APEX AIRSPACE

AIRSPACE DEVELOPMENT-
CONSTRUCTION METHODS
AND TECHNIQUES

BACKGROUND

The modern construction landscape is characterized by the adoption of innovative technologies, use of sustainable materials, and implementation of automated information systems. However, in comparison to other industries, construction as a sector has embraced innovation at a much slower pace. While innovation has taken its time to embed into industry practices; increasing urbanization, coupled with the environmental impact of traditional construction methods, make it imperative for breakthrough innovation to transform the construction industry dynamics to meet the rising demand.

Airspace Development-the creation of new homes in the ‘air-rights’ on top of existing buildings, by usually one or two additional storeys, is a promising solution to the growing housing crisis across the world, and Britain in particular. Airspace development carries with it the potential to cater to mismatch in supply and demand for homes, as urban densification continues to rise. The paradox lies in the increasing demand which makes construction imperative, and the environmental degradation that is a consequence of traditional construction practices.

Airspace Development utilizes Modern Methods of Construction (MMC), largely comprising off-site techniques that cause minimum disruption at site; use sustainable materials and cause less demolition and waste, while preserving existing buildings, communities and the environment.

Airspace Development, while is a promising solution to the housing crisis, comes with its set of challenges. Being at a nascent stage, this innovative construction methodology suffers from lack of industry expertise and publicly available knowledge, that can enable its mainstream adoption. Evaluation of the existing asset, its capabilities and structural integrity generates different and new construction challenges, where existing industry methods cannot be routinely adapted to provide a solution. Most projects require a different structural solution dependent on the building's existing height, structural composition, age, use (residential, commercial, hybrid combination), and adaptations that have taken place over time. Often times, challenges emerge after works have commenced, which might require substantial change in methodology being deployed, or abandoning work to start the process from scratch. In worst cases, the project might have to be discontinued if an optimum solution is not derived, or if the nature of work done and changes required make the project financially infeasible.

WORKING WITH DIFFERENT BUILDING TYPOLOGIES-A CASE STUDY ON APEX AIRSPACE

Apex Airspace, a pioneer in rooftop development, has executed multiple projects; while some have been successful, many were abandoned due to technical uncertainties for which no established solutions were available.

Understanding building typology and corresponding roof constraints present the biggest challenge for airspace development. Over the years, Apex has conducted R&D to understand different building typologies and innovative design solutions to address challenges specific to each

Apex has identified the following key topologies to cater for existing roof types and constraints:

Typology 1: Victorian Terraced Dwelling in Solely Residential Use
Typology 2: Victorian Terrace with Ground Floor Commercial Uses
Typology 3: Mansion Block
Typology 4: Inter-war Residential Block with Ground Floor Shopping Parade
Typology 5: Local Authority Estate Low-Rise and Mid-rise Blocks
Typology 6: Local Authority Estate Tower Blocks
Typology 7: Small Flatted Block with Single Core
Typology 8: Miscellaneous

Apex has executed number of projects, each with a unique set of structural considerations. Some projects were abandoned, due to structural challenges arising, for which Apex had no solution being a new player in the industry. Over years, Apex has and continues to conduct extensive R&D to discover optimum design solutions for different building types.

AIRSPACE DEVELOPMENT ON FLAT ROOF-DESIGN CONSIDERATIONS

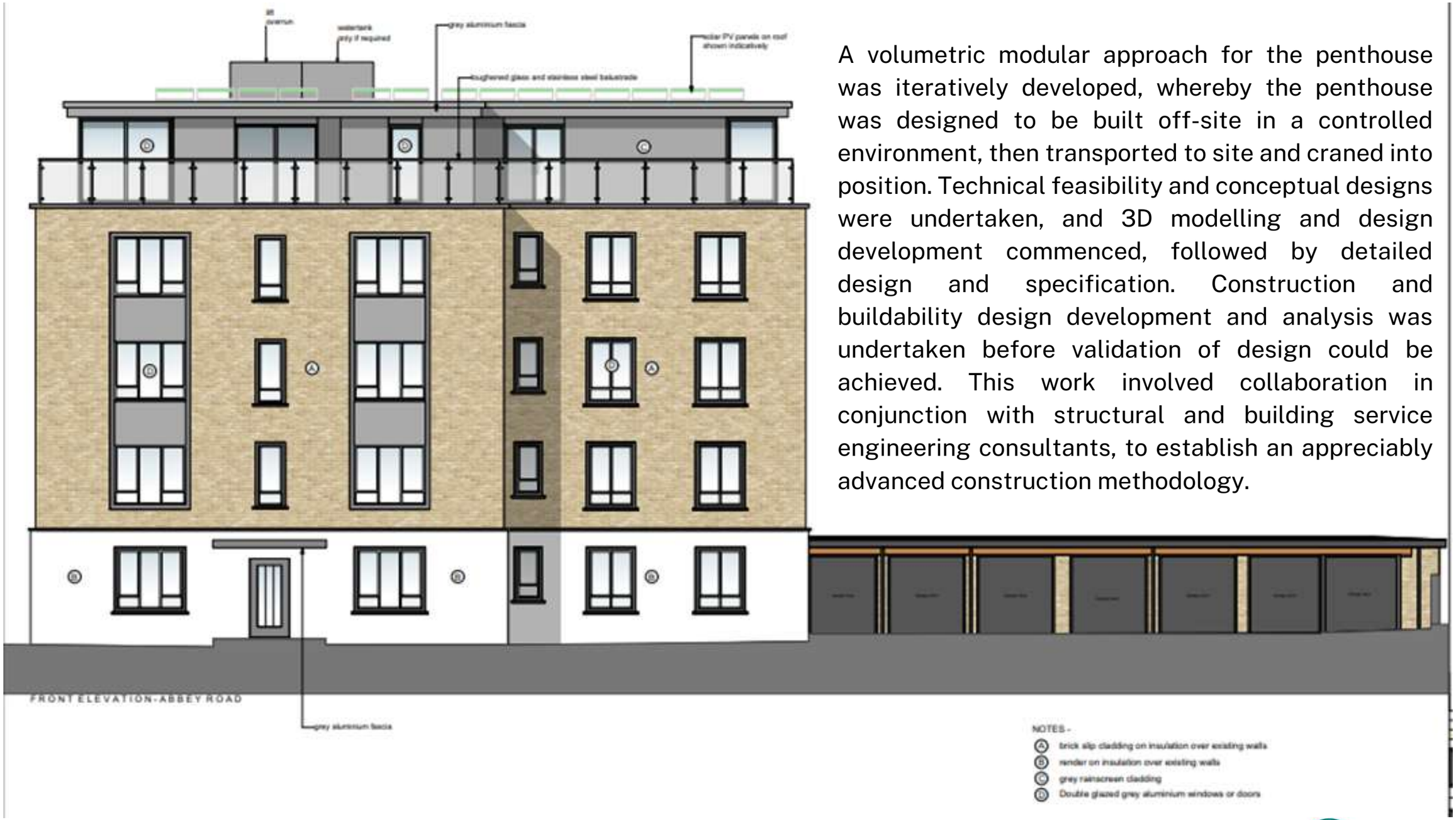
Flat roof presents an ideal platform for volumetric modular construction whereby building modules are manufactured in an off-site facility and assembled on-site, causing minimum disruption to residents and neighbors. This is an environmentally friendly construction technique that contributes towards sustainability, causing less demolition and waste, while preserving existing buildings, communities and the environment.

Apex has utilized volumetric modular construction in many of its projects; however, this technique cannot be replicated across different buildings in a similar manner. Not only will the technique vary from one roof type to another, but also for similar roof types, with other structural considerations. Few examples of Apex building on top of flat roof are discussed below:

145 ABBEY ROAD NW6- VOLUMETRIC OFFSITE CONSTRUCTION

145 Abbey Road NW6 Is located on the iconic and glamorous Abbey Road in Camden, connecting affluent St Johns Wood and Lord's Cricket Ground, to the busy and vibrant Camden town center. The site is within walking distance of underground stations West Hampstead and Kilburn High Road, with quick access to central London.

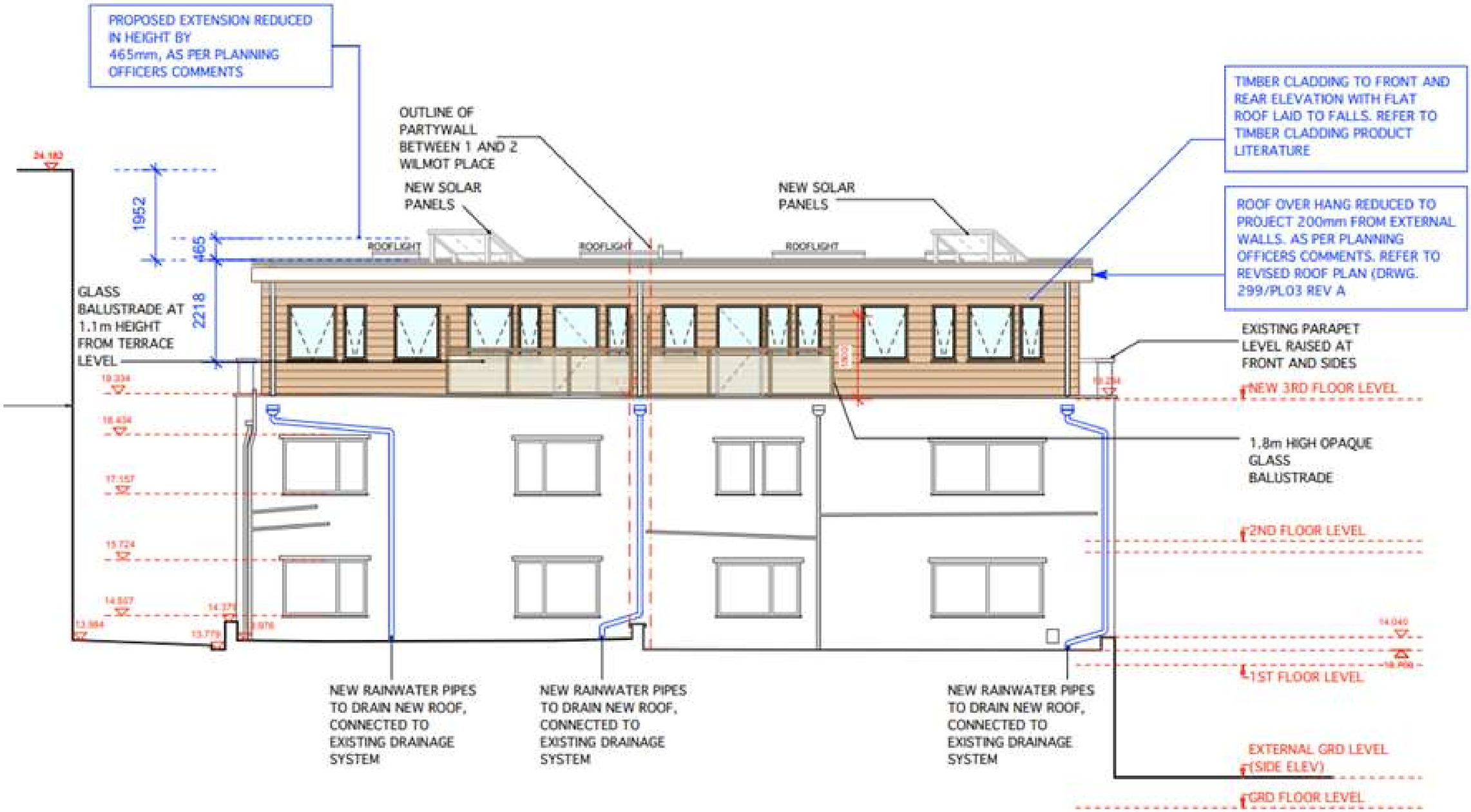
Apex sought a design solution to convert the site- a block of 7 flats, into a new luxury penthouse with a private spacious terrace area, with connecting lift services and external landscaping. Brick cladding and glass fenestration were used to provide aesthetic appeal to the site.Renovation works were also undertaken to upgrade the communal areas and external façade of the existing flats, to match the new modern apartment and affluent surrounding area. Both internal and external walls were constructed with thermal insulation, and double-glazed aluminum framed windows were installed at each floor, to improve energy efficiency of the building.



A volumetric modular approach for the penthouse was iteratively developed, whereby the penthouse was designed to be built off-site in a controlled environment, then transported to site and craned into position. Technical feasibility and conceptual designs were undertaken, and 3D modelling and design development commenced, followed by detailed design and specification. Construction and buildability design development and analysis was undertaken before validation of design could be achieved. This work involved collaboration in conjunction with structural and building service engineering consultants, to establish an appreciably advanced construction methodology.

1 WILMOT PLACE NW1 9JS-VOLUMETRIC OFFSITE CONSTRUCTION

This project proposed the erection of a recessed third floor to create 5 studio apartments at 1-2 Wilmot Place, London. A flat roof was designed with a fall, to facilitate drainage, and allow installation of solar panels, aiming to reduce energy consumption. A glass balustrade, made of tempered glass, was constructed at a height of 1.1m from the terrace to provide an unobstructed view of the surroundings while providing natural light and ventilation to the building. Volumetric offsite construction was used to build the units off-site and assembled on site, similar to Abbey Road project. A green roof, with photovoltaic cells installed, was built, adding thermal insulation to the building and reducing cooling load by up to 90%.



MARION COURT –ONSITE CONSTRUCTION USING LIGHT GAUGE STEEL ON FLAT ROOF WITH CHIMNEYS

In the above two projects, volumetric modular construction was effectively implemented; however, in later projects Apex had to face challenges whereby similar approach failed, and considerable variations were required, owing to site specific complications.

One such project was Marion Court, in which Apex designed a five-storey existing building for four penthouses. Following its portfolio of built airspace projects, Apex hypothesized that volumetric modular construction would work for this site as well. At the time of construction initiation, it was realized that volumetric modular technique could not be implemented due to the roof design; the chimneys did not allow for the designed modular units and required a change of scheme, which would raise the overall height of the building. Building around chimneys requires high accuracy in determining the chimney position in design, making off site construction ineffective. This also meant inhabitable spaces if extra spaces were to be left around the chimney as a precautionary measure. There was no readily available knowledge on how to successfully build on top of existing flat building around chimneys; this required significant research and development work to develop a solution.

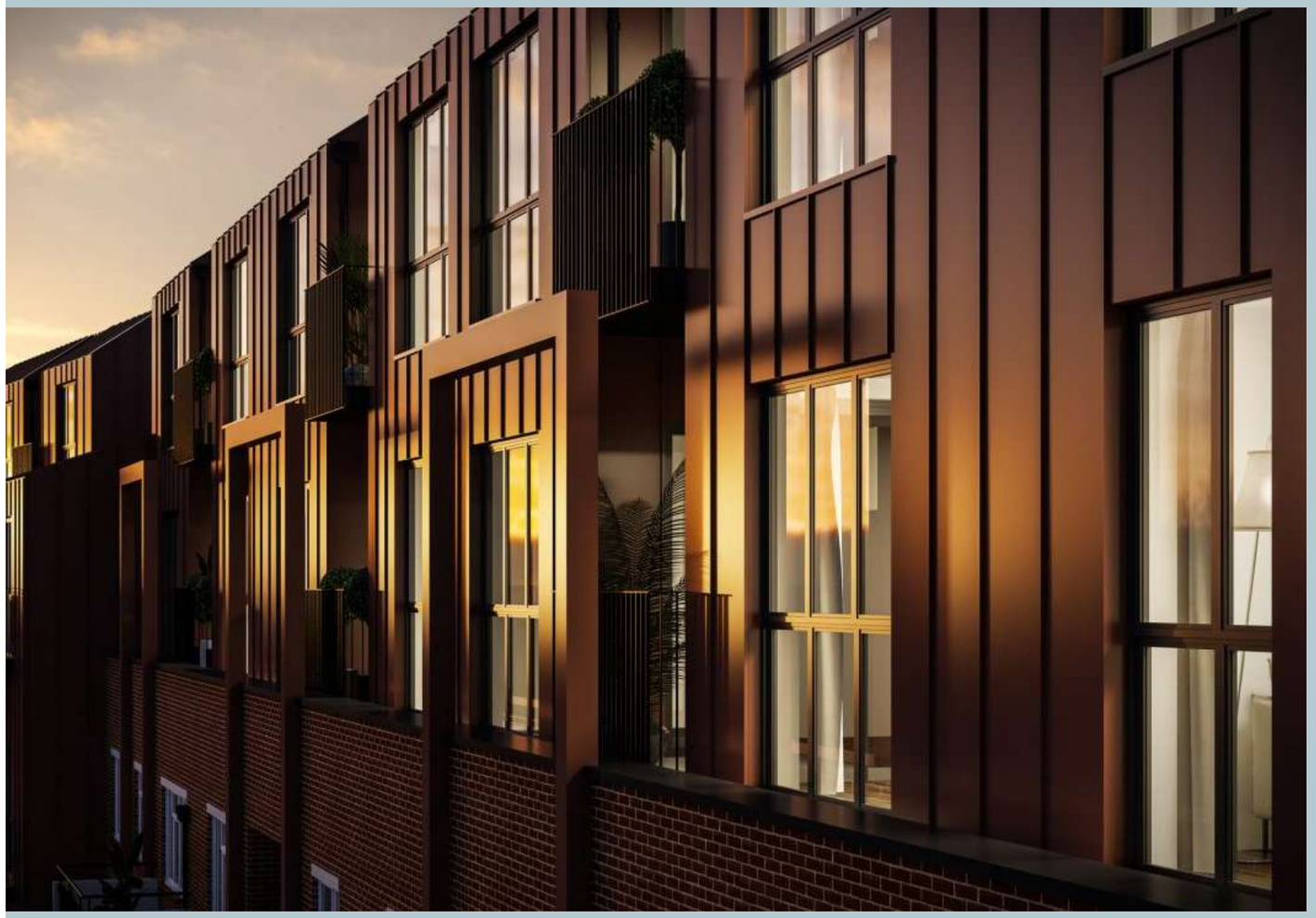
Iterative design work was necessary to develop a solution for the integration of chimneys on the roof of the building. This required a highly accurate design to make off-site construction more effective and avoid inhabitable spaces left around the chimney, a solution which had not been established in the past. Timber-based modules had to be discontinued as the use of light gauge steel (LGS) frame on structural steel frames was progressed, supported from the existing load bearing elements of the original building, with a portable on-site facility utilized to build and assemble steel frames produced using recycled materials. This approach was highly sustainable, with 85% of the steel used being recyclable, reducing waste up to 70%, and is up to 50% quicker to install. The floor height of the additional storey had to be raised due to the chimneys, increasing possibility of disproportionate collapse, and an improved design solution was determined, with the incorporation of LGS assisting with the floor height as well as weight distribution. This was also another aspect that has no publicly available experience and knowledge, with a solution developed during both the design and construction phases.

Prior to Marion Court, Apex faced similar challenges with another project Malcolm Way, where volumetric modular construction could not be implemented due to the roof design and existence of chimneys. At that time, significant cost was spent on design, but the project was aborted due to technical infeasibility. Similarly, iterative design was necessary on other projects including Wood Street to check their technical feasibility. Owing to the complex nature of building's structure and no previous work done on such typology, Wood Street was also aborted due to structural inability of the building to carry another floor on top.

AIRSPACE DEVELOPMENT ON PITCHED ROOF-DESIGN CONSIDERATIONS

A pitched roof, in simple words, is a roof that slopes downwards, typically in two parts, from a central ridge. Building on top of a flat roof can be considerably easier, provided other structural variables are constant. Attempting airspace development on pitched roof can be more challenging, especially if it requires removing the roof with occupants of the building in situ.

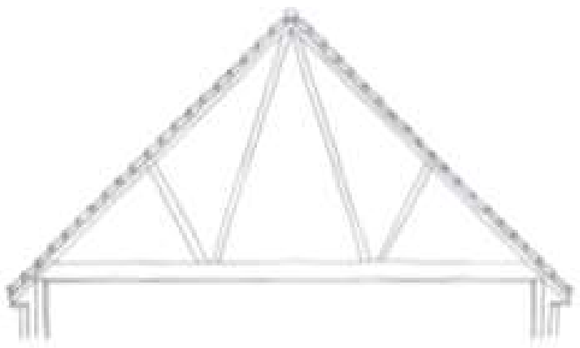
ANTONY & RODERICK HOUSE- VOLUMETRIC MODULAR OFFSITE CONSTRUCTION ON PITCHED ROOF



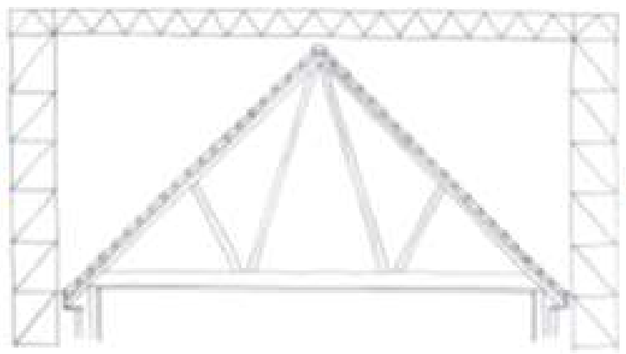
Apex sought a design solution for combining two existing occupied buildings in London using a central connecting core with lifts for access, and ‘bookends’ of maisonette apartments at either end. The requirement to maximize the number of new affordable tenure flats on the site led investigations into the use of the airspace above the existing two buildings to form a double- storey rooftop extension for 30 additional homes. All of the additional flats had to be provided for affordable use, with the aim to deliver enhancements across the public realm, including landscaping, lighting, residents lift, stairwell, with new communal entrance. It was also envisaged that the development could deliver a range of sustainability improvements resulting in lower energy bills for residents. To minimize disruption to existing residents and minimize time on site, Apex hypothesized that a modular construction could be adopted for the rooftop extension.

The methodology for removal of the pitched roof without relocating the residents presented a significant technological challenge, as this was not an industry standard approach and there was no publicly available information on how this could be done safely and efficiently. The development involved three elements: the removal of existing pitched roofs and provision of flats in the airspace above; the infill between structures forming new flats; and the bookend maisonette apartments at each end. This was a complex technical challenge involving multi-party workshops to establish a methodology to determine whether it was feasible to undertake the development and, if so, how could it be achieved.

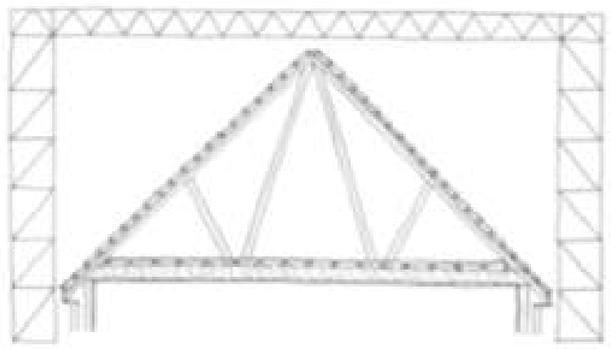
BUILDING OVER PITCHED ROOF - TYPICAL SEQUENCE OF WORKS



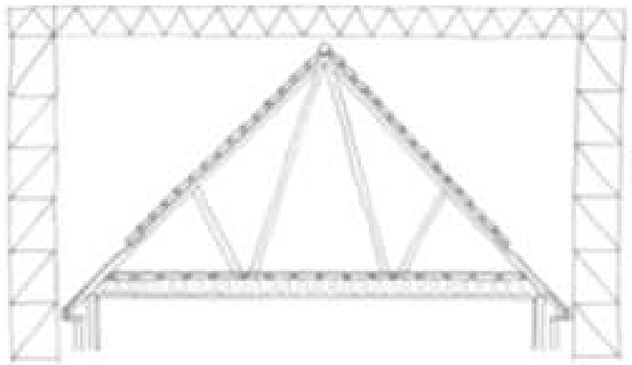
1. CONDITION SURVEY OF EXISTING FLATS



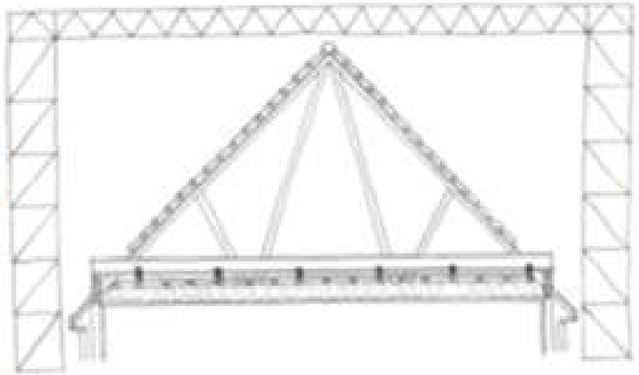
2. ERECT SCAFFOLD AND TEMPORARY ROOF



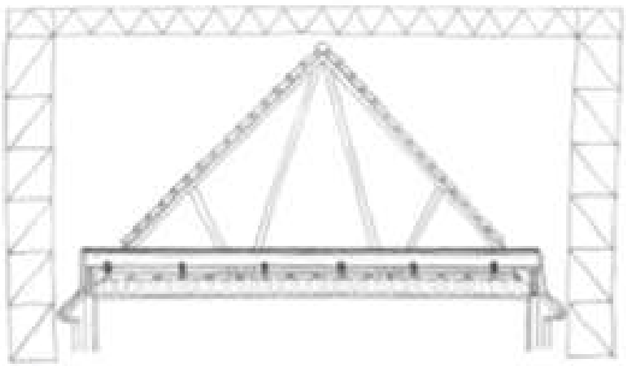
3. LAY CHIPBOARD AS TEMPORARY WORK PLATFORM AND INSUILATE UNDERNEATH



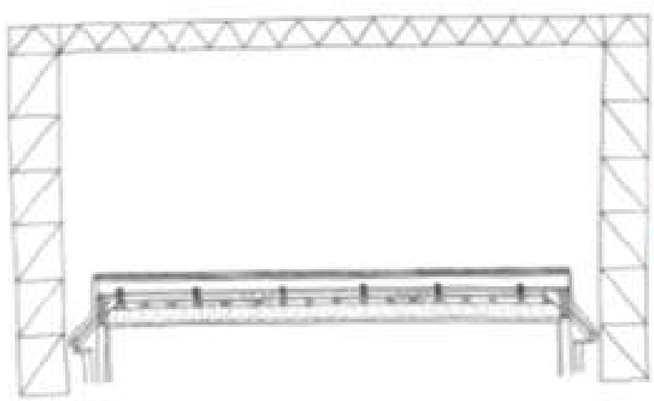
4. STRIP LOWER 4-5 COURSES OF TILES



5. EXTEND INNER WALL LEAF, INSERT STRUCTURAL MEMBERS ACROSS WIDTH OF ROOF AND FIX BRACKETS TO SUPPORT EXISTING CEILING

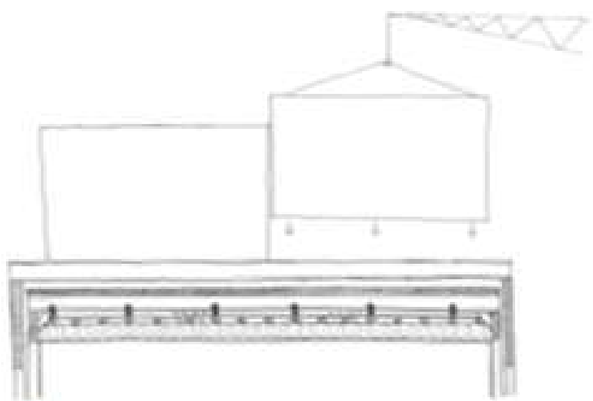


6. INSTALL NEW DECKING AND LAY NEW WATERPROOF MEMBRANE OVER



7. REMOVE EXISTING ROOF

8. EXTEND OUTER WALL LEAF, INSTALL STEEL GRILLAGE AND REMOVE TEMPORARY ROOF



9. INSTALL NEW MODULES

It was hypothesized that the removal of the pitched roofs could be achieved section by section, with temporary roof structures formed as the work progressed. However, following a structural assessment it was clear that the existing buildings could not bear the additional loadings associated with the additional dwellings. The solution involved iterative designs, involving the development of a steel frame exoskeleton over the existing buildings, comprising beams spanning over the building width, connecting to columns either side of the building that bear on to pile caps and piles in the foundations; this design development involved ‘opening up’ investigations (trial pits and holes into walls and making good). As a result of this project, Apex created a solution where all of the additional 30 homes were built utilizing offsite modular construction methods, which reduced site construction timescales by half. In addition, a ‘fabric first’ approach was deployed to deliver highly insulated homes to reduce energy bills for the new residents.

CONCLUSION

Airspace development is a specialized field that brings with it, the potential to transform standard industry practices and overcome the growing housing crisis through innovative solutions. While the opportunity is immense, so are the challenges; particularly there are multiple key considerations for property developers, architects and contractors, requiring them to work in close synergy to develop optimum site-specific design solutions. Apex has attempted multiple projects and while has successfully implemented few till date, each project provides lessons for future; while many projects were abandoned due to technical and financial infeasibility, the learnings can be adapted to create success stories. This case study highlights the R&D work conducted by Apex while building on different roof types. Apex aims to publish more of the work undertaken till date, to make available publicly, the knowledge to accelerate scalability of airspace development.

Read Next: Fire Safety Consideration in Airspace Projects