Waterman Moylan
Engineering Consultants

Planning Stage Structural Report

Proposed Strategic Housing Development at Belcamp, Dublin 17

April 2022

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Client Name:	Gerard Gannon Properties
Document Reference:	19-114r.032 Planning Stage Structural Report
Project Number:	19-114

Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2015 and BS EN ISO 14001: 2015)

Issue	Date	Prepared by	Checked by	Approved by
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Comments

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Contents

1. Introduction

1.1 Scope

Waterman Moylan has been appointed by Gerard Gannon Properties to provide Structural Consultancy Services for the proposed residential development at lands at Belcamp, Dublin 17 and to develop the scheme to Planning Stage.

The proposed development consists of a total of 2,527 no. residential units - comprising of 473 no. houses, 274 no. duplexes and 1,780 no. apartments, and 4,424m^2 of commercial space including retail units, café/bar/restaurant units, a clubhouse and two crèches.

The main structural issues covered are as follows:-

- Develop an understanding of site constraints.
- Form of the new structures.
- Advise structural dimensions.
- Review of construction methodology in relation to the site constraints

2. Site Constraints

The Belcamp lands are located centrally in the Dublin North Fringe area, north of the Northern Cross Route, R139, to the east of the IDA lands zoned HT, and to the west of the Malahide Road (R107). The total site area is c.67.2 hectares.

The subject site is bounded to the north and to the west by agricultural lands, to the south by the R139 Regional Road and to the east by an existing mixed-use development, by Phase 1 of the Belcamp development, which is currently under construction by the Applicant, and by the Malahide Road (R107).

The Mayne River flows from west to east through the site. The northern portion of the subject site is within Fingal County Council's jurisdiction, while the southern portion of the site is within Dublin City Council's jurisdiction, with the Mayne River forming the border between the two Local Authorities.

The site location is indicated in Figure 1 below:

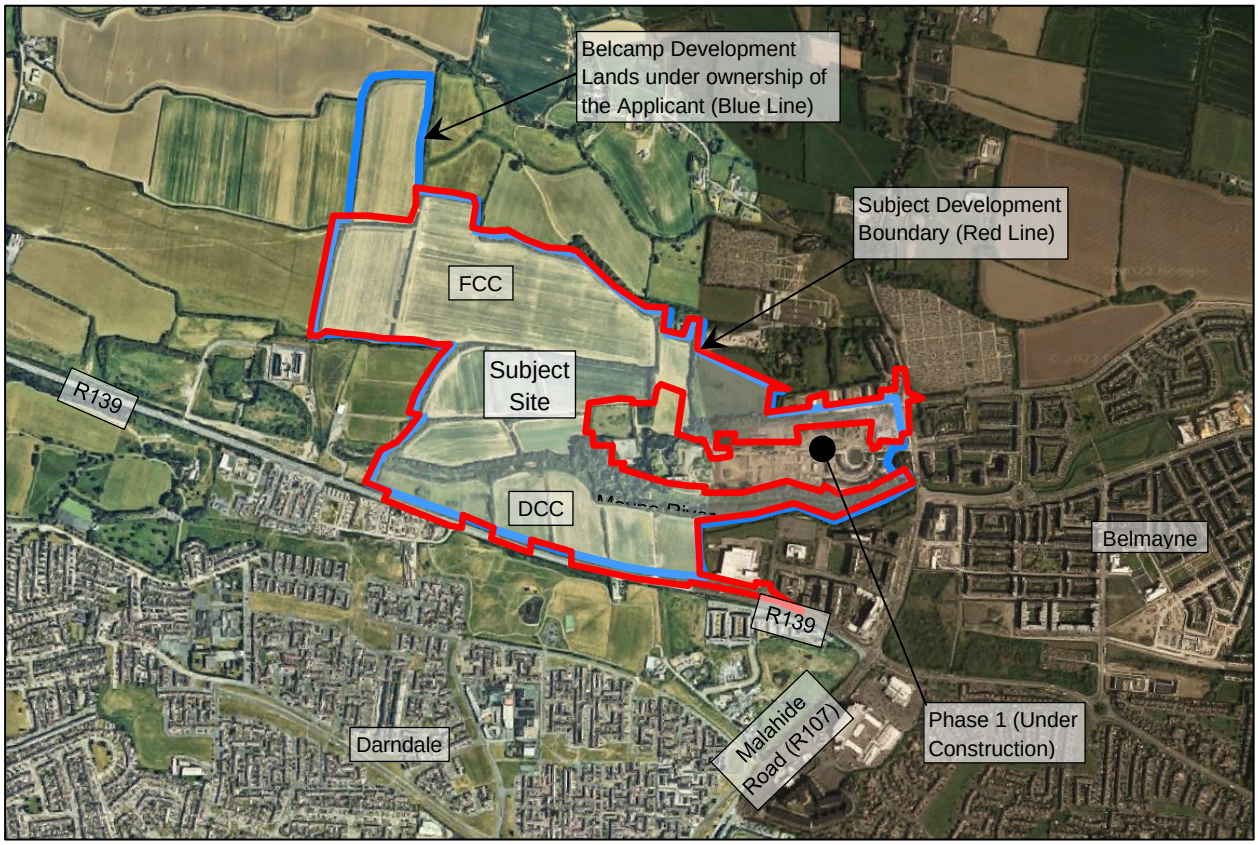


Figure 1 | *Site Location (Source: Google Maps)*

The subject site is a greenfield site. A topographic survey generally shows in the southern part of the site, there is a fall generally from south-west to north-east towards the Mayne River. The high point is approximately 35.55m OD Malin at the south-west of the site and the low point on the north-east of the site is approximately 26.5m OD Malin.

The northern part of the site falls generally from north-west to south-east towards the Maybe River. Some of the lands in the north-east fall towards the north-east, away from the river and towards a ditch and culvert at the north-eastern boundary of the site.

Figure 2 | *Proposed site plan (source: CCK Architects)*

2.1 Site Access

The site will be primarily accessed by via entrances on the R139 and a new East-West link road connecting with the Malahide Road.

2.2 Traffic Management

Construction timings and methods, protection and potential temporary detours for both pedestrians and vehicles shall be studied prior to the commencement of construction activities. The Contractor shall agree and submit proposals to Fingal County Council and Dublin City Council for approval.

2.3 Adjacent residential Properties

The site is adjacent to several existing properties and structures including Belcamp House and Walled Garden and a number of existing private residences. The proposed development will also need to consider the currently under construction Belcamp Phase 1A. Dilapidation surveys will need to be undertaken to these properties ahead of the works commencing, in addition to monitoring of noise and vibration during demolition and construction.

2.4 Site Gradient

In order to provide a rationalised layout for the site, material cut and fill of the existing levels will be required underneath the roads and structures. Where possible the vast majority of this material will remain on site. Should excess cut be produced this will be removed off site. Similarly, if additional fill is required this material will be imported to site.

3. Structural Concept

The structural scheme has been developed following review of the architectural planning drawings and analysis of floor spans and structural zones.

The structural concept varies between the different building typologies proposed for the development. Below is a table summarising the structures across the development.

Dublin City Council (Southern Part of Site)		
Building	**Code**	**Description**
Block 1 273 Units	BLK1	Nine storey apartment block
Block 2 160 Units	BLK2	Nine storey apartment block
Block 3 297 Units	BLK3	Nine storey apartment block
Block 4 285 Units	BLK4	Nine storey apartment block
Block 5 96 Units	BLK5	Eight storey apartment block (incl. Lower Ground Floor)
Block 6 119 Units	BLK6	Nine storey apartment block

Fingal County Council (Northern Part of Site)		
Building	**Code**	**Description**
Block A 23 Units	BLKA	Four storey apartment block.
Block B 23 Units	BLKB	Four storey apartment block.
Block C 27 Units	BLKC	Four storey apartment block.
Block D 42 Units	BLKD	Five storey apartment block (including penthouse) with commercial space at Ground Floor.

Block F 103 Units	BLKF	Six storey apartment block (including basement) with podium slab. Commercial space at Ground Floor.
Block G 65 Units	BLKG	Five storey apartment block (including penthouse) with podium slab and undercroft parking. Commercial space at Ground Floor.
Block H 46 Units	BLKH	Five storey apartment block with partial Ground Floor undercroft parking.
Block J 40 Units	BLKJ	Five storey apartment block with partial Ground Floor undercroft parking and commercial space at ground floor.
Block L 46 Units	BLKL	Five storey apartment block with partial Ground Floor undercroft parking.
Block M 56 Units	BLKM	Six storey apartment block with partial Ground Floor undercroft parking.
Block N 56 Units	BLKN	Five storey apartment block.
Block P 23 Units	BLKP	Five storey apartment block.
Duplexes 274 Units	DUP	Four storey duplex blocks
Houses 473 Units	HSE	Semi detached and terraced two and three storey units

Table 1 | *Proposed buildings*

3.1 Substructures

From an analysis of the anticipated building loads and the soil conditions described in the preliminary site investigation report, and in consideration of the cut and fill works required on the site, the proposed buildings have been divided into four different substructure typologies.

Building	Description	Substructure Typology	Description
Block 1 273 Units	Nine storey apartment block	Type 3	Reinforced Concrete Strip Footings under load bearing walls and columns.
Block 2 160 Units	Nine storey apartment block	Type 3	Reinforced Concrete Strip Footings under load bearing walls.
Block 3 297 Units	Nine storey apartment block	Type 2* & Type 3 (Ground Level Varies)	Pilecaps, piles and ground beams under load-bearing walls. Reinforced Concrete Strip Footings under load bearing walls
Block 4 285 Units	Nine storey apartment block	Type 3	Reinforced Concrete Strip Footings under load bearing walls and columns.
Block 5 96 Units	Eight storey apartment block (incl. Lower Ground Floor)	Type 2* & Type 3 (Ground Level Varies)	Pilecaps, piles and ground beams under load-bearing walls. Reinforced Concrete Strip Footings under load bearing walls
Block 6 119 Units	Nine storey apartment block	Type 2	Pilecaps, piles and ground beams under load bearing walls and columns
Block A 23 Units	Four storey apartment block.	Type 2 & Type 3	Pilecaps, piles and ground beams under load bearing walls and columns Reinforced Concrete Strip Footings under load bearing walls.

Block B 23 Units	Four storey apartment block.	Type 2 & Type 3	Pilecaps, piles and ground beams under load bearing walls and columns Reinforced Concrete Strip Footings under load bearing walls.
Block C 27 Units	Four storey apartment block.	Type 2 & Type 3	Pilecaps, piles and ground beams under load bearing walls and columns Reinforced Concrete Strip Footings under load bearing walls.
Block D 42 Units	Five storey apartment block (including penthouse) with commercial space at Ground Floor.	Type 2	Pilecaps, piles and ground beams under load bearing walls and columns
Block F 103 Units	Six storey apartment block (including basement) with podium slab. Commercial space at Ground Floor.	Type 1	Pilecaps, piles and ground beams under load bearing walls and columns Basement/undercroft walls constructed in reinforced concrete.
Block G 65 Units	Five storey apartment block (including penthouse) with podium slab and undercroft parking. Commercial space at Ground Floor.	Type 2	Pilecaps, piles and ground beams under load bearing walls and columns
Block H 46 Units	Five storey apartment block with partial Ground Floor undercroft parking.	Type 2	Pilecaps, piles and ground beams under load bearing walls and columns
Block J 40 Units	Five storey apartment block with partial Ground Floor undercroft parking and commercial space at ground floor.	Type 2	Pilecaps, piles and ground beams under load bearing walls and columns

Block L 46 Units	Five storey apartment block with partial Ground Floor undercroft parking.	Type 2	Pilecaps, piles and ground beams under load bearing walls and columns
Block M 56 Units	Six storey apartment block with partial Ground Floor undercroft parking.	Type 2	Pilecaps, piles and ground beams under load bearing walls and columns
Block N 56 Units	Five storey apartment block.	Type 2	Pilecaps, piles and ground beams under load bearing walls and columns
Block P 23 Units	Five storey apartment block.	Type 2	Pilecaps, piles and ground beams under load bearing walls and columns
Duplexes 274 Units	Four storey duplex blocks	Type 2 & Type 3	Pilecaps, piles and ground beams under load bearing walls and columns Reinforced Concrete Strip Footings under load bearing walls.
Houses 473 Units	Semi detached and terraced two and three storey units	Type 3	Reinforced Concrete Strip Footings under load bearing walls.

Table 2 | *Proposed Substructures*

3.1.1 Foundations for typology 1 and 2

The soil conditions and anticipated building loads would require piled foundations. The proposed piles are to be conventional continuous flight auger (CFA) or rotary bored piles of 600-750mm diameter, subject to a site investigation, and will be designed to resist the vertical and horizontal loads from the structure above. Driven piles may also be acceptable where there is no vibration concerns with adjacent structures.

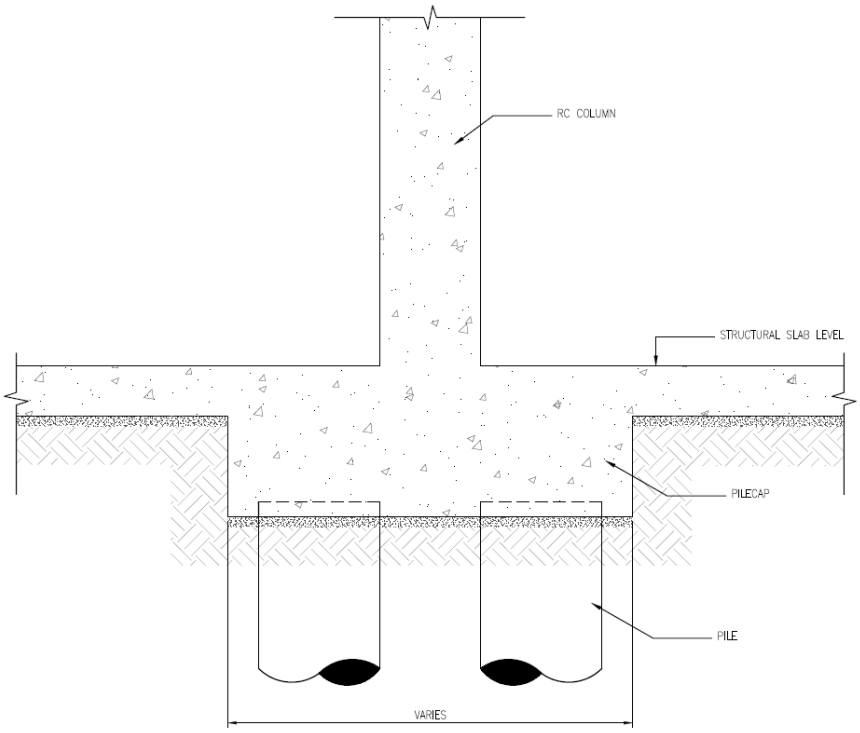
Rectangular reinforced concrete beams (Ground Beams) will span between pilecaps to support load bearing walls.

Type 1 is differentiated from Type 2 due to the additional need for basement/retaining walls. Typical basement wall details are provided in section 3.1.2.

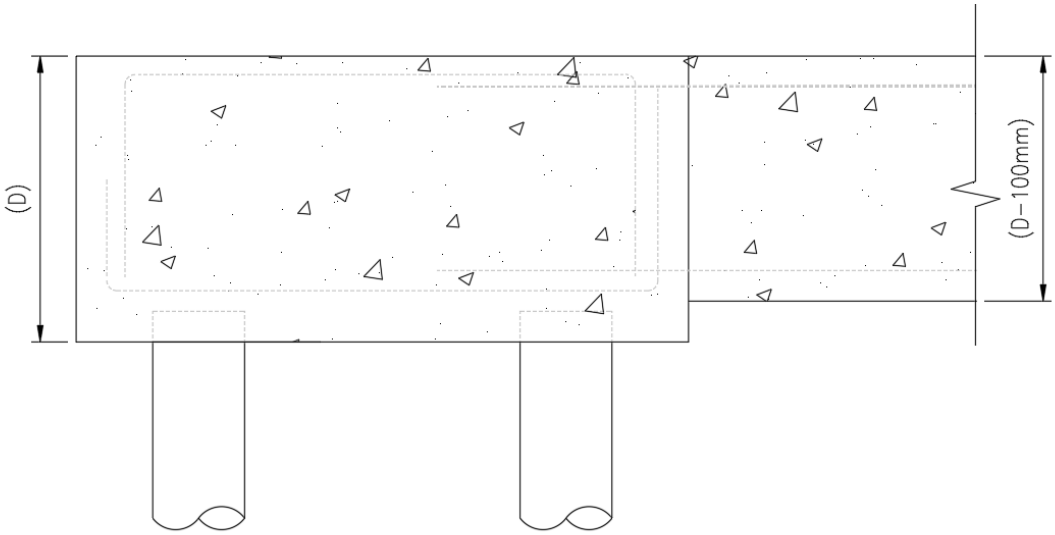
Pile caps will be reinforced concrete cast in-situ elements designed to spread the building loads into the piles. The pile caps are typically 1000 to 1800m deep for 600-750mm diameter piles

- Typical Pile Cap dimension*****: 2500x2500x1800mm deep square pilecap under columns.
- Typical Ground Beam dimension*****: 700x900mm deep spanning between pilecaps.

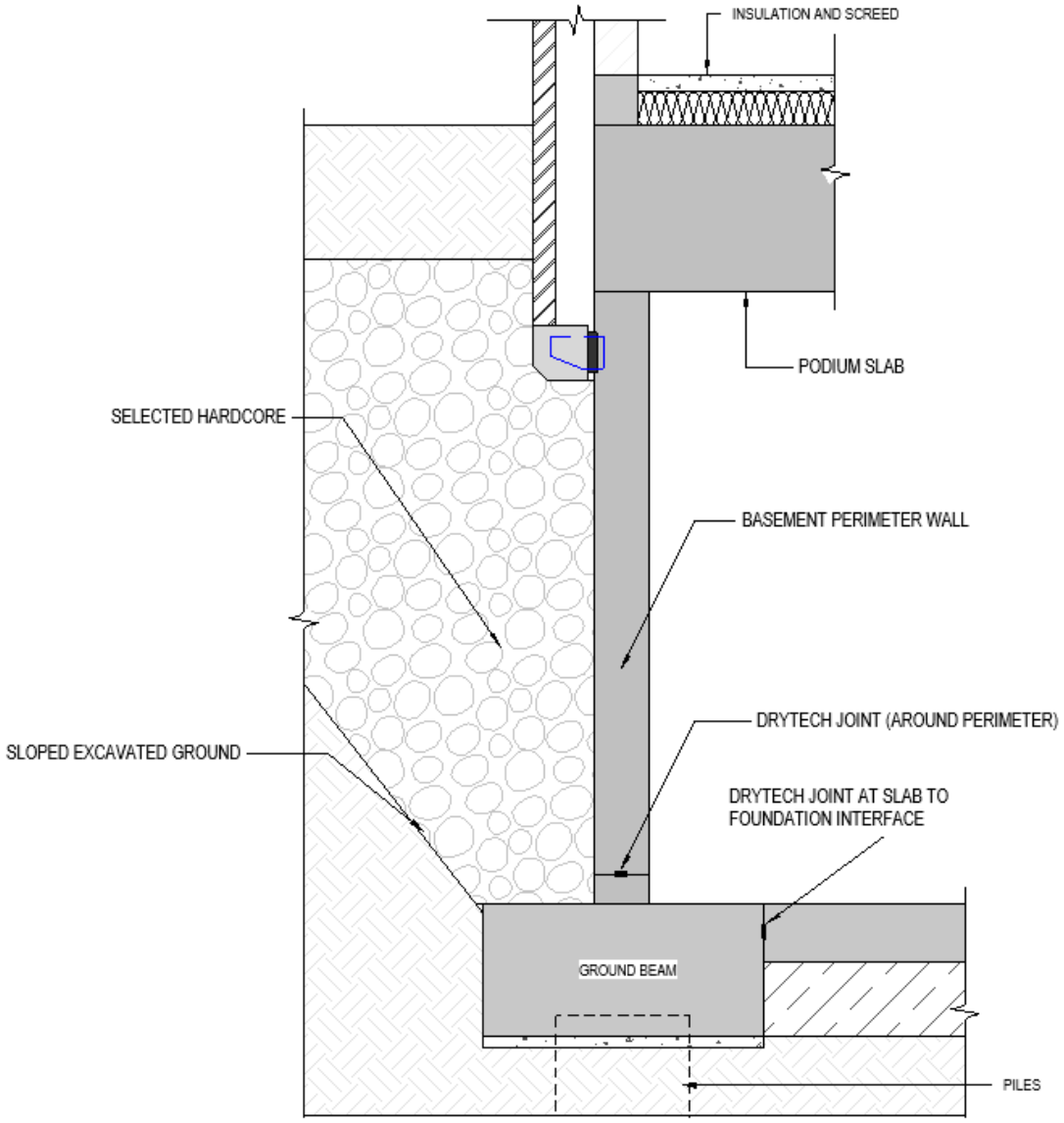
***Note**: Dimensions shown above are typical of what will be required but may be subject to change when more detailed Ground Investigation information or other information on site conditions becomes available.



Typical Foundation Type 1 and 2



Typical Pilecap-Groud Beam Interface



Typical Basement Perimeter (w/piling)

3.1.2 Basement Structure for typology 1

The perimeter of the basement will be constructed using reinforced concrete walls, 250-300mm thick.

Foundations will be ground beams and pile caps as described in Section 3.1.1.

Note: The basement footprint will not encroach on any tree root protection area.

3.1.3 Basement/Undercroft Waterproofing for typology 1

Requirement and details for basement waterproofing are shown by the Architect.

Table 2 **Grades of waterproofing protection**

Grade	Example of use of structure[A)]	Performance level
1	Car parking; plant rooms (excluding electrical equipment); workshops	Some seepage and damp areas tolerable, dependent on the intended use[B)] Local drainage might be necessary to deal with seepage
2	Plant rooms and workshops requiring a drier environment (than Grade 1); storage areas	No water penetration acceptable Damp areas tolerable; ventilation might be required
3	Ventilated residential and commercial areas, including offices, restaurants etc.; leisure centres	No water penetration acceptable Ventilation, dehumidification or air conditioning necessary, appropriate to the intended use

A) The previous edition of this standard referred to Grade 4 environments. However, this grade has not been retained as its only difference from Grade 3 is the performance level related to ventilation, dehumidification or air conditioning (see BS 5454 for recommendations for the storage and exhibition of archival documents). The structural form for Grade 4 could be the same or similar to Grade 3.

B) Seepage and damp areas for some forms of construction can be quantified by reference to industry standards, such as the ICE's *Specification for piling and embedded retaining walls* [1].

Grades of Waterproofing Protection (extract from BS8102:2009)

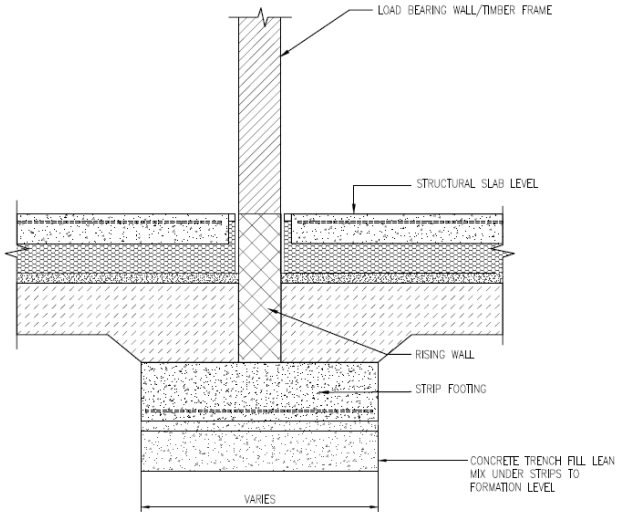
In basement habitable areas, core lobbies, electrical rooms and lift-pits, the basement waterproofing performance will need to be BS 8102:2009 Grade 3. Elsewhere the basement will be designed for Grade 2.

Current proposals to achieve this required environment will be developed over the next stage. At this stage and for any preliminary cost plans we would suggest that a “white tank” system by Rascor or Drytech is considered.

3.1.4 Foundations for typology 3

From the anticipated soil conditions, it is expected that the structure will be supported on shallow foundations. This will comprise in reinforced concrete strip footings on mass concrete (leanmix) extending to the stiffer ground layers where necessary.

The ground floor slabs are 150mm thick reinforced concrete and ground bearing. The slabs are formed on 50mm T3 Blinding with minimum 225mm T2 hardcore to SR:21 requirements.



Typical Foundation Type 3

- Housing Blocks
    - Typical Strip Footings: 900 to 1500mm wide by 300mm deep*****.
- 4 Storey Duplex Blocks
    - Typical Strip Footings: 1200 to 1800mm by 300mm deep*****.
- 4 Storey Apartment Blocks
    - Typical Strip Footings: 1200 to 2000mm by 300-400mm deep***.**

***Note**: Dimensions shown above are typical of what will be requires but may be subject to change when more detailed Ground Investigation information or other information on site conditions becomes available.

3.2 Superstructures

A material options study for the super-structure was undertaken for all the proposed building typologies and can be summarised as follows.

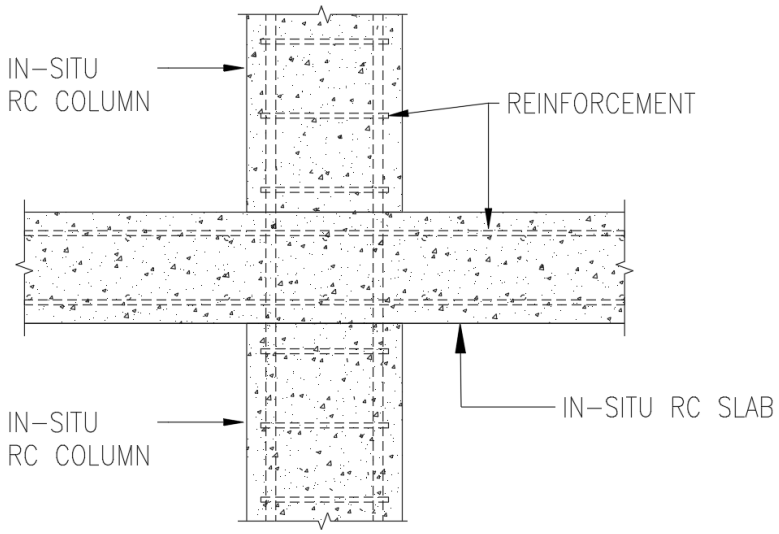
Houses, Duplex and Four Storey Apartment Blocks					
	Framing Layout	Speed-of-Construction	Fire Resistance	Acoustic Performance	Vibration Performance
Masonry Walls & Precast Concrete	Average	Average	Good	Good-Average	Good
Timber Frame	Good	Good	Average	Average	Average
Masonry Walls & Timber Floors	Good	Average	Average	Average	Average

For the houses it is proposed to use either Masonry Walls and Timber Floors (Traditional build) or Timber Frame for the superstructure.

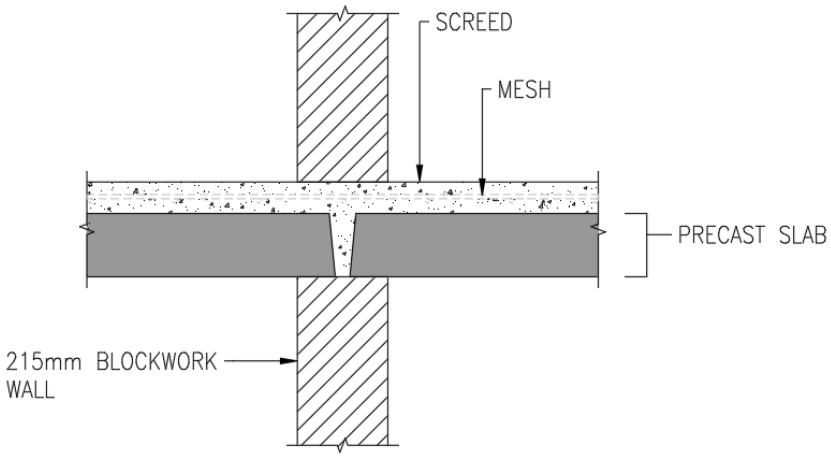
For the duplex and apartment blocks, it is proposed to use Masonry Walls & Precast Floors for the superstructure.

All Blocks of Five+ Storeys					
	Framing Layout	Speed-of-Construction	Fire Resistance	Acoustic Performance	Vibration Performance
Hybrid Precast Hollowcore & Crosswalls	Good	Good	Good	Good-Average	Good
In-situ Concrete Frame	Good	Poor	Good	Good	Good
Steel Frame & Precast Concrete	Good	Good	Average	Good-Average	Average
Masonry Walls & Precast Concrete	Poor	Poor	Good	Good-Average	Good

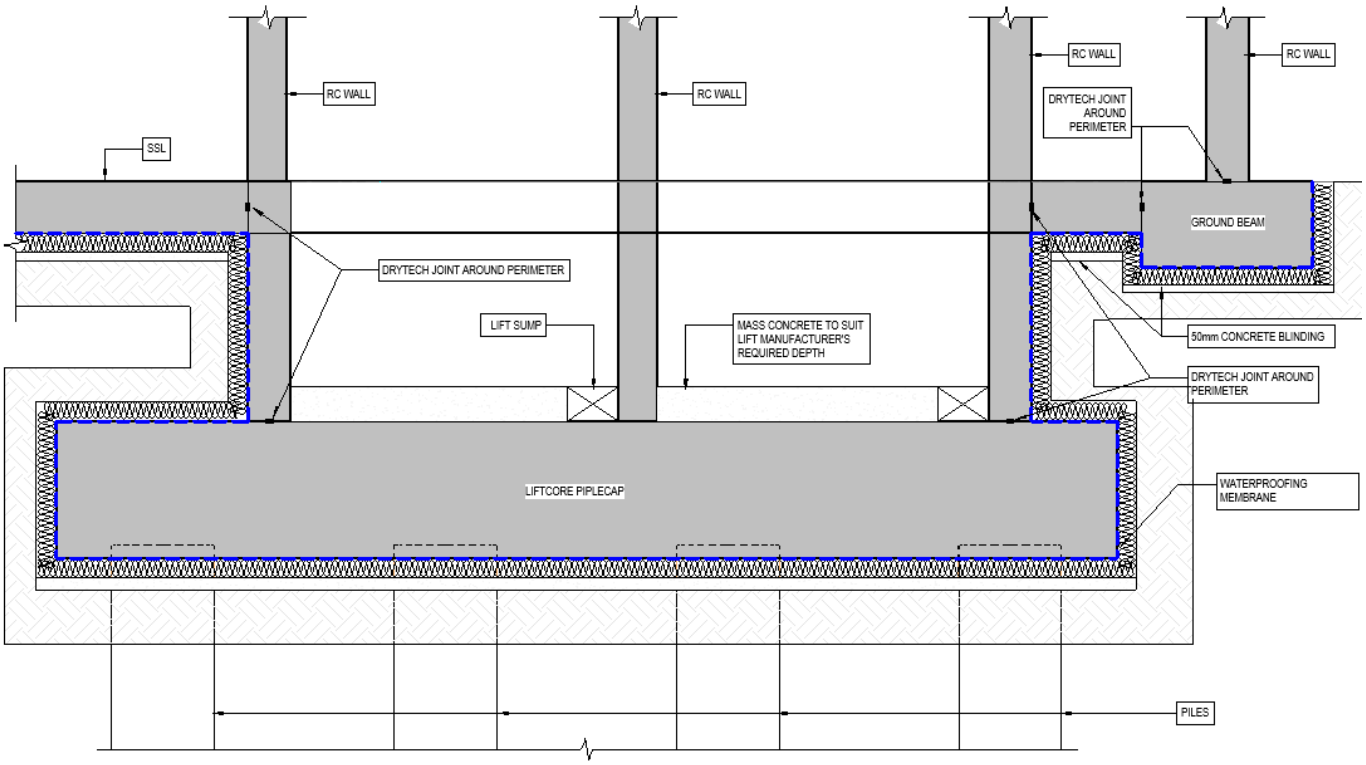
All Blocks: The proposed structure is to be an in-situ reinforced concrete frame due to the size and geometry of the blocks. This structure type will be overall lighter compared to precast wall or masonry wall structure and provides greater flexibility in reducing areas of transfer and to achieve the architectural intent.



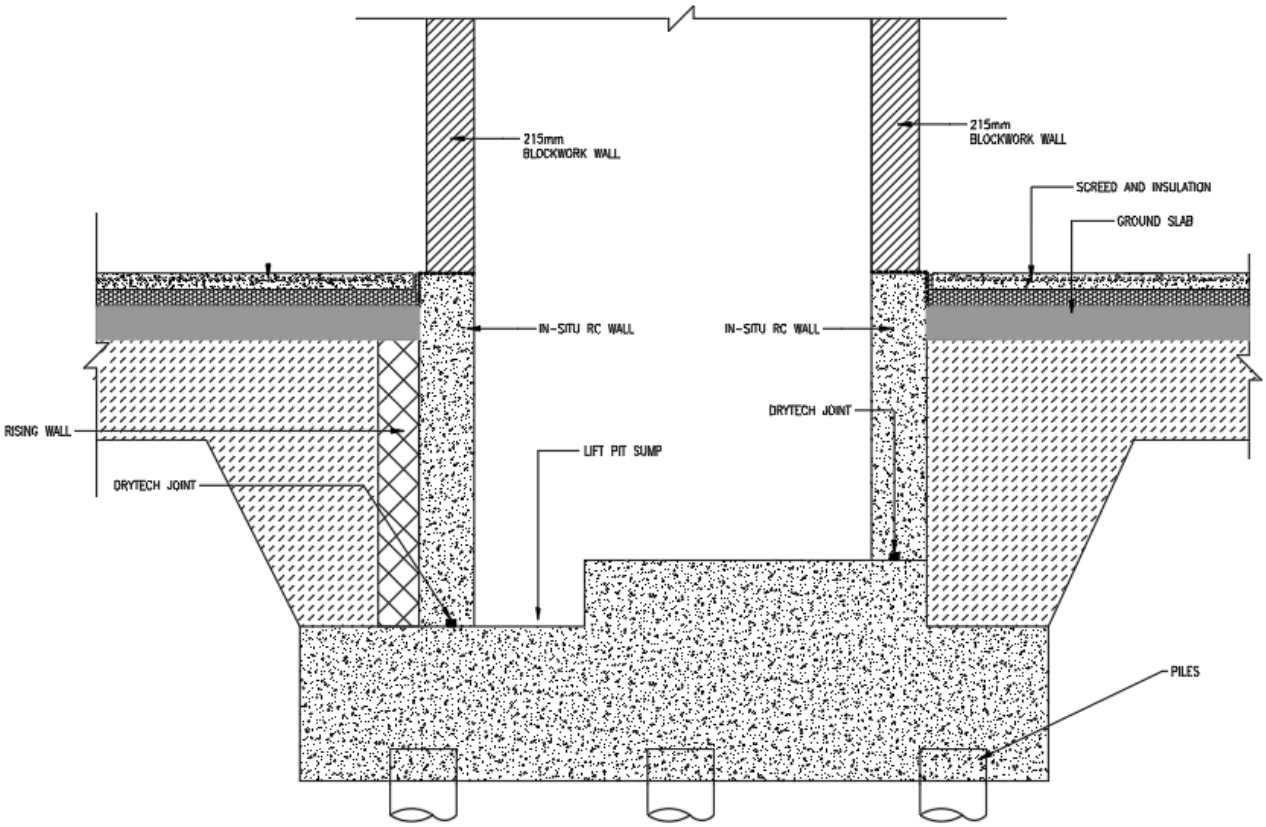
Typical In-Situ Reinforced Concrete Floor Structural Build-up



Typical Masonry Walls & Precast Concrete Floor Structural Build-up



Typical Lift Pit
(In-Situ RC Frame Superstructure)

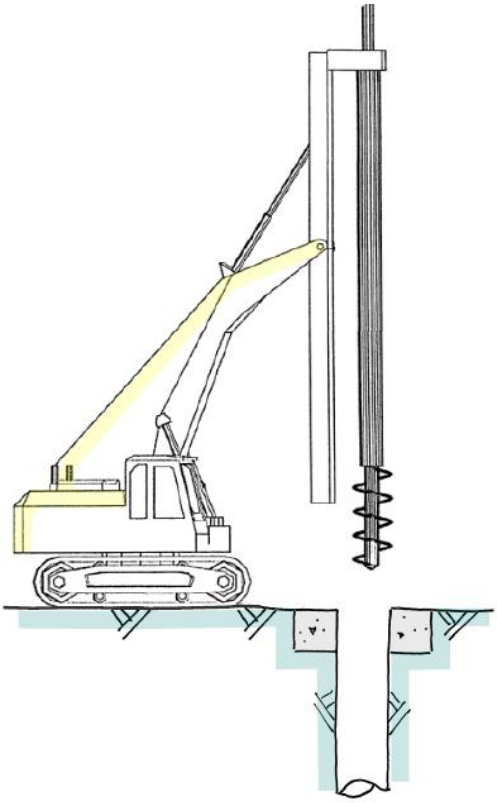


Typical Lift Pit
(Masonry Walls & Precast Concrete Floor Superstructure)

4. Construction Methodology

4.1 Foundations Type 1

The sequence of works for the construction of the basement will be as follows:



Typical Piling Installation

- Excavate basement, secure excavation & Install Temporary Works (if required).
- Install Piling Mat & Temporary guide wall (if required)
- Install Piles
- Construct RC Ground Beams and Pile Caps
- Construct Basement RC Slab
- Construct Basement RC Walls and Columns
- Construct Podium/Transfer Slab

4.2 Foundations Type 2

The sequence of works for the construction of the type 2 foundations will be as follows:

- Excavate to foundation level
- Install Piling Mat & Temporary guide wall (if required)
- Install Piles
- Construct RC Ground Beams Beams and Pile Caps
- Construct masonry/concrete rising elements over the pile caps and ground beams.
- Place and compact approved granular fill to the underside of ground floor slab
- Construct RC Ground Floor Slab

4.3 Foundations Type 3

The sequence of works for the construction of the type 3 foundations will be as follows:

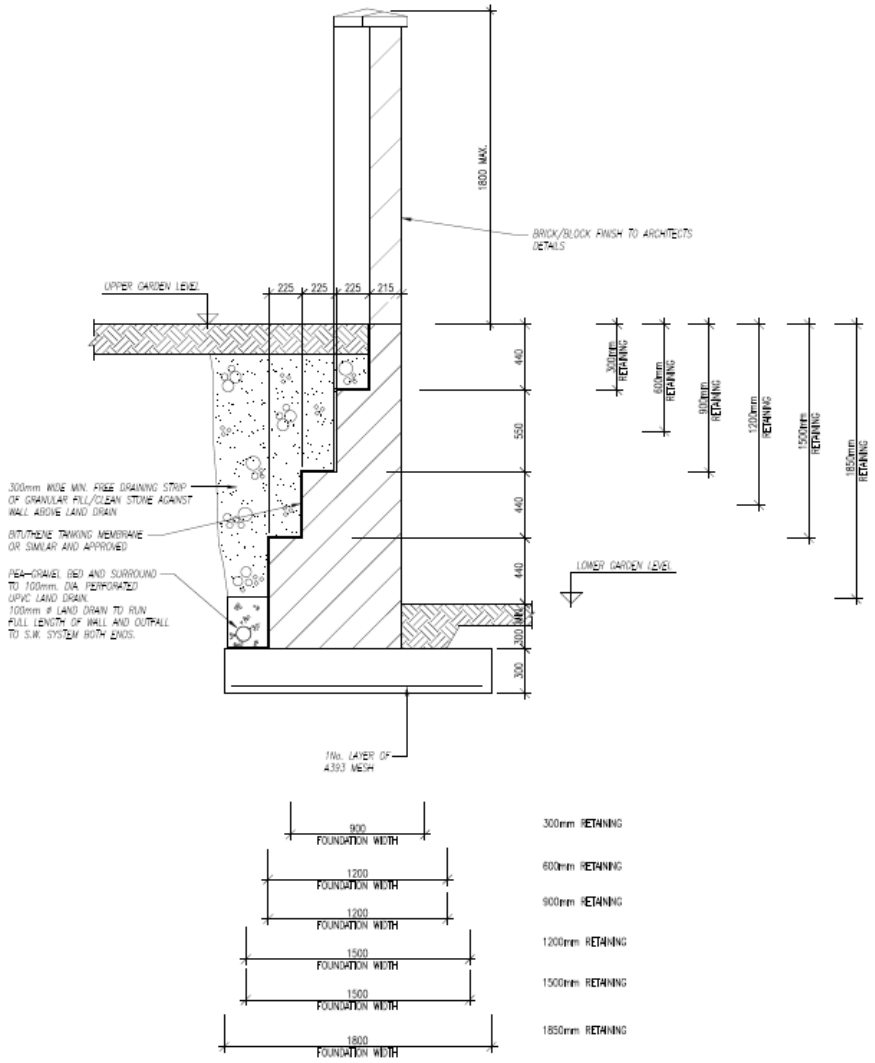
- Excavate to formation level
- Place lean mix to reach foundation level (if required)
- Construct RC Strip footings
- Construct masonry rising walls
- Place and compact approved granular fill to the underside of ground floor slab
- Construct RC Ground Floor Slab

4.4 Civil Works / Retaining Structures

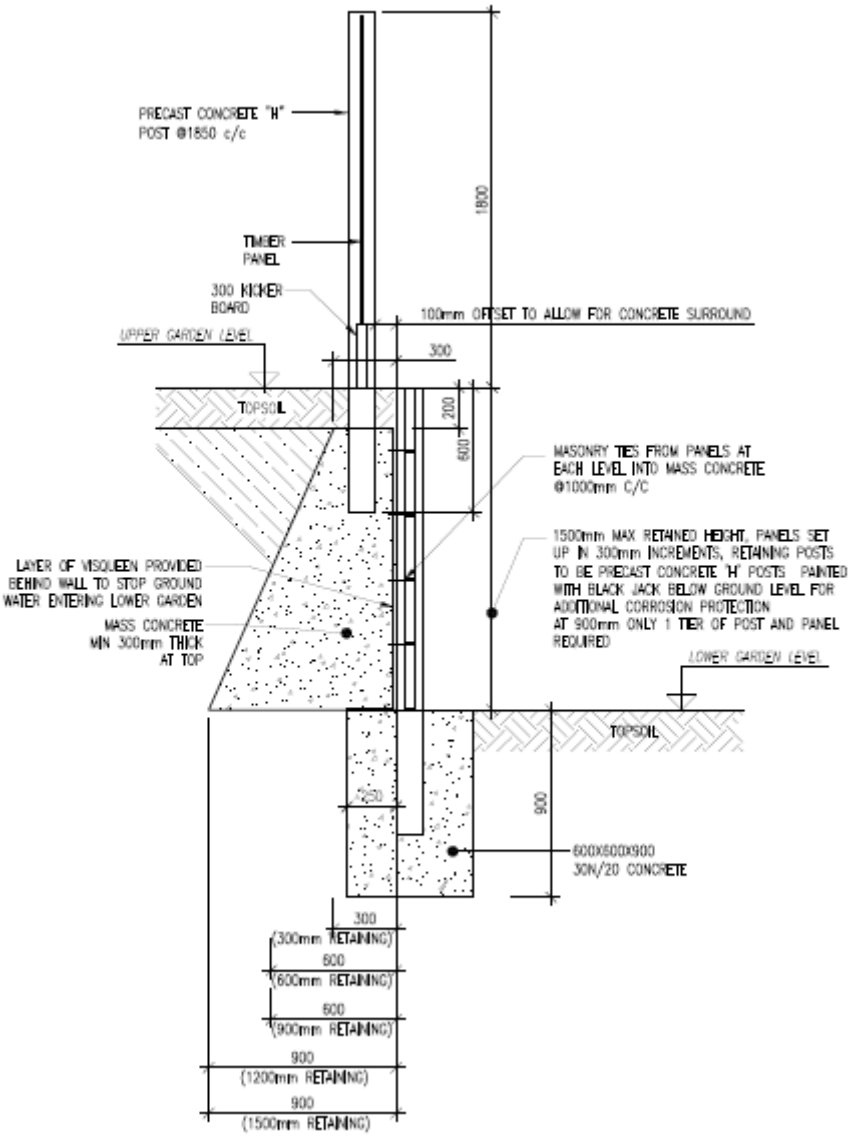
Back of garden areas will be treated with various types of retaining wall structures. The finished boundary structure above retaining level may vary (blockwork, timber post and panel, railings, etc.) Depending on retained heights, the form of the retaining structure may be as follows:

- Post and Panel Retaining (w/Mass Concrete)
    - Up to 1.5m Retaining
- Blockwork Retaining
    - Up to 1.85m Retaining
- Concrete Retaining
    - Up to a maximum of 3.5m

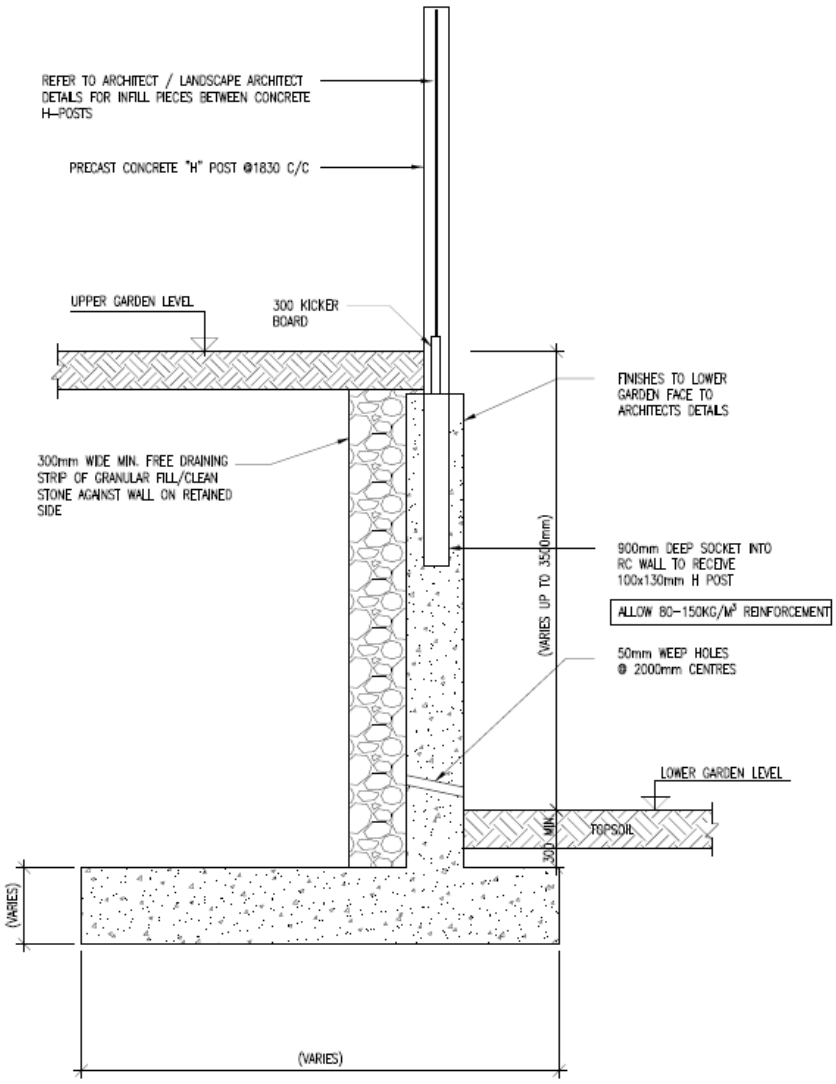
Example retaining sections are included below.



Typical Blockwork Retaining Wall



Typical Post and Panel Retaining Wall



Typical RC Retaining Wall (Up to 3.5m Retaining)

4.5 Measures to Protect Adjacent/Nearby Structures

The following measures have been considered in design over the Planning Stage to protect the adjacent/neighbouring structures:

(1) The extent of basements footprint and depth of basement have been kept to a minimum.

(2) The basements have been set-out and positioned away from the site boundaries. It is deemed that this is far enough away so that the zone of influence from the basement excavation will not affect the nearby buildings.

(3) Driven piles may be used and will be subject to vibration monitoring. Driven piles will not be used adjacent sensitive structures.

(4) CFA Piling is generally proposed to minimise noise and vibration during the works.

(5) The basement walls will provide a groundwater cut-off and prevent groundwater movement between the basement excavation and surrounding subterranean area. This will mitigate the risk of changes to the existing groundwater levels during construction (subject to the ground investigation and level of the existing groundwater).

(6) Additional measures will be adopted by the Contractor during construction as per health and safety requirements and best practice.

5. Fire Protection of the Structures

It is currently understood that a 90-minute fire protection will be required generally for the apartments, with 120 minutes required for certain cores and escape routes, and 60 minutes for the houses and duplex apartment blocks, subject to the Fire Consultants Report.
240 minutes is required in electrical ESB substation rooms.

Fire protection to all concrete elements will be achieved as follows, as per IS EN 1992-2:

Core walls and Columns	-	RC concrete cover and minimum element dimensions
Horizontal members and hollowcore slabs	-	RC concrete cover and minimum element dimensions.
120 minute areas	-	RC concrete cover and minimum element dimensions.
240 minute areas	-	RC concrete cover and minimum element dimensions.

6. Proposed Loadings

6.1 Design Loadings and Service Movements

6.1.1 Vertical Loads

These comprise superimposed live loads [due to occupancy, plant, storage, etc.], superimposed dead loads [due to M&E services, etc.] and self-weight of structure plus cladding. Superimposed live loads and dead loads are listed below and the design takes into account structure and cladding self-weight.

6.1.2 Horizontal Loads

These comprise either wind loading on the building façade or "EHF – Equivalent Horizontal Forces" as defined in Eurocode. EHF loads occur due to lack of fit of the structure, etc. The combination of these two are used in the design in accordance with IS EN 1990.

6.1.3 Service Movements

Horizontal and vertical movements due to superimposed live loads and wind loads are limited to the following:

Horizontal building sway [wind load] = $\frac{height}{500}$

Vertical slab/beam deflections [superimposed live load]:

i] Floor beams = $\frac{span}{360}$

ii] Slab/Beam supporting cladding = $\frac{span}{500}$ or 10 mm whichever is less.

6.1.4 Loading Table (Subject to Final Confirmations of Superstructure)

A1	Typical Apartment Floor (Precast)	
	200 Precast Slab	3.00 kN/m^2
	75mm Screed	1.80 kN/m^2
	Floor Finishes	0.35 kN/m^2
	Ceiling & Services	0.25 kN/m^2
		5.40 kN/m^2
	Imposed load (Class A2)	3.0 kN/m^2
	[Including 1.0kN/m^2 partitions]	

A2 Typical Apartment Floor (Insitu)

225 Insitu Slab	5.63 kN/m^2
Floor Finishes	0.35 kN/m^2
Ceiling & Services	0.25 kN/m^2
	6.23kN/m^2
Imposed load (Class A2) [Including 1.0kN/m^2 partitions]	3.0 kN/m^2

B Typical Podium (Building Footprint)

750 normal weight slab	18.75 kN/m^2
Finishes	0.50 kN/m^2
75mm Screed (2000kg/m^3)	1.50 kN/m^2
Floor insulation	0.05 kN/m^2
Ceiling &services	0.45 kN/m^2
	21.25 kN/m^2
imposed load (Class A2) [Including 1.0kN/m^2 partitions]	3.0 kN/m^2

C Typical Podium (Landscaped Area)

550 normal weight slab	13.75 kN/m^2
Landscaping (TBC)	10 kN/m^2
Waterproofing	0.5 kN/m^2
Insulation	0.20 kN/m^2
Ceiling & Services	0.45 kN/m^2
	24.9 kN/m^2
Imposed load (Vehicle Access)	10 kN/m^2

D Roof Areas

200 Precast Slab	3.00 kN/m^2
75mm Screed	1.80 kN/m^2
Sedum	3.00 kN/m^2
Waterproofing	0.30 kN/m^2
Insulation	0.20 kN/m^2
	8.30 kN/m^2
imposed load (MEP)	7.5 kN/m^2
Imposed load (PVs)	3.0 kN/m^2
Access/Maintenance	0.6 kN/m^2

E Corridor / Lobby Areas

200 Precast Slab	3.00 kN/m^2
75mm Screed	1.80 kN/m^2
Floor Finishes	0.35 kN/m^2
Ceiling & Services	0.45 kN/m^2
	5.60 kN/m^2
Imposed load	5.0 kN/m^2

F Disproportionate Collapse

The structure is in excess of five storeys and therefore will be checked for disproportionate collapse in accordance with IS EN 1991-1-7:2006 Annex A and Building Regulations.

Accidental loading at 34 kN/m^2 will be applied to "key elements", i.e. columns and beams carrying columns, and criteria in regard to perimeter ties and tying forces.

UK and Ireland Office Locations