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1 Introduction

Price and Myers have been asked by Colwyn Foulkes and Partners on behalf of our Client to consider the structural issues surrounding the proposed development at 3 Palace Green.

The proposed structural works include demolition of the existing superstructure and subterranean structure. Consequently construction of a new three storey building will replace the demolished superstructure and will also include a double storey subterranean structure beneath the footprint of the proposed structure. The new development will cover a larger footprint than the existing building.

The report should be read in conjunction with the Price and Myers Structural drawings which can be found in the Appendix of this report.

2 The Site

2.1 Existing Site

The site is located in the Royal Borough of Kensington and Chelsea, approximately 350 m to the northeast of High Street Kensington London Underground station on the southern part of Kensington Palace Gardens, known as Palace Green. It is bounded by Palace Green to the east, an access road for No 2A Palace Green to the north and adjoining properties, comprising No 2A Palace Green and the Israeli Embassy (No 2) to the west and south respectively.

The site is irregular in shape, measuring approximately 40 m by 30 m and is already occupied by a two storey brick building with a single level basement which occupies a level area on the western part of the site. A front driveway and stepped patio / garden area fronts onto Palace Green and a side driveway is on the northern part of the site. The ground level slopes down towards the south, along the line of Palace Green at a very low angle, such that northern part of the site is approximately 1.0 m higher than the central and southern part of the site. Numerous mature and semi-mature trees of mixed deciduous and coniferous species are present within the small garden area on the northeastern part of the site, whilst a number of mature London plane or poplar trees are present adjacent to the northern boundary.

2.2 Existing building

The property at 3 Palace Green is atypical of those on the remainder of the street. It was extensively remodelled in the 1970s which has irreversibly changed the original building and removed most of the original fabric.

Our experience of other buildings in the area suggests that the building is likely to be of traditional construction, with load-bearing external solid brickwork walls and internal brickwork / studwork walls supporting the floor structures. There is also possibly some filler-joint construction as well as modern steel framing introduced as part of the works in the 1970s. The basement walls are likely to be solid masonry retaining walls, although this has not been confirmed.

The overall stability of the building is provided by the cellular arrangement of the masonry walls and diaphragm action of the timber floors at each level.

2.3 Existing Utilities and Underground Services

Complete information is not available at the time of writing on existing sewers, drainage runs, gas or electricity services within the site, and a CCTV survey will need to be carried out.

Experience from other properties on the street suggests that there are simple, direct connections to services running in Palace Green, which can hopefully be reused as much as possible to minimise disruption.

3 Ground Conditions

An extract from the British Geological Survey Map for the area indicates that the site is in an area between the Lynch Hill Gravel and Taplow Gravel Formations, underlain by London Clay.
3.1 Site Investigation

Geotechnical Environmental Associates (GEA) undertook a detailed site specific ground investigation of the ground conditions and produced a report which can be found in Appendix E. The figure below indicates the approximate location of the boreholes undertaken during their investigation. The investigation confirmed the expected profile in figure 3.

3.1.1 Made Ground

Beneath the existing areas of hard surfacing, comprising tarmac, brick and paving slabs, made ground was encountered to depths of between 0.80 m (17.10 m OD) and 1.50 m (17.25 m OD) and comprised a mixture yellowish brown sand and brown silty sandy clay with variable amounts of brick, whilst on the northern part of the site the made ground typically comprised brick rubble with reddish brown silty clayey sand and gravel.

3.1.2 London Clay

The underlying London Clay comprised an upper re-worked layer of firm brown to brownish grey mottled orange-brown and bluish grey silty clay, with occasional partings of sand and fine gravel and rootlets and was found to extend to depths of between 3.0 m (15.4 m OD) and 5.2 m (12.8 m OD).

Underlying these upper layers was firm becoming stiff fissured brownish grey becoming dark grey silty clay, which was proved to the full depth of the investigation.

Claystone fragments were encountered at a depth of 5.70 m (13.05 m OD). The London Clay was found to be desiccated in the vicinity of trees to a maximum depth of 3.50 m (15.25 m OD). One borehole in particular was located close to a large London Plane tree on the adjoining site and root fragments were encountered to a depth of 3.2 m at this location.

The results of laboratory testing indicated the clay to be of high volume change potential.

3.1.3 Soil Contamination

No visual or olfactory evidence of contamination was observed in either the Made Ground or London Clay stratum.

3.1.4 Ground Water

Groundwater was not encountered during the investigation. Groundwater monitoring standpipes were installed to a depth of 6.0 m and have been monitored on a single occasion to date, approximately three weeks after installation. The groundwater was recorded at a depth of 3.10 m (14.90 m OD) in Borehole No 1, at 4.52 m (14.28 m OD) in Borehole No 2 and 3.70 m (15.05 m OD) in Borehole No 3. The monitoring results generally indicate a groundwater flow direction towards the west. The EA Flood Maps do not indicate any risk of flooding as shown in Figure 5 below.
Review of the London Bomb Damage Maps as well as the fact that there were extensive works in the 1970s indicate that there is a very low risk of unexploded ordnance on this site.

4.2 Substructure

The proposed development involves the construction of a new three storey house with a double storey basement under the full footprint of the new house, and extending partly under the front driveway.

As the proposals include demolition of the existing building the new construction will not require underpinning of any existing structures to form the new basement, however the sequencing will need to take into account the presence of the existing basement walls. The new basement has been designed so that the retaining structure can be easily installed within the property boundary, i.e. there will not be any need to underpin any party wall structures. Typically, the retaining structure to the basement and sub-basement is to be a secant piled wall, which is installed around 900-1000mm inside the property boundary, which will be propped at ground floor level and basement floor level by the new floor slabs. However, at sub-basement level there is an area that steps in from the line of the secant piled wall, these walls will therefore be standard reinforced concrete retaining walls. Internally, elements such as the reinforced concrete columns, car stacker, swimming pool and RC retaining wall will be supported off piles to limit deflections.

4.2.1 Basement secant pile wall construction

The basement retaining walls would be constructed using secant piles to create an intersection between one pile with another to create a water tight internal structure. The water table was found to be at a depth of 3.5m below ground level therefore it is very likely that ground water would be encountered during construction therefore a secant pile wall would be the preferred construction option. The usual practice is to construct alternative piles along the line of the wall leaving a clear space of a little under the diameter of the required intermediate piles. The piles would be drilled using a cased CFA piling system or similar approved by the Structural Engineer. The casing generally ensures verticality. The exact spacing of the piles is determined by the construction tolerances which can be achieved. Refer to the photograph below indicating secant piled wall construction.
4.2.2 Basement Waterproofing Strategy

The basement has been designed to a minimum of Class 3 to BS 8102 and so Type C construction, or drained cavity, will be used (see following table for an extract of the Standard). The basement walls will be lined with a reinforced concrete wall to give a flat working surface and take up the pile tolerances. The drained cavity protection is provided inside this line.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Example of use of structure</th>
<th>Performance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Car parking; plant rooms (excluding electrical equipment); workshops</td>
<td>Some seepage and damp areas tolerable, dependent on the intended use&lt;sup&gt;10&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local drainage might be necessary to deal with seepage</td>
</tr>
<tr>
<td>2</td>
<td>Plant rooms and workshops requiring a drier environment (than Grade 1); storage areas</td>
<td>No water penetration acceptable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Damp areas tolerable; ventilation might be required</td>
</tr>
<tr>
<td>3</td>
<td>Ventilated residential and commercial areas, including offices, restaurants etc, with relative humidity maintained below the intended level</td>
<td>No water penetration acceptable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ventilation, dehumidification or air conditioning</td>
</tr>
</tbody>
</table>

Table 1 - Grades of waterproofing protection within a basement (extract taken from BS 8102)

The drained cavity protection, which would be designed by others, will be sited in a cavity provided by non-load-bearing block walls around the full basement perimeter and a traditional raised screed across the lowest floor. A pump would remove any small amounts of water that leak through the primary wall into the cavity.

4.3 Disproportionate Collapse

The new property will have a three storey superstructure and a double storey basement, which means that the house will have a total of five storeys. The new house will therefore be defined as Class 2A and will be designed to satisfy these requirements.

4.4 Party Wall Matters

The proposed development falls within the scope of the Party Wall etc Act 1996. Procedures under the Act will be dealt with in full by The Employer’s Party Wall Surveyor. The Party Wall Surveyor will prepare and serve necessary Notices under the provisions of the Act and agree Party Wall Awards in the event of disputes. The Contractor will be required to provide The Party Wall Surveyor with appropriate drawings, Method Statements and other relevant information covering the works that are notifiable under the Act. The resolution of matter under the Act and provision of the Party Wall Awards will protect the interests of all owners.

5 Sequence of Construction

All of the works, particularly the sub-structure, are to be carried out in a manner which minimises any noise and vibration that may affect the neighbouring properties. The engineer will make regular site visits during the construction.

Outline construction sequence and temporary works assumed in the design as described below will be superseded by the Contractor’s proposals. The Contractor will be required to submit full proposals, method statements and calculations to the engineer for review prior to the start of any works on site.

The Contractor will be responsible for the design, erection and maintenance of all temporary works in accordance with all relevant British Standards. The Contractor is to provide adequate temporary works and supervision to ensure that the stability of the existing structure, excavations and surrounding structures are maintained at all times.
5.1 Preliminary Assumed Sequence of Construction

In completing the preliminary structural design we have assumed the sequence below. The overall strategy for the construction sequence is that the main substructure works for the construction of the new basement should be undertaken first followed by the superstructure works to the building above. Temporary works will be installed to support the building above while the superstructure works are being completed. A ‘top down’ construction sequence has been assumed at this stage.

The following stages should be read in conjunction with Price and Myers ‘Basement Construction Sequence’ which is included in Appendix B of this report.

5.1.1 Stage 1: Site Set Up

Erect a fully enclosed site hoarding (painted plywood or similar) to the whole of the site at 3 Palace Green. All works are to take place within the hoarded zone. Any vulnerable services within the site and footpath should be identified and isolated if required.

5.1.2 Stage 2: Preliminary Works and Enabling Works for Piling

Provide temporary props to the existing single storey basement prior to demolishing the superstructure (particularly the ground floor slab, as this could be propping the top of the retaining walls). Demolish the upper levels of the existing superstructure to allow full access for a piling rig. Agree the principles for the removal of spoil from the site, for example a conveyor to transport the soil to a skip within the hoarded zone.

5.1.3 Stage 3: Backfill Existing Basement

Once the existing superstructure has been demolished, the existing basement is to be backfilled to the formation level of the new ground floor slab to provide a piling platform. Alternatively, the existing ground floor slab may be retained and propped sufficiently to allow this to be used as the piling platform.

Figure 8 - Prop existing basement walls and demolish superstructure

Figure 9 - Backfill existing single storey basement
5.1.4 Stage 4: Installation of Secant Piled Wall and Internal Piles

Refer to the preliminary design calculations in Appendix C for the design of the piles. Set up piling rig outside of basement footprint and construct the secant piled wall. The existing temporary propped masonry retaining walls would act as a guide wall for the secant piles to ensure the piles are within design tolerance.

Construct alternative piles along the line of the wall leaving a clear space of a little under the diameter of the required intermediate piles. The exact spacing is determined by the construction tolerances which can be achieved. These initially placed piles do not have to be constructed to the same depth as the intermediate piles which follow, depending on the way in which the wall has been designed and reinforced. This design would be subject to a Structural Engineer.

Once the secant piled wall construction is complete, the piles that are required internally may be installed, these will be in pile groups that are to be indicated on the Structural Engineer’s pile/foundation layout. Internal piles are typically required beneath the columns to support the axial loads from the frame, and also to support the sub-basement floor slab.

5.1.5 Stage 5: Cast Capping Beam and Ground Floor Slab

Once the secant pile wall has been constructed, cast the pile capping beam to restrain the top of the piles. Once the capping beam has been cast, the reinforced concrete suspended ground floor slab would be cast and tied into the pile capping beam. The new slab will be cast on the ground. This ground floor slab would act as a permanent prop to the basement secant piled wall. The ground floor slab would be cast with the voids required for areas such as the car stacker and the stairs, as these will be used for access to the ground beneath the slab, meaning that the fill can be excavated from above and structure can be installed.

Figure 10 - Pile new basement perimeter walls

Figure 11 - Cast pile capping beam and ground floor slab
5.1.6  **Stage 6: Excavation of the Proposed Basement**

Excavate the fill beneath the ground floor slab, this includes demolishing and excavating the existing single storey basement, down to basement floor level. Demolish the existing basement and allow for propping of the piles during demolition and excavation of the soil within the footprint of the secant piled wall. Once the ground beneath the slab has been excavated down to basement floor slab formation level, temporary propping must be installed before continuing with the excavation. When the propping has been installed the ground can continue to be excavated down to the sub-basement formation level.

![Figure 12 - Excavate the ground beneath the ground floor slab](image)

5.1.7  **Stage 7: Construction of New Sub Basement Slab and Retaining Wall**

The sub-basement floor slab would probably overlay CellCore heave protection to reduce the heave effects of the London Clay once the excavated soil has been removed. The slab would most likely have to span across this material, therefore in order to minimise slab deflections, the slab would be suspended and supported off the piles that have been cast into the ground, to support the basement slab at various locations to limit the total span. This would also minimise the depth of the basement floor slab to an acceptable thickness. Refer to the preliminary design calculations for the design of the sub-basement floor slab.

The sub-basement reinforced concrete slab would be constructed and tied into the secant piled wall to provide a permanent lateral prop. The slab would be designed as a support to the piles to accommodate the lateral pressure from the soil and water forces behind. Also at the sub-basement level there is an area where the sub-basement perimeter steps in from the main secant wall, this means that a reinforced concrete wall is required to support the backfill. Therefore, once the sub-basement slab has been cast, the retaining wall will also be constructed. Once this has been cast, temporary propping is to be provided to the top of the retaining wall, and the area behind may be backfilled as required.

![Figure 133 - Cast new sub-basement floor slab and retaining wall](image)
5.1.8 Stage 8: Construction of Basement Slab and Lining Wall

The reinforced concrete suspended floor slab at basement floor level would be cast once the sub-basement structure has been completed. This slab would be tied into the secant piled wall, as well as the reinforced concrete retaining wall to provide a permanent lateral prop to the top of the retaining wall and to the mid-span of the secant piled wall. The lining wall would also be cast, and tied to the secant wall behind to provide a vertically level wall surface. This wall would provide a flat vertical surface and can be designed to either act independently to the pile wall and only resist axial forces or act combined with the pile wall to share the lateral forces applied.

5.1.9 Stage 9: Construction of New Building Above Basement

Once the basement has been built, construct the new 3 storey building above. The pile capping beam and reinforced concrete floor slabs would be designed by the Structural Engineer to support the expected axial loading of the concrete frame above.

5.2 Construction Generally

Some of the issues that affect the sequence of works on this project are:

- The stability of adjacent buildings
- Forming sensible access onto the site to minimise disruption to the neighbouring residents
- Heave issues from the London Clay
- Providing safe working environment
- Sustainability

Generally the scale of the works is such that relatively straightforward methods can be used for the piling of the new basement retaining walls. Having said this, the undertaking of such projects in proximity to existing buildings is specialist works and the Structural Engineer will be involved in the selection of an appropriate Contractor who will need the relevant expertise and experience for this type of project.

5.3 Noise and Vibration

The Contractor shall undertake the works in such a way as to minimise noise, dust and vibration when working close to adjacent buildings in order to protect the amenities of the nearby occupiers. The demolishment of existing structure shall be carried out where possible to minimise vibration to the adjacent properties and associated construction noise. All demolitions and excavations will be undertaken in a carefully controlled sequence, taking into account the requirement to minimise vibration and noise.

5.3.1 Monitoring Building Movement

During the construction of the basement, monitoring points can be set up to record any variable movements between properties. By using a system of targets, monitored and logged at regular intervals, any differential movements can be identified and the construction method and sequence altered accordingly to limit movements.

5.3.2 Monitoring Ground Water Levels

The water table is expected to be encountered during the construction of this basement at a depth of approximately 3.5m however, secant piles will be used to construct the basement walls to create a water tight structure.

5.4 Impact on Local Environment

Although the existing structure is to be demolished, the new structure will be designed and built with detailed consideration to the impact of the local environment. The external landscaping would be designed sufficiently to allow there to be little change to surface water flows. Similarly we would expect there to be little effect on the on local flora. There are no trees immediately adjacent to the property to be impacted upon other than what has been noted on the Architect’s drawings.

5.5 Impact on Adjoining Buildings and Structures

A secant piled wall will serve as the new double storey basement perimeter wall. These piles will be used to deepen the existing basement foundations where appropriate to allow the basement construction. The proposed method and sequence of works is set out on page 6. We would expect there to be very little impact on adjacent structures and buildings as a result of these works as there are no adjoining structures.
Using the Burland Category as described in CIRIA CS80 we would expect damage to adjoining structures and buildings to be limited to Category 1 - Very Slight < 1mm. The piles and excavations will remain propped until the permanent secant wall retaining structure is in place. Therefore we expect no ground stability issues. From records of neighbouring site investigations, the existing and adjoining buildings are all founded in similar ground conditions, that being London Clay. We would therefore not expect issues to arise form differential movement of seasonal movement of the foundations.

6 Sustainability

6.1 Materials

6.1.1 Reinforced concrete

Concrete in a typical commercial building can contribute up to 45% of the total environmental impact of the structure and about 50% of this is due to the cement content of the concrete. To produce 1 tonne of traditional Portland cement approximately 1.6 tonnes of quarry materials are used and around 1 tonne of CO2 produced. In contrast, however, nearly all reinforcement used in the UK comes from a recycled source.

There are two things that can be done to reduce the environmental impact of concrete as a material: the use of recycled or secondary aggregates, and the reduction of Portland cement usage.

6.1.2 Recycled or secondary aggregates

Recycled aggregates: derived from reprocessing materials previously used in construction. Examples include construction and demolition waste material and railway ballast. In the case of this building there is a chance that such material will be available from the demolition of the existing building, and our specifications will allow its use. Close and early coordination with the contractor will be required for this option, as they will need to allow sufficient space for storage.

Secondary aggregates; usually by-products of other industrial processes not previously used in construction. Examples include china clay waste, used foundry sand and metallurgical slags.

Some advantages associated with the use of recycled or secondary aggregates include:

- Reduction of waste to landfill from demolition of the existing building (space is available for stockpiling on site).
- Reduction in energy use.
- Reduction in emissions.
- Reduced drain in natural resources.

One of the major disadvantages with the use of recycled or secondary aggregates is associated with obtaining material, at least in the South East, with the majority of such material being used in road building.

There is also little precedent in the U.K. for the extensive use of recycled aggregates in new structures – any available material is usually used as road sub-base or coarse fill material – however the specification and testing required for its use is relatively straightforward. The use of recycled aggregates also relies on the cooperation of the contractor and concrete suppliers in terms of stockpiling and continuity of supply. Another factor to consider in the use of recycled or secondary aggregates, especially if exposed concrete soffits (to increase thermal mass) or other surfaces are going to be used, is the colour and finish that will be produced.

6.1.3 Reduction of Portland cement usage

In comparison to some of the difficulties that can be encountered in using recycled or secondary aggregates, the reduction of Portland cement is very straightforward and already quite common. In terms of CO2 production the impact of cement is much higher than that of the aggregate and incremental increases in efficiency of its use will generally have a greater effect on a building’s environmental impact than use of recycled or secondary aggregates. Portland cement replacements are already in common usage in the U.K. (typically in the range of 25-70%), mostly either fly ash (PFA) or ground granulated blast furnace slag (GGBS).

Fly ash: commonly called PFA or pulverised fuel ash, fly ash is a very fine ash by-product from coal-fired power stations that imparts many beneficial properties to concrete.

Ground granulated blast furnace slag: or GGBS is a by-product of the iron-making process and a very consistent material. A slow-setting cement in its own right which needs to be activated and accelerated by the addition of Portland cement, with or without lime. Concrete containing GGBS generally costs no more than the equivalent concrete produced with CEM I PC and costs less than concrete with sulphate resisting Portland cement. GGBS also gives a white/cream colour to the finished concrete that is often desirable when exposed concrete faces are used in a building.

The addition of GGBS provides the following environmental benefits:

- Alleviating the disposal of large amounts of blast furnace slag generated by coal burning power plants and steel mills.
- Helps reduce embodied energy consumption from Portland cement production. Approximately 40% of the embodied energy of concrete can be reduced.
- Reduce damaging pollutants including: CO2, NOX and SO2 and therefore reduce impact on climate change and acid rain.

BREEAM assessment also awards credits for using post-industrial wastes such as PFAs and GGBS under its materials specification criteria.

![Figure 15 - Advantage for using GGBS](image)

Modern plasticisers allow for a decreased cement content in concrete and specifications should allow its use so that the maximum practical amount of cementitious additions can be used. Replacing a percentage of the cement with ground granulated blast furnace slag (GGBS) or pulverised fuel ash (PFA) also produces a significantly less permeable concrete with improved resistance to aggressive conditions. BS 8500 recognises the value of GGBS and PFS in increasing the sulphate resistance of concrete and allows the use of those materials. In addition, these composite cements offer workability and strength
advantages through lower water content in the mix and a reduction in early age heat development. This helps to minimise the possibility of thermal cracking.

Our specification will dictate the use of GGBS in the concrete mixes to be adopted for the project.

### 6.1.4 Structural Steel

Steel construction products are highly recycled and are 100% recyclable using existing technologies; all new steel has a recycled content of between 10 and 100%. The fact that steel construction products can be recycled again and again without any degradation in terms of properties or performance is an important differentiator in construction product selection.

Current global demand for steel exceeds the supply of scrap, necessitating the production of new steel by the BF/BOS steel-making route. While this remains the case, and as construction steel is already nearly 100% recycled, there is no net environmental benefit in specifying a minimum recycled steel content.

For products like metals that are recyclable into new products with the same properties, the end-of-life recycling rate is the more important sustainability indicator and should be used in preference to the recycled content when assessing the credentials of construction materials.

### 6.2 Construction Practices

The primary consideration in terms of sustainability for construction practices on site is waste minimisation and disposal. Waste disposal costs building projects about 0.4% of the project cost and is set to double within the next 5 years.

The simplest and most effective way to reduce waste on site is through waste segregation which:

- Encourages the recycling of materials.
- Reduces landfill.
- Saves money.
- Makes sites safer.
- Obtains BREEAM credits.

Contractor’s experience where simple waste segregation has been adopted suggests that the amount of waste that needs to be disposed of in landfill is reduced by around 20%, which can equate to cost savings of around 40% on waste disposal.

Empirical evidence also suggests that sites with waste segregation also tend to have more careful storage and handling of materials, re-use of cut-offs and return of unused materials to stockpiles (rather than disposal). This in turn means reduced requirements to over-order and more efficient use of materials. Sites with waste segregation also tend to be cleaner, tidier, and hence safer sites.

It is relatively simple to ensure that waste strategy is included as a tender requirement, and to get waste segregation specified in the contract documents. For very little effort on the part of the contractor this simple.
# APPENDIX A - Design Parameters

## British Standards

<table>
<thead>
<tr>
<th>Loading</th>
<th>Standard</th>
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<tbody>
<tr>
<td>Part 1 (Dead &amp; Imposed Loads)</td>
<td>BS6399</td>
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<tr>
<td>Part 2 (Wind Loads)</td>
<td>BS8110</td>
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<td>Part 3 (Imposed Roof Loads)</td>
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<td>Concrete</td>
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</tr>
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<td>Foundations</td>
<td>BS8110</td>
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<tr>
<td>Steelwork</td>
<td>BS5950</td>
</tr>
</tbody>
</table>

## Building Regulations 2004


### Design Loadings

#### Imposed

- Residential, Internal: 1.50 kN/m²
- Basement plant/storage rooms: 4.00 kN/m²
- Construction access (temporary condition): 1.50 kN/m²

#### Dead

- Finishes incl. screed: 3.00 kN/m²
- Ceilings and services: 0.50 kN/m²

#### Wind

- Scheme design (detailed analysis required): 0.50 kN/m²
APPENDIX B - Preliminary Construction Works Sketches