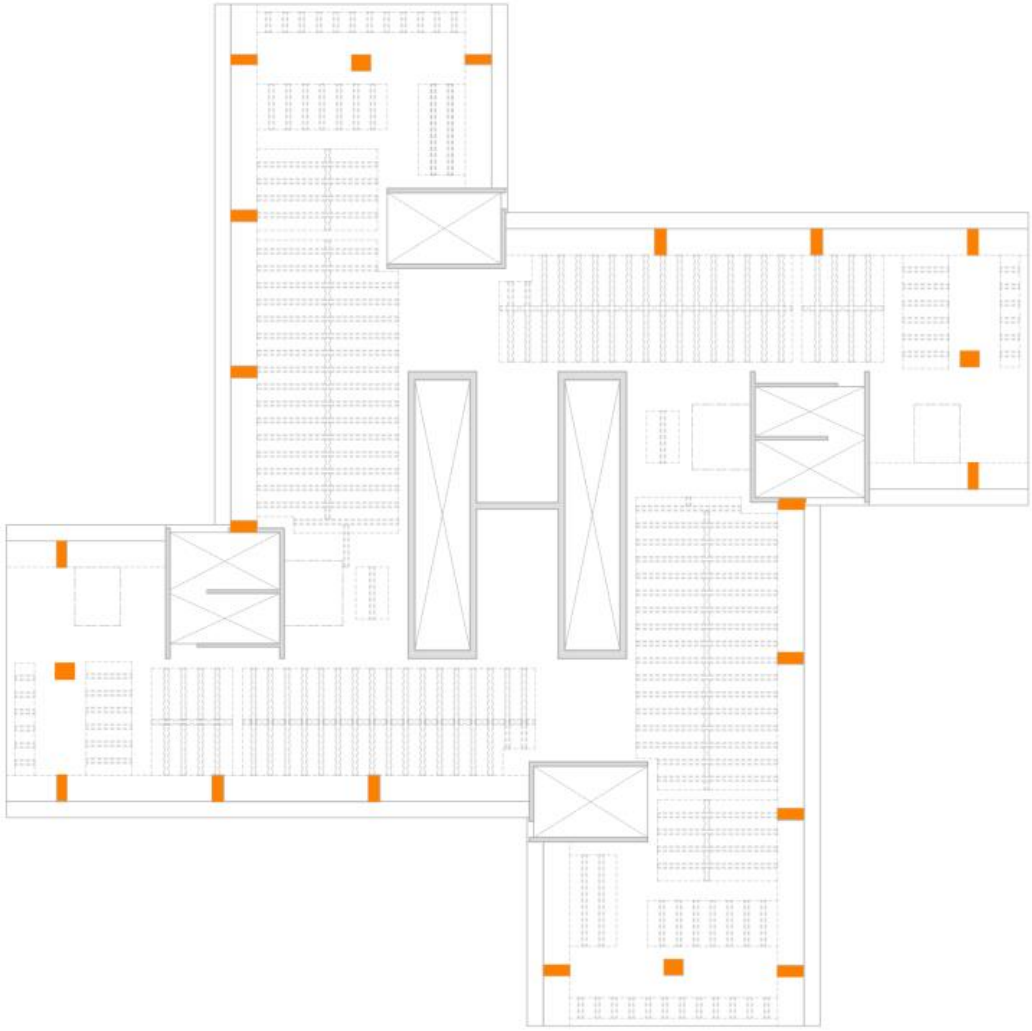


Figure 13: Typical existing structural floorplate with existing columns highlighted.

4.2.5.2 Slabs

The existing slab system comprises of three primary components: a ring beam around the perimeter, areas of ribbed slab, and areas of in situ flat slab. These are shown in red, orange, and yellow respectively in Figure 13. Spans range from 5m to 7.5m, with thicknesses ranging from 9 to 15 inches (~230 to 380mm).

Existing slabs appear to be in reasonable condition, although many appear to have undergone modification since construction, with some areas of steel strengthening and retrofit voids. The thin slabs are known to contain small diameter (~6mm) mesh reinforcement. Shear links have been observed in some ribs. The fire performance of the slab in its original condition is generally understood to be below the 90- or 120-minutes fire resistance required today. Structural intervention will be needed to mitigate this if the slabs are to be reused. There is an existing cementitious spray in the lower portion of the tower which is believed to be a retrofit addition to address fire performance concerns. This measure further constrains floor-to-floor height for these floors.

A bonded screed layer is present on the office floors which would be challenging to remove. This is understood to be a non-structural build up.

Figure 14: Typical existing structural floorplate with highlighted ribbed slabs

5. Proposed Structure

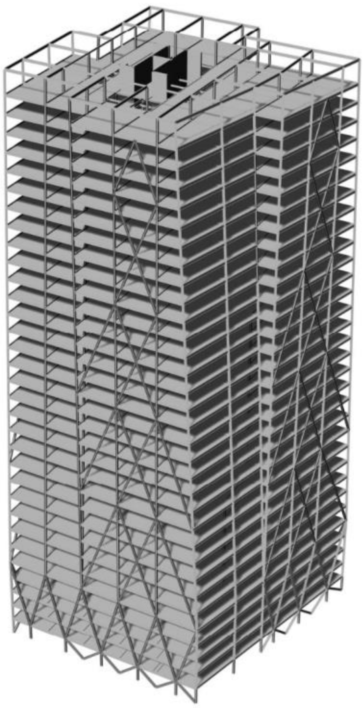


Figure 15: New proposed structural model

The structural design for the proposed redevelopment of Euston Tower is driven by a number of key principles. The design team has made holistic proposals towards achieving these aims.

5.1.1.1 Sustainability

Minimising the embodied carbon is at the heart of the design. The design team has worked holistically to maximise the retention of existing structure and minimise the quantity of new structure. This work is demonstrated in the feasibility reports, the volumes for which are listed below:

- "Euston Tower feasibility study volume zero: Summary of the Feasibility Study."
- "Euston Tower feasibility study volume one: Assessing the existing building."
- "Euston Tower feasibility study volume two: Pathways for alternative uses."
- "Euston Tower feasibility study volume three: Options for retention and extension."

The design team is continuing to explore innovative use of reclaimed material and elements.

5.1.1.2 Reuse of Existing Structure

Retaining as much of the existing structure as possible is a key driver of the structural design. This will lead to significant embodied carbon savings. The core, pile caps and dense arrangement of foundation piles have excellent potential to be reused in place. Trials are ongoing to investigate the possibility of extracting and retaining discrete sections of existing slab in a new arrangement.

5.1.1.3 Long-Life and Adaptability

Designing for a long-life and adaptable structures is a key driver. The structure will be specified for an enhanced design life compared to BCO standards and future adaptability is embedded in the selection of structural systems and framing solutions.

5.1.1.4 Demountability

The structural solutions adopted for the building, such as the selection of grids, framing arrangements, floorplates, and stability systems, are based on the aspiration to provide a demountable structure and maximise reuse potential at the end of life.

5.1.1.5 Lab Enablement

Euston Tower is designed as a commercial building with lab-enabled spaces. A series of design decisions were taken to address the requirements of lab spaces such as:

- Proposing a denser grid and adopting a solution that involves the clever use of hangers to maximise dynamic mass and control vibrations.
- Considering higher imposed loads at lab spaces.
- Adjusting the ASMEP floorplate build-up to accommodate lab needs.

5.2 Structural Strategy

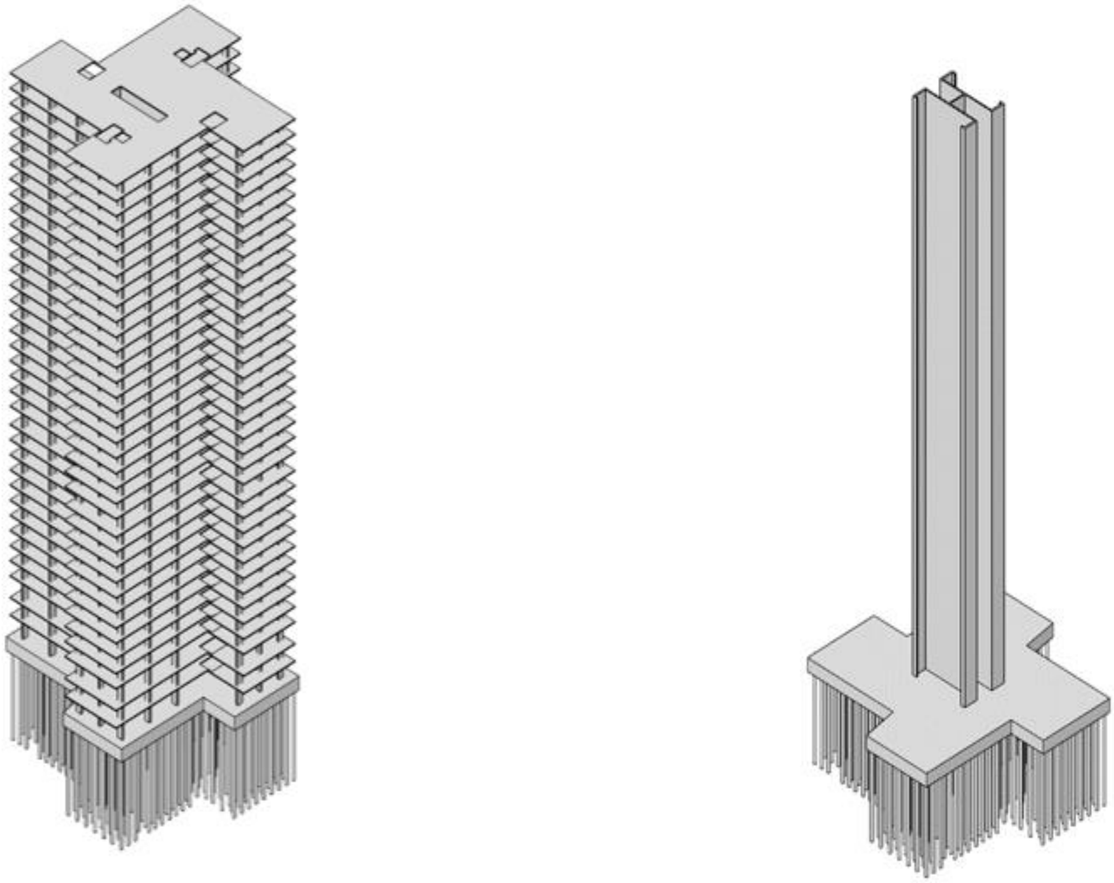


Figure 16: Existing tower structural model (left) and retained structure (right)

The existing floor-to-floor heights and existing column grids are undesirable for modern office use, but the core, pile caps and dense arrangement of foundation piles have excellent potential to be reused. With the limited knowledge gained through site investigation of the retained structure, we believe there is very little scope for the new loading regime to exceed the previous loading regime. This means that a load balance approach must be followed whereby new load applied to the structure must be limited to being equal or less than the precedent established by the existing building. For instance, new column loads applied to the existing foundations must be no greater than the existing column loads. A substantial increase in load applied to the pilecap in such a scenario would likely require significant structural intervention.

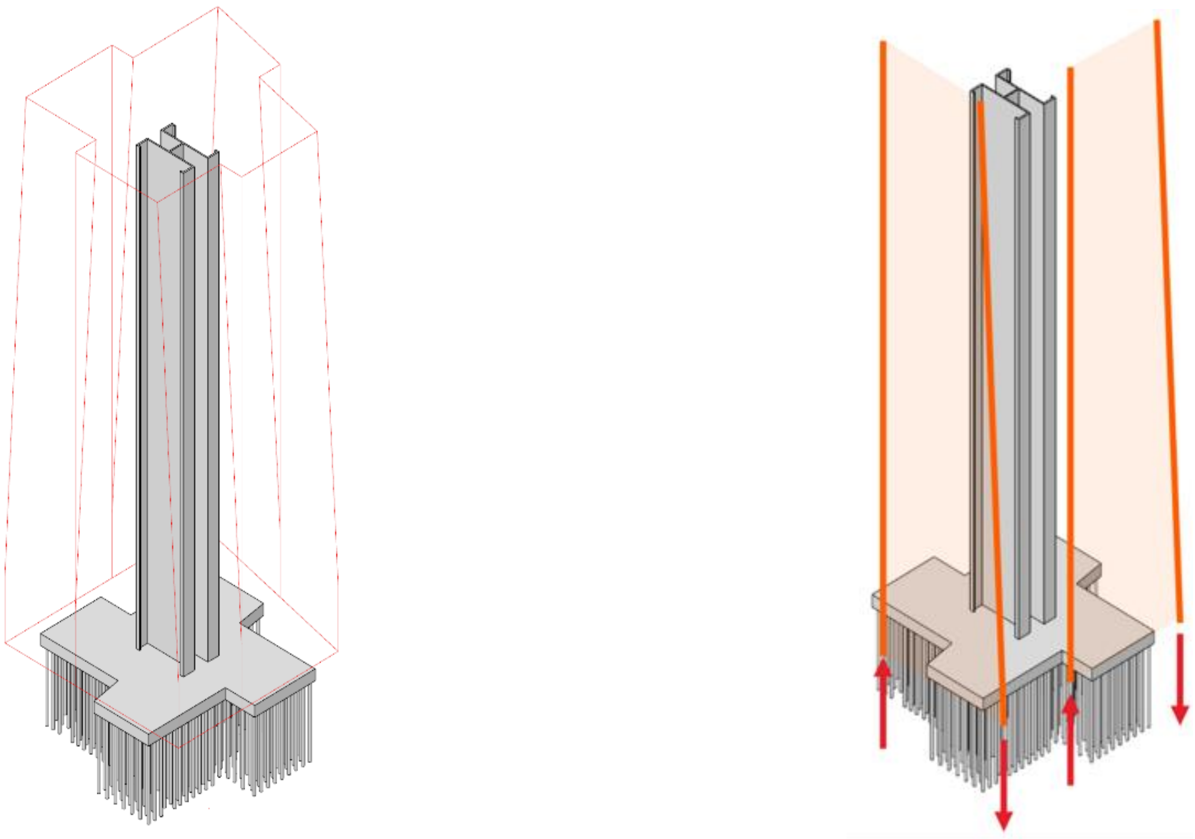


Figure 17: Existing core with new structure in wireframe (left); basic principles behind the new stability system (right)

The new building has grown outwards, which means that it will attract more wind load. The removal of walls in the existing core for new lifts means the capacity of the central core has decreased. The stability system needs to be supplemented which has been achieved with perimeter bracing.

5.3 Stability System

New, central reinforced concrete walls would be challenging to incorporate while retaining the existing foundations due to the increased weight and the strong ambition for a demountable and adaptable structure. New perimeter steel bracing is thus proposed to meet these requirements.

Perimeter bracing alleviates the structural need for new stability walls in the core. This grants greater flexibility in the core for architectural and statutory requirements (such as for fire). The geometry and overall massing of the tower means that not all perimeter bays require bracing. If the vertical facades are braced, new wind load can be supported on new foundations outside the extent of the existing pile cap. A mega braced option is proposed.

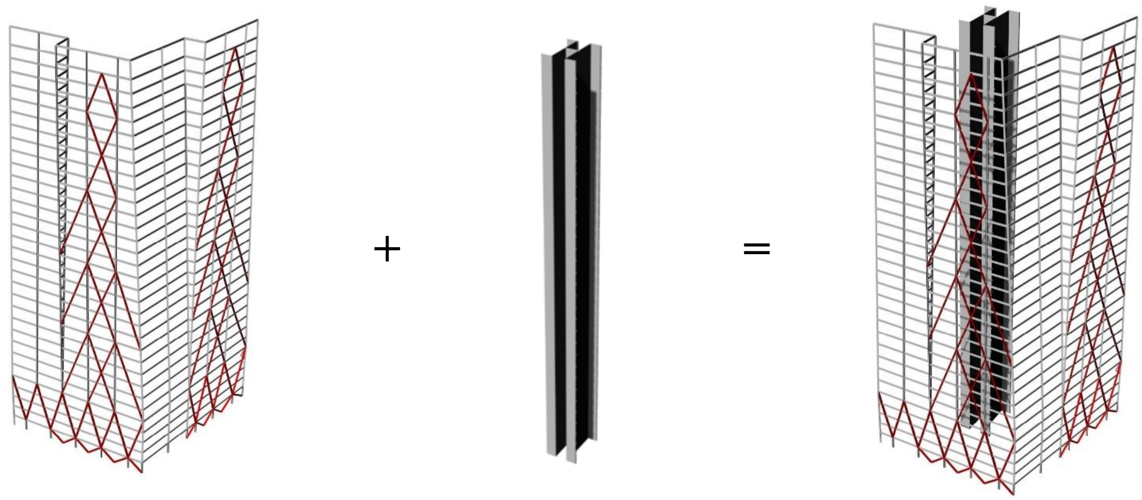


Figure 18: Stability system exploded diagram.

The mega-brace system nodes out every three floors. The retained existing central core restrains the intermediate floors between mega-levels. The diaphragm therefore transfers wind load from the façade to the central core on these floors.

5.4 Vertical Load Path

As there is limited knowledge of the existing foundation system, the strategy is to put new loads as close to the existing loads as possible. The new grids have been so influenced so that new column lines broadly align with the existing. Load spreading structure is used to translate the new column locations to the old column locations in the basement.

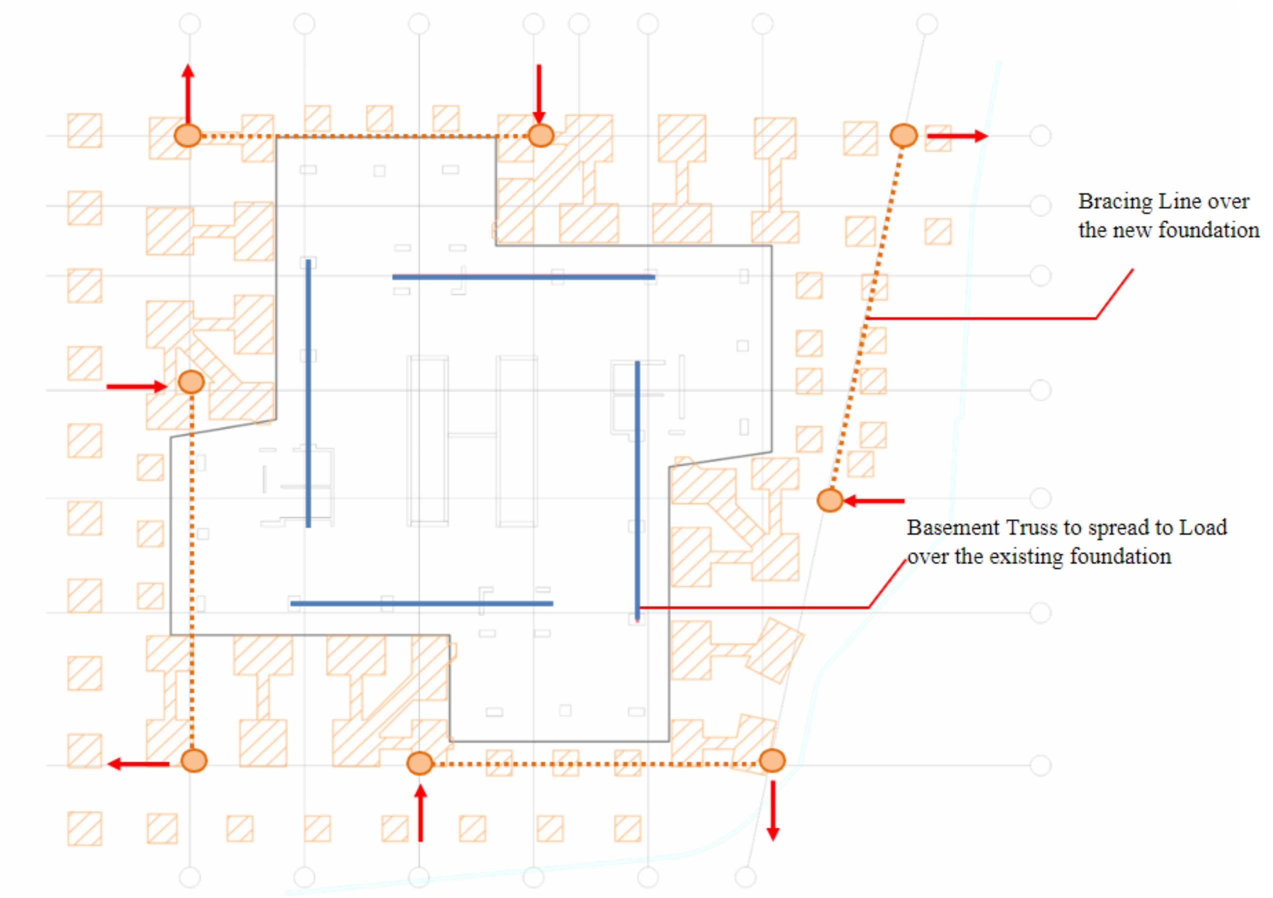


Figure 19: Influence on the grid

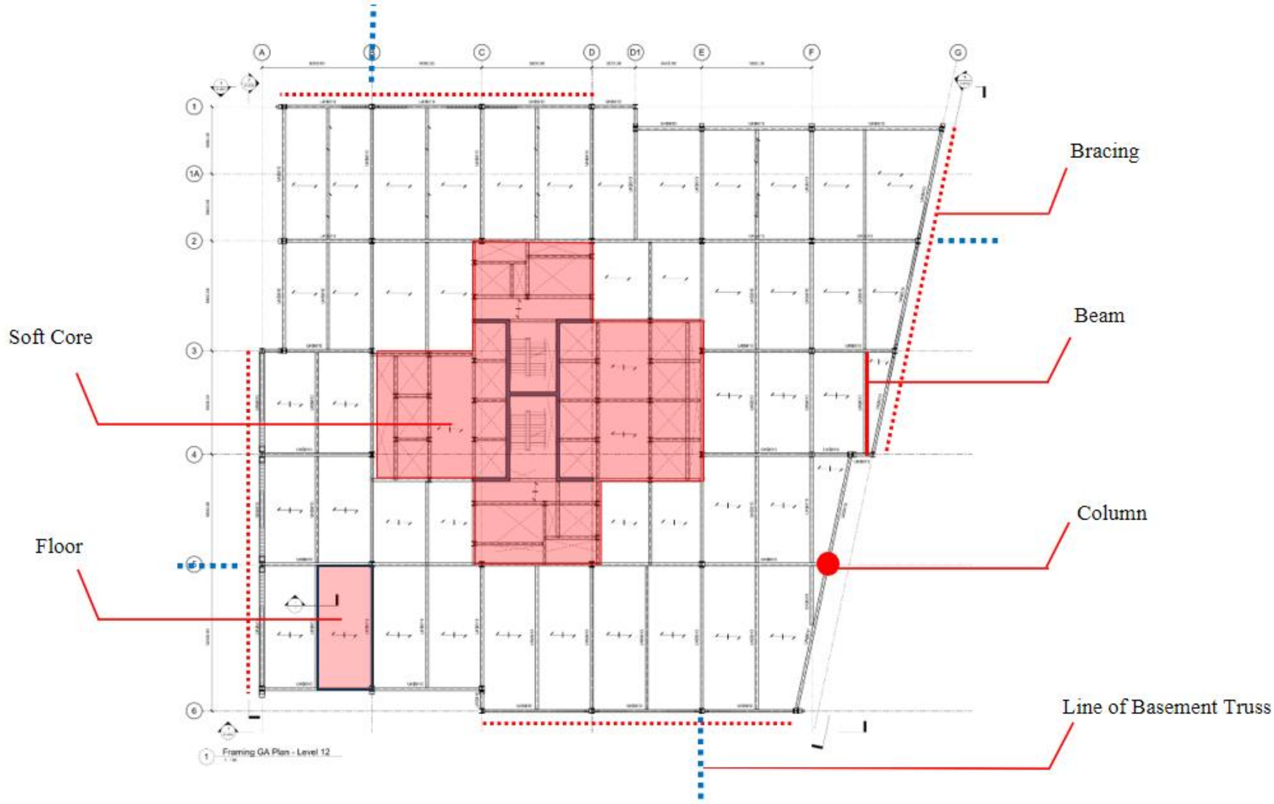


Figure 20: Typical GA

The existing core elements contribute to local stability by transferring loads to megafloor levels. The core is framed in steel to minimise self-weight. Avoiding heavy concrete walls minimises loads on the existing foundations.

5.5 Foundations

Load spreading structure is used to translate the new column locations to the old column locations in the basement. The function of these trusses is to transmit the new column loads into the existing foundations in the same location as the existing columns loads. This is because we have limited knowledge of the existing foundations and must follow a load balance approach, ensuring new demand on the retained structure is less or equal to the existing demand.

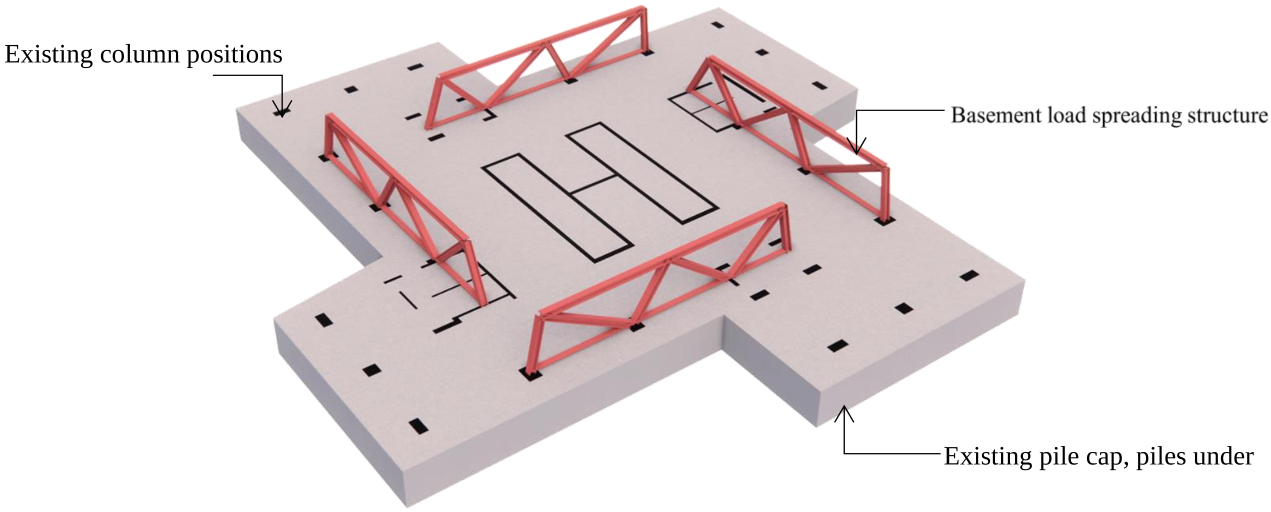


Figure 21: Load spreading structure.

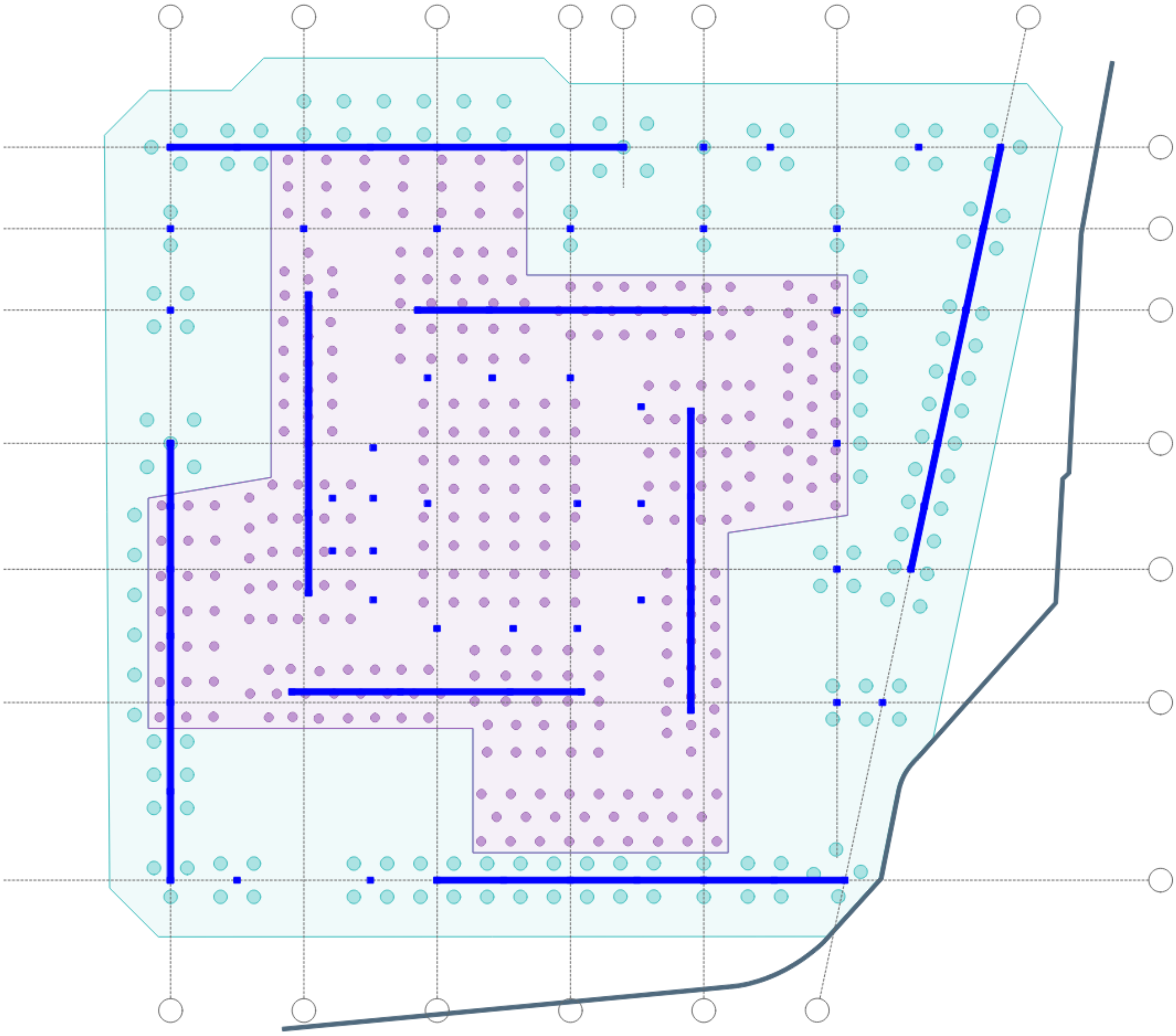


Figure 22: New Foundations

The columns landing outside the existing raft will be supported on a 1500mm thick piled raft with 900mm diameter piles. The current proposal allows for the retention of the existing pinwheel foundations and basement. It is anticipated that there will be localised deepening of the basement level to allow for the incorporation of water tanks.

5.6 Retained Elements.

5.6.1 Foundations and Basement

The building is understood to be founded on 24” (610mm) diameter piles, extending approximately 19m into in the London Clay. Piles are grouped under columns and share an 8’ (2438mm) thick reinforced concrete pile cap which extends over the full tower footprint. This was observed in the foundation investigations undertaken in 2022.

A sheet pile surrounds the perimeter of the pile cap. It is believed that this was used during the construction works to reduce water ingress. A single storey basement extends across the full site. Reinforced concrete columns for these areas are supported on individual pad footings.

5.6.2 Core

We believe that the original design intent was for the wind loads to be resisted solely by the central core in bending and shear. The provision for larger lifts carts in the main core requires the demolition of specific existing walls.

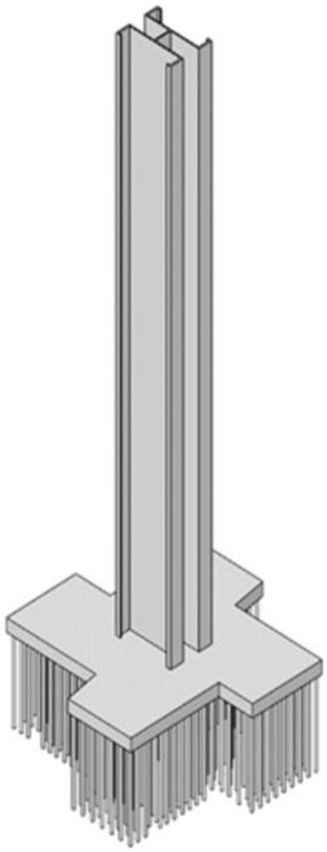


Figure 23: Retained central core.

5.7 New Elements

5.7.1 Floor Structure

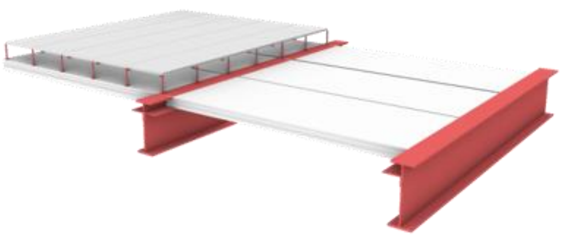
The new structure will be framed in steel. This is considered to be the most appropriate form of construction for the project due to its light weight, the speed and ease of construction, and for promoting future flexibility. The floor structure of Euston Tower will be a lightweight solution infilling a steel frame.

The floor plates will consist mainly of rolled open sections trimming out risers and slab edges as necessary. The framing of the primary and secondary beams has been arranged to be as economical as possible.

In the office, a typical grid of 9m x 9m has been adopted, where a 150mm thick floor structure will span between beams. In the lab spaces a tighter grid is adopted (typ. 9m x 5.5m) to control footfall induced vibration. In these spaces a thicker solid slab of 250mm is proposed to provide additional dynamic mass.

The design team undertook an appraisal of various structural systems against the key design drivers. Two floorplate options are still being considered:

Precast solid planks in beam depth



In-situ composite metal deck

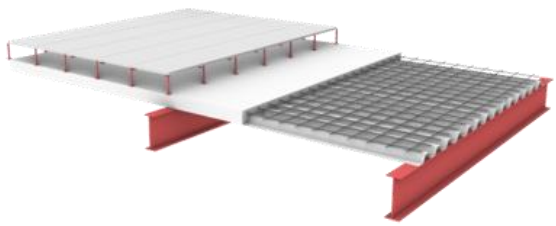


Figure 24: Floorplate Options

The proposed structural framing and grid will make the building adaptable for future use. The flexible structure will allow for smaller scale changes like new risers, or modifications to vertical circulation. Indeed, the new floorplate will explicitly allow for new staircases between levels. The structure can also be adapted for the long-term, enabling programmatic changes in the way the building is used.

5.7.2 Columns

Euston Tower is a steel frame building and various options could be adopted for its columns, with steel columns being the traditional solution.

Hybrid concrete and steel systems could be explored such as Concrete Filled Tubes (CFT) which combine some of the advantages of steel and concrete construction.

5.8 Podium

One of the prominent features of Euston Tower is the podium structure at the base of the building which creates accessible outdoor spaces.

The podium will be of steel construction attached to the primary steel superstructure. Consequently, various structural arrangements could be adopted to provide an efficient framing, including perimeter trusses, hangers or props.

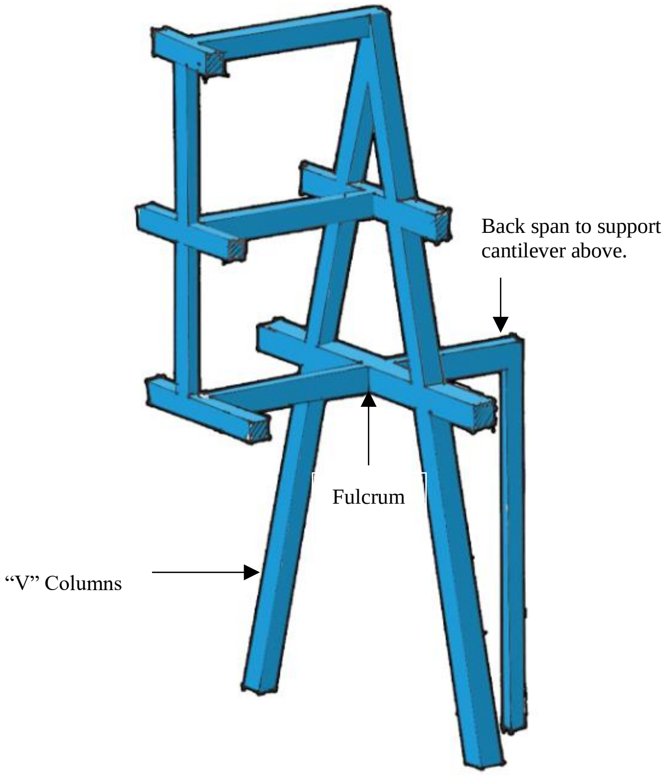


Figure 25: Podium Structure

6. Surveys

Several intrusive and non-intrusive surveys have been conducted on existing reinforced concrete elements, along with several site visit surveys. These helped us to understand the strength and condition of the existing structure and to confirm the location of reinforcement and existing concrete cover. The surveys confirmed concerns about concrete cover for specific columns and slabs being insufficient for contemporary fire requirements, but also demonstrated that the structure was generally in good physical condition, both in terms of strength and chemical condition, and that reuse was structurally viable.

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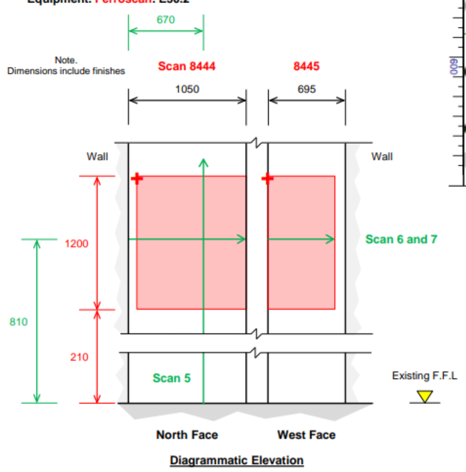

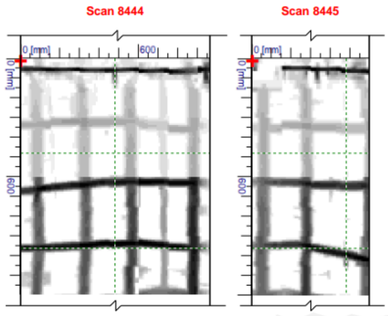

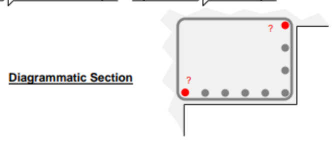

	Links	Vertical Bars
Estimated diameter	8mm	36mm
Minimum link cover (including finishes)	17mm	-
Link centres (Average)	310mm	-
Number of main bars (Total)	-	Estimated Sixteen

Figure B.3: Basement. Column 1. Scanning.

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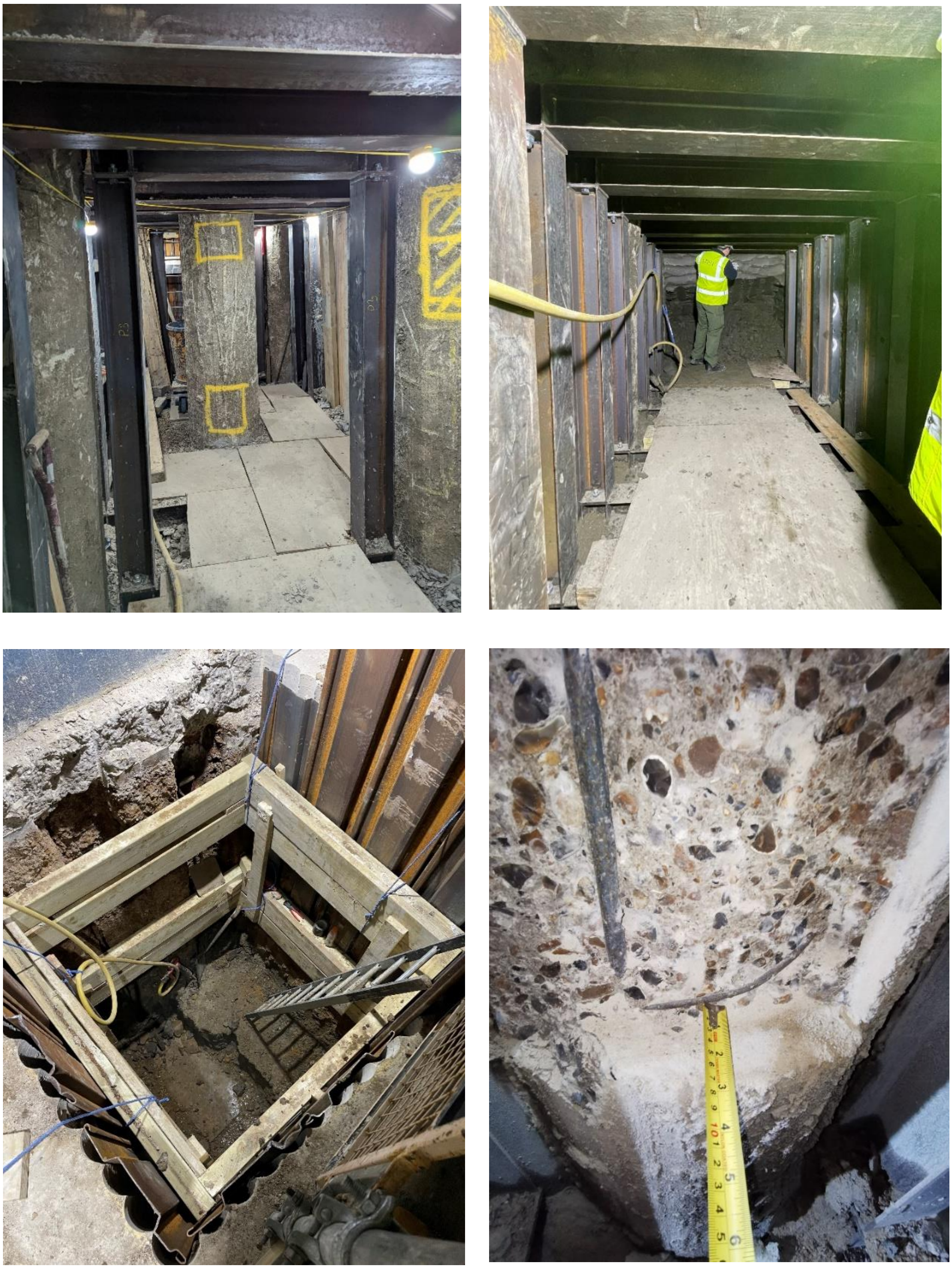
Links	Vertical Bars	Condition	Finishes (mm)	Concrete cover (mm)	Carbonation (mm)
8.0 Plain round	31.5 Square twist	Slight patchy surface corrosion	0	22	3

Figure B.4: Basement. Column 1. Breakout Details.

Figure 26: Extract from the 2019 investigation

6.1.1 Foundation

In 2021, targeted excavation work was conducted under the existing tower's foundation to reveal the distribution, quality, and composition of the existing piles.



Photograph 3: Intrusive investigations on the foundations were completed in 2022

6.1.2 Core

As of October 2023, very limited existing information has been located describing the structural layout of the existing central core. Intrusive structural investigations have thus been carried out to better understand reinforcing bar layout, depth of cover, layout of penetrations and openings, and rebar and concrete strength. These surveys are in addition to previous work undertaken in 2019.

The walls appear to be in good condition for their age. Concrete compression tests to determine concrete strength are currently being undertaken. Numerous holes have been formed in the wall over time and the impact of these modifications will be assessed when surveys are complete. The central wall linking the two halves of the central lift shaft, appears to have several unexpected voids throughout its height.

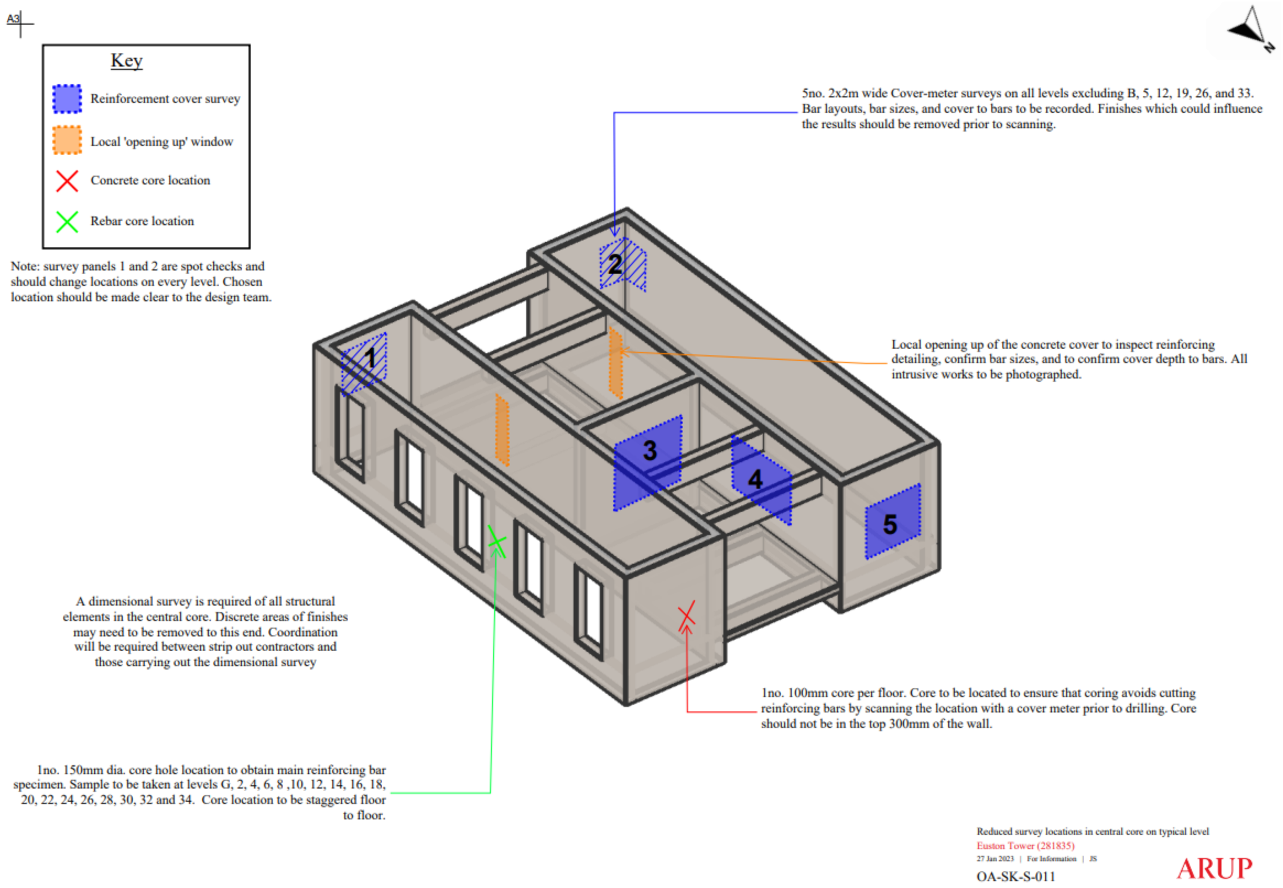


Figure 27: Example of survey specification of the central core

7. Conclusion

This statement describes the proposed structural arrangement to support the planning application for the redevelopment of Euston Tower.

Site surveys and investigation has shown that the structure is physically in good condition and is viable to reuse. As such, the redevelopment of Euston Tower involves the partial deconstruction and retention of the existing structure. The proposal keeps the existing core, foundations, and basement. Careful design and arrangement of loads ensures that the retention of these elements will result in a structure which is fit for purpose today and into the future. The combination of existing structure and new structure will be lean, efficient and provide a new, best in class, 32-storey tower.

The proposed structural system allows for future adaptability both in the terms of short-term modifications to vertical circulation, for instance allowing the installation or removal of staircases between floors, and long-term change, allowing for programmatic changes in the way the building is used. This is achieved with a uniform grid and an adaptable floorplate system. The structure is designed for future scenarios that enable low-destructive adaptations to avoid building obsolescence.