Waterman Moylan
Engineering Consultants

Planning Stage – Structural Report

Proposed Strategic Housing Development at Fosterstown North,
Dublin Road / R132, Swords, Co. Dublin

April 2022

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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)

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Comments

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1. Introduction

1.1 Scope

Waterman Moylan has been appointed J. Murphy (Developments) Limited to provide Structural Consultancy Services for the proposed residential development at Proposed Strategic Housing Development at Fosterstown North, Dublin Road / R132, Swords, Co. Dublin and to develop the scheme to Planning Stage.

This report has been prepared as part of a Strategic Housing Development planning submission to An Bord Pleanála, for the proposed development which will consist of 645no. residential units (comprising of 208no. 1-bedroom units, 410no. 2-bedroom units, and 27no. 3-bedroom units), in 10no. apartment blocks, with heights ranging from 4no. storeys to 10no. storeys, including undercroft / basement levels (for 6no. blocks). The proposals include 1no. community facility in Block 1, 1no. childcare facility in Block 3, and 5no. commercial units (for Class 1-Shop, or Class 2- Office / Professional Services or Class 11- Gym or Restaurant / Café use, including ancillary takeaway use) in Blocks 4 and 8. The proposal includes all associated and ancillary development.

This report sets out the intended approach to the building structure and foundations.

The site is located within an area which is identified in the Fingal County Development Plan as being subject to a masterplan. In this regard the "Fosterstown Masterplan" has been published by Fingal County Council and this assessment takes into consideration recommendations within the masterplan relating to the engineering aspects of the proposed development.

2. Site Location

The site is located in Fosterstown, Swords, Co. Dublin and is bound to the north by a greenfield site, which forms the northern portion of the Swords Masterplan, to the east by the R132 and to the south and west by the Boroimhe residential development. The subject site is located 2km north of Dublin Airport and 1km south of Swords Main Street.

Refer to Figure 2-1 for the location of the proposed development.

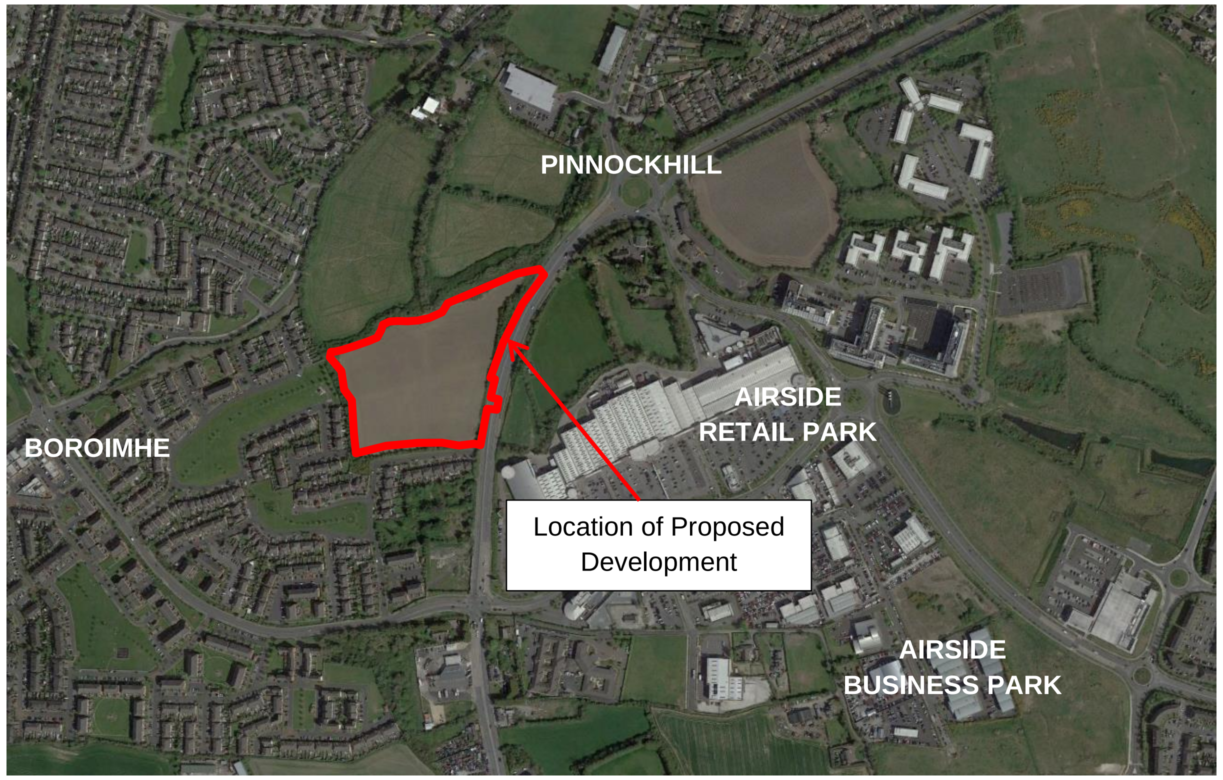


Figure 2-1: Site Location (image taken from Google Maps)

2.1 Existing Land Use

The total site area is approximately 4.635 hectares and is currently greenfield. The site falls from the existing high point in the southwest corner with a level of 47.88m OD Malin to the low point in the northeast corner of the site with a level of 36.75m OD Malin. The site slopes sharply to the northeast with an average slope of 1:34. There is an existing watercourse (Gaybrook Stream) along the entirety of the northern boundary of the site which flows from west to east. The site is currently accessed by a gate from the R132.

Refer to Figure 2-2 for the map of the existing site topography.

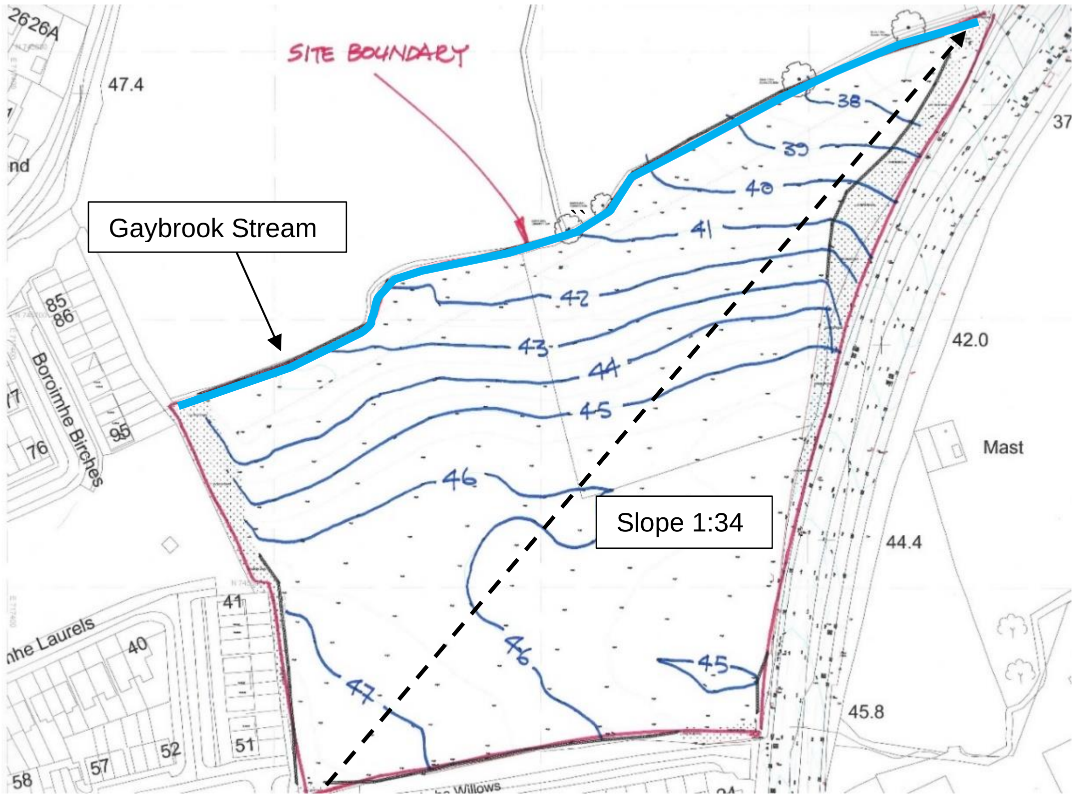


Figure 2-2: Subject Site Topography

2.2 Proposed Development

The proposed development comprises a Strategic Housing Development of 645no. residential units (comprising of 208no. 1-bedroom units, 410no. 2-bedroom units, and 27no. 3-bedroom units), in 10no. apartment blocks, with heights ranging from 4no. storeys to 10no. storeys, including undercroft / basement levels (for 6no. blocks). The proposals include 1no. community facility in Block 1, 1no. childcare facility in Block 3, and 5no. commercial units (for Class 1-Shop, or Class 2- Office / Professional Services or Class 11- Gym or Restaurant / Café use, including ancillary takeaway use) in Blocks 4 and 8. The proposal includes all associated and ancillary development.

The proposal includes a total of 363no. car parking spaces, 63no. at surface level and 300no. at undercroft / basement level, and 1,519no. bicycle parking spaces. Bin stores, plant rooms and block cores are located at undercroft / basement level. The proposed development includes private amenity space in the form of balconies / terraces for all apartments The proposed development will also include the provision of public and communal open space, including 2no. playing pitches, children's play areas and an ancillary play area for the childcare facility.

The proposed development includes road upgrades, alterations and improvements to the Dublin Road / R132, including construction of a new temporary vehicular access, with provision of a new left in, left out junction to the Dublin Road / R132, and construction of a new signalised pedestrian crossing point, and associated works to facilitate same. The proposal includes internal roads, cycle paths and footpaths, vehicular access to the undercroft

/ basement car park, with all infrastructure provided up to the application site boundary to facilitate potential future connections to adjoining lands.

The development includes all associated site and infrastructural works, including foul and surface water drainage, PV panels at roof level, 5no. ESB Substations, hard and soft landscaping, boundary treatment, and all associated and ancillary site works.

2.3 Ground Conditions

IGSL carried out geotechnical site investigation in 2005 [Report No. 10741] and included in the EAR as part of the planning documents.

The borehole records from the site investigation indicate that Firm to Stiff to very Hard Brown/Black Clay extends across the site and is suitable for shallow foundations. The anticipated subsurface geology is likely to be as follows:

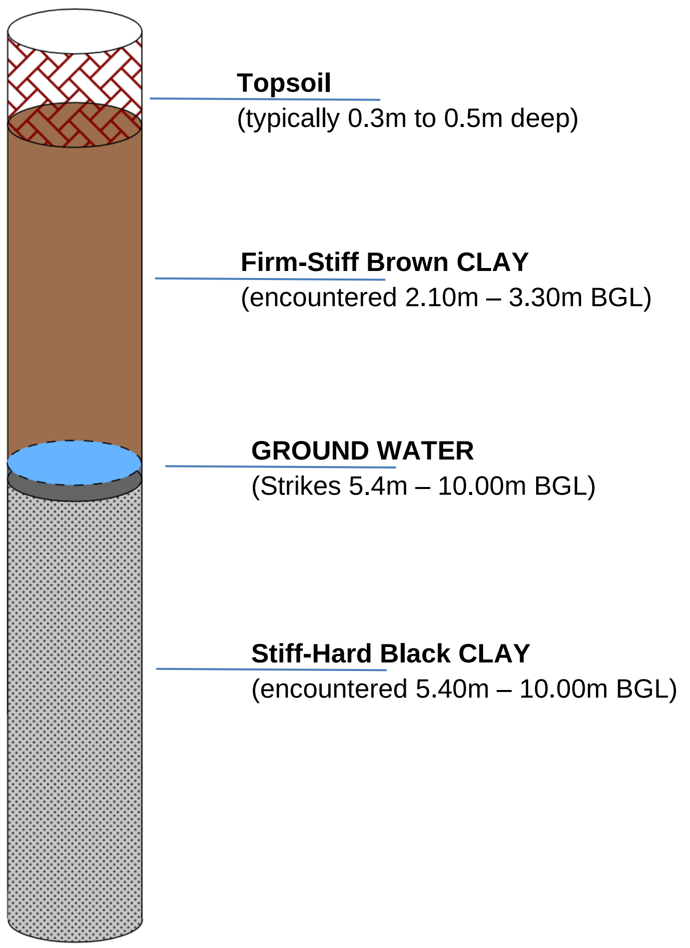


Figure 2-3: Ground Conditions

2.4 Ground Water Table

Groundwater strikes were noted in the borehole logs and were typically encountered between the brown and black Clay stratum. With regards to the basement waterproofing and consideration in accordance with BS8102:2009 – code of practice for the protection of below ground structures against water from the ground, the water table can be classified as category “low” in accordance with clause 5.1.3.

3. Structural Concept

The structural scheme has been arrived upon following the review of a number of design iterations and assessment of floor spans and structural zones.

The scheme presented here aims to:

- Provide a flush soffit (as much as possible), achieving optimal floor sandwich whilst maximising clear floor-to-floor heights.
- Provide a clear path for service routes (as much as possible)
- Minimise the number column transfers between the ground floor and basement layouts;
- Avoid ground floor transfer structures through the use of cross-walls acting as deep beams;
- Be capable of fast construction minimising on-site programme time;

3.1 Substructure

3.1.1 Foundations

From the anticipated soil conditions, it is expected that the structure will be supported on shallow foundations. This will comprise of reinforced concrete strip and pad footings between 600mm and 1000mm deep.

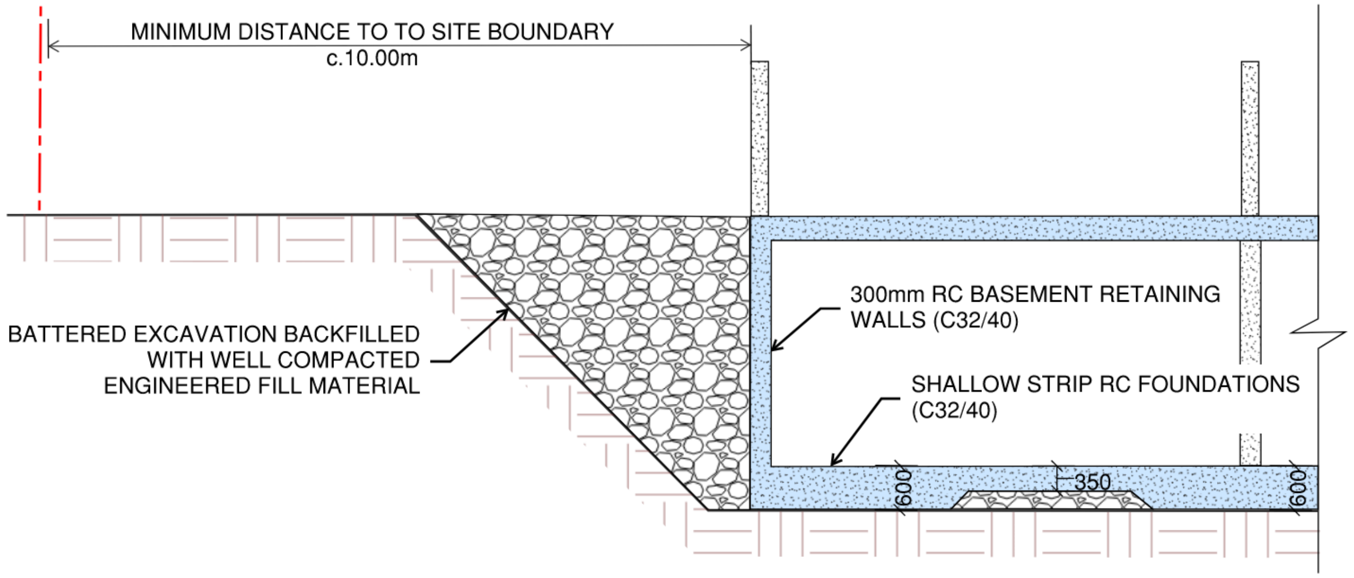


Figure 3-1: Typical Basement Section

3.1.2 Retaining Wall Structure

The undercroft and basement level will be formed in reinforced concrete. This will require a 300mm thick reinforced concrete retaining wall to uphold the site levels. The reduced level will be constructed using open-cut battered excavation, with the excavation back-fill using well compacted engineered fill material behind the formed retaining walls.

3.1.3 Ground Floor & Basement Slab

The ground bearing floor slabs at Basement Level and Ground Level are 350mm and 300mm thick reinforced concrete and suspended between the strip and pad footings. The slabs are formed on 50mm T3 Blinding with minimum 225mm T2 hardcore to SR:21 requirements.

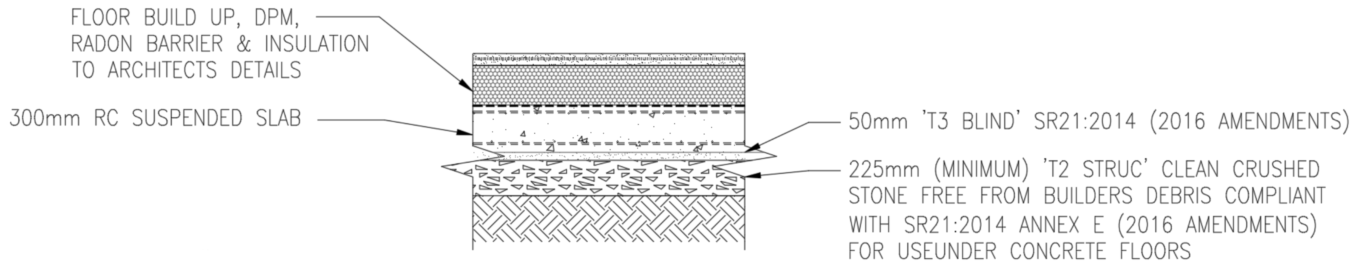


Figure 3-2: Typical Ground Bearing Slab Detail

3.1.4 Below Ground Waterproofing

Requirement and details for waterproofing to the below ground elements 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 habitable areas, core lobbies, electrical rooms and lift-pits, the basement waterproofing performance will need to be BS 8102:2009 Grade 3. 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 Dryteck is considered.

3.2 Super-Structure

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

	Structural Slab Depth	Framing Layout	Speed-of-Construction	Fire Resistance	Acoustic Performance	Vibration Performance
Hybrid Precast Wideslab & Crosswalls	225mm	Good	Good	Good	Good-Average	Good
In-situ Concrete Frame	250mm	Good	Poor	Good	Good	Good
Post-tensioned Concrete Frame	225mm	Good	Poor	Good	Good	Good
Steel Frame & Precast Concrete	225mm	Good	Good	Average[1]	Good-Average	Average
Masonry Walls & Precast Concrete[4]	275mm	Poor[4]	Poor	Good	Good-Average	Good
Timber CLT Slabs & Crosswalls[3]	n/a[3]	n/a[3]	Good	Poor[2]	Average-Poor	Average

1. Additional measures required (intumescent paint/fire boarding/etc))
2. Additional measures required (fire boarding/etc) & early engagement with the local Fire Officer
3. Spans are too great for CLT
4. Not suitable for taller residential buildings

It is proposed to use a hybrid precast concrete hollow-core floor slabs with reinforced concrete cross-walls for the superstructure. The structural solution provides economy of design and speed of construction, whilst achieving the Architectural aspirations for minimum transfer structures at Ground Floor.

A hybrid precast concrete and in-situ cross-wall construction has a number of benefits over a conventional concrete frame approach:

- High strength to weight ratio
- Greater opportunity for off-site prefabrication
- Higher quality of finish due to off-site construction
- Less requirement for temporary works and back-propping slabs
- Less formwork and shuttering on site
- Faster construction time on site (early stage first-fix MEP)
- Longer achievable floor spans for shallow floor zone

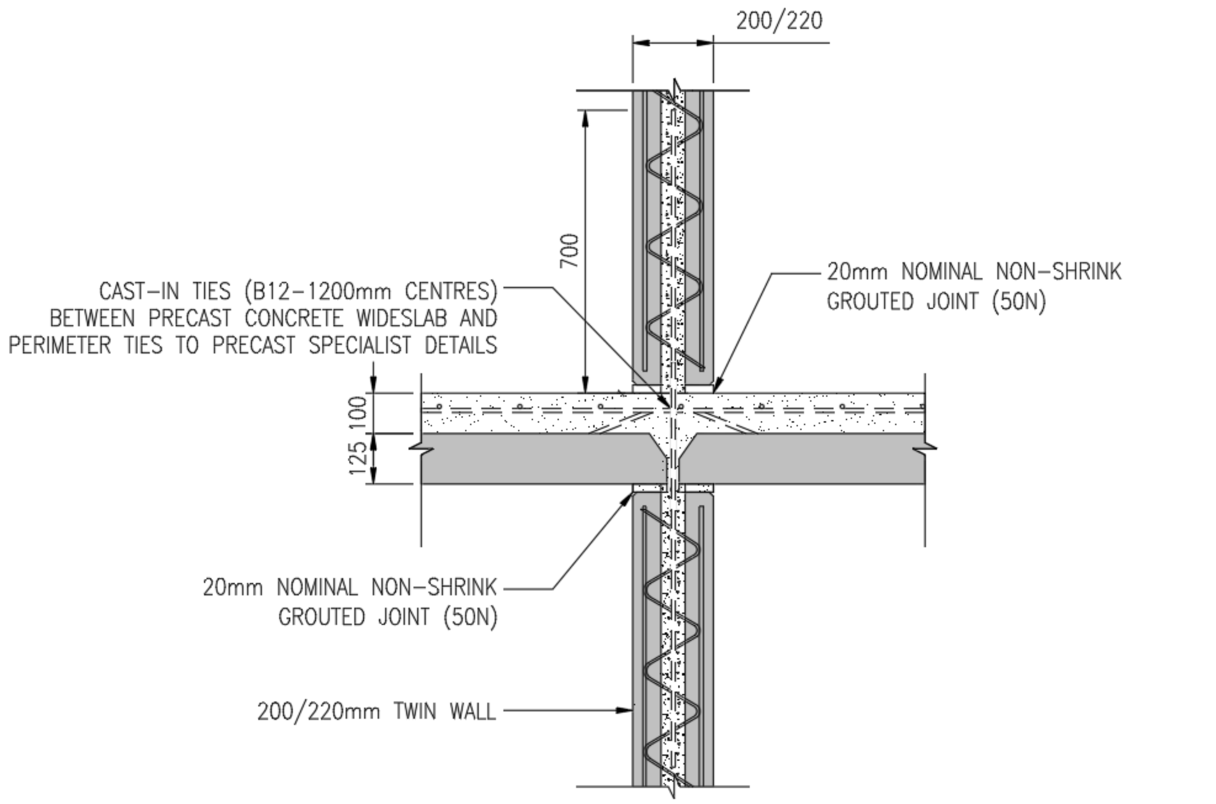


Figure 3-3: Typical Superstructure Slab to Wall Detail

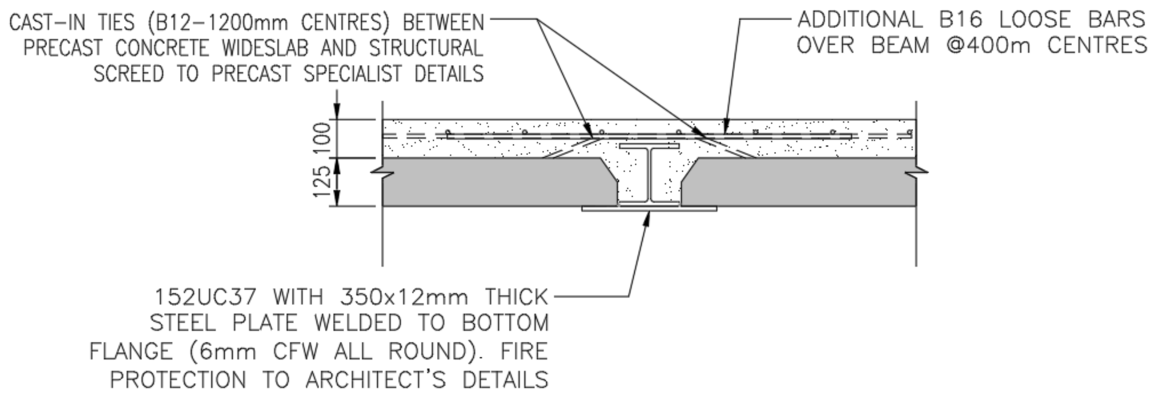


Figure 3-4: Typical Superstructure Slab Detail

4. Sustainability

The two main types of carbon impact associated with buildings and infrastructure comprises embodied carbon, which is associated with the locked-up carbon in construction materials, and operational carbon which results from the running of the building's heat, energy and services.

4.1 Embodied Carbon

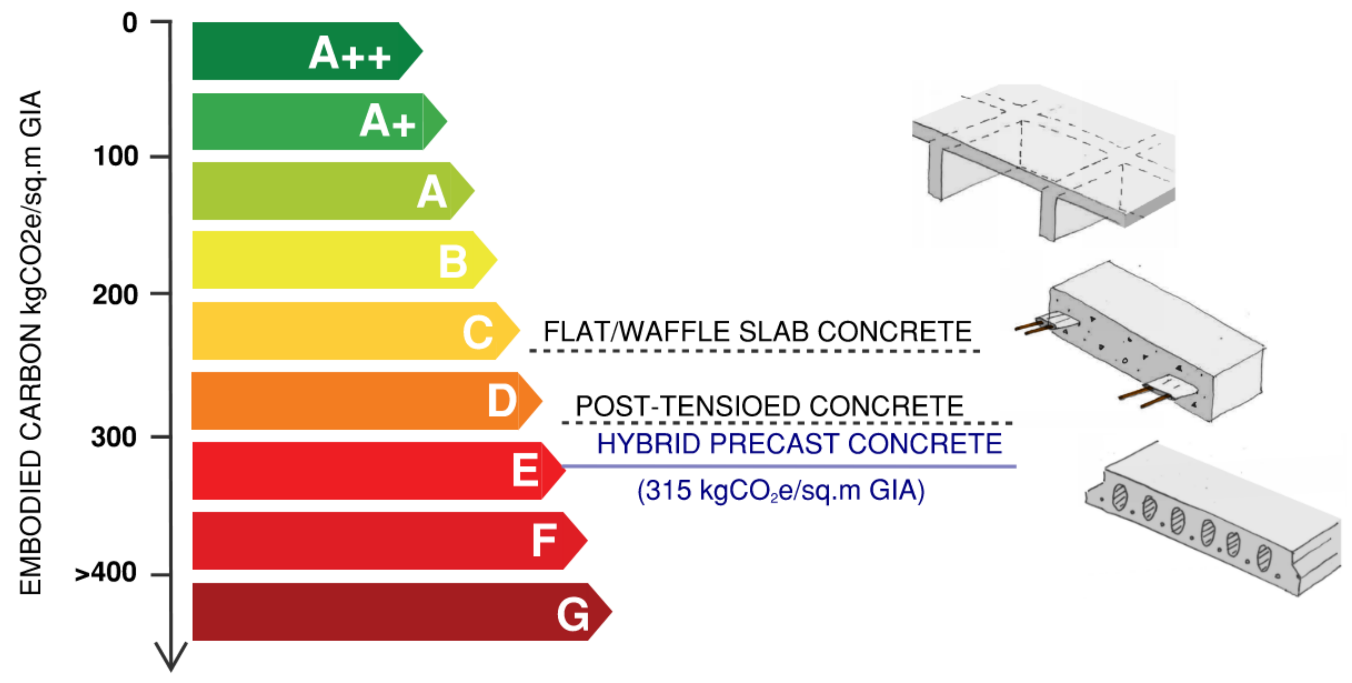
Waterman-Moylan are committed to minimising the embodied carbon in buildings and raising awareness of the impact design decisions have on the environment. Our design process has adopted the following measures in order to reduce embodied carbon in construction:

- Minimising materials used in construction (efficient sizing of all structural members).
- Avoid transfer structures where possible and if used maximise their efficiencies within the structure.
- Develop opportunities for off-site prefabrication/construction to minimise material wastage.
- Consider low carbon material substitutes (GGBS, PFA, etc) replacing carbon intensive materials.
- Seek to repurpose and refurbish existing buildings and/or re-use existing structural elements (existing foundations, etc).
- Consider the performance of the structure in conjunction with other disciplines (thermal mass, waterproofing performance, etc).
- Considering buildability, installation requirements and follow-on trades to avoid complex details that slows construction and escalates costs.

4.2 Preliminary Embodied Carbon Assessment

Over the Planning Stage, we undertook an initial carbon assessment of the proposed building structure in order to assess the structural scheme against alternative materials. We have developed a simple carbon assessment tool that calculates the carbon of the principle structural materials (steel, concrete, timber, etc) through stages A1-A5 of the BS EN 15978.

MATERIAL	EC (kg/CO_2e/m^2)	% Used
Precast Hollowcore	55	17.5
Screed (C30/37)	24	7.6
In-situ Concrete (C32/40)	120	38.1
Reinforcement	106	33.6
Steelwork	10	3.2
TOTAL	**315**	**100**



Embodied Carbon SCORE Rating Scheme (IStructE 2020)

The proposed structural scheme has a higher embodied carbon in comparison to alternative materials. This is primarily due to the carbon intensive production of precast concrete elements and the reluctance by precast manufacturers to use cement replacements (GGBS, PFA, etc).

In-leu of the above, the following measures may be incorporated into the design over the next Stage to reduce the embodied carbon of the proposed structural scheme:

1. Further rationalise the transfer structures at Ground Floor and at 6th Floor.
2. Incorporate cement replacement GGBS (up to 50% by volume) within the structural screeds, mass concrete, foundations and ground floor slabs.
3. Consider an exposed structure where possible in-leu of architectural finishes.
4. Consider designing the structural elements for a longer design life of 75 years.
5. Optimise the thermal mass of the building's concrete elements for a reduced M&E operational demand.

5. Fire Protection of the Structure

It is currently understood that a 90-minute fire protection will be required generally for the structure, with 120 minutes required for certain core and escape routes, 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 "notional loads" as defined in British Standards. Notional 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

A <u>Typical Bedroom Floor</u>

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 A1)	3.0 kN/m^2

[Including 1.5kN/m^2 partitions with finishes]

B <u>Typical Ground Floor Commercial</u>

350 normal weight slab	8.75 kN/m^2
Raised floor	0.35 kN/m^2
90mm Screed (2000kg/m^3)	1.80 kN/m^2
Floor insulation	0.05 kN/m^2
Ceiling &services	0.45 kN/m^2
	11.40 kN/m^2
imposed load	5 kN/m^2

D <u>Roof Areas</u>

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 <u>Corridor / Lobby Areas</u>

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

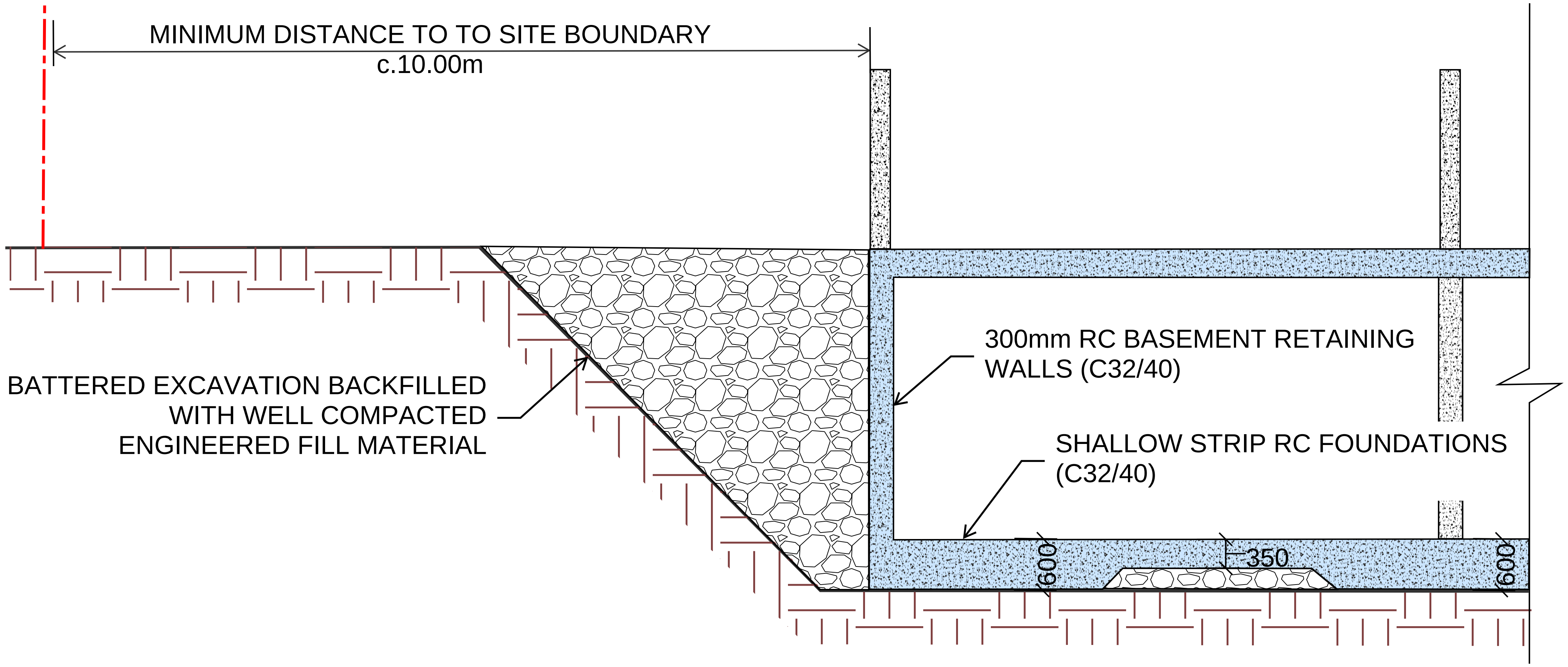
F <u>Disproportionate Collapse</u>

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.

APPENDIX

A. Waterman-Moylan Drawings



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STATUS
PRELIMINARY

CLIENT ARCHITECT	TITLE Basement Section			
PROJECT Fosterstown North	DRWN.	DESIGNED	APPROVED	DATE
	SCALE NTS	JOB NO. 17-062	DRG. NO. B01-WM-ZZ-ZZ-SK-S-004	REVISION

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