CIVE3871: DESIGN STUDIO 3.2

CALL LANE RIVERSIDE OFFICES PROJECT

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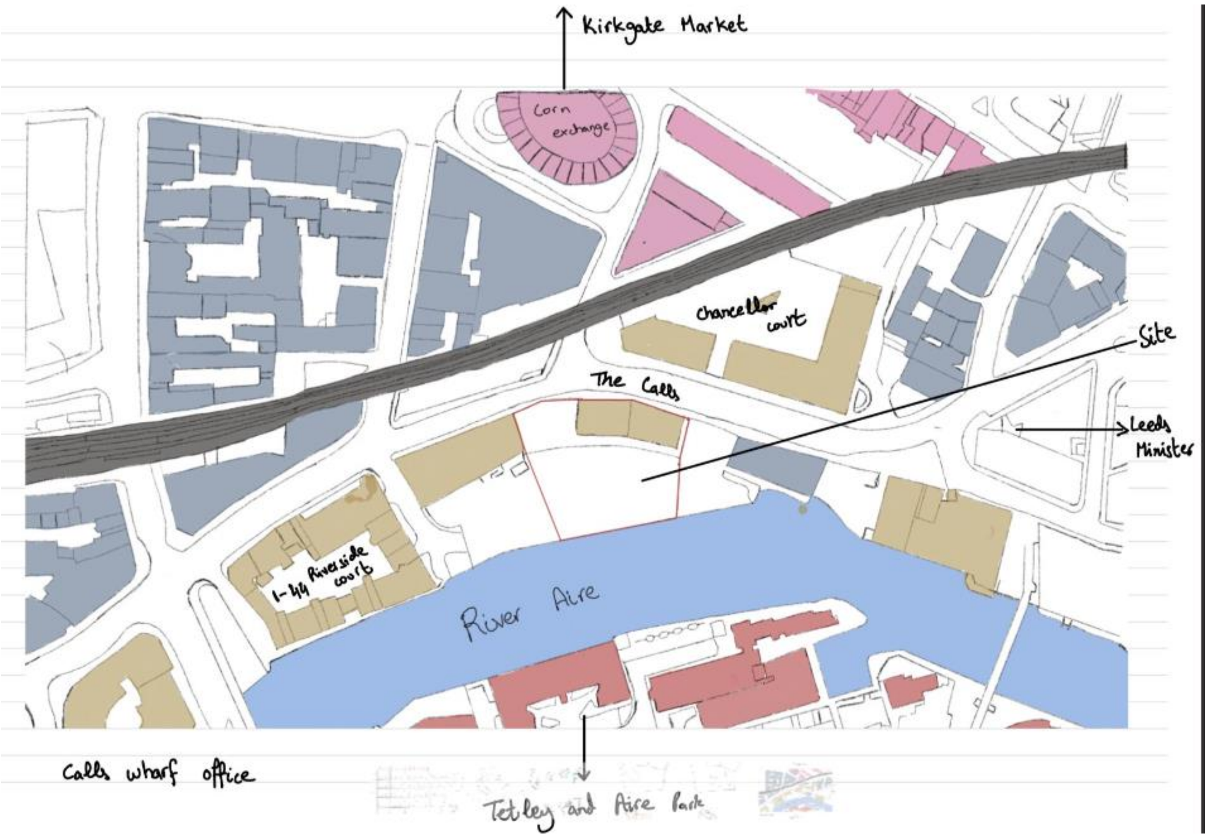
Contents

1. INTRODUCTION

This architectural proposal aims to develop a multi-storey office building located in the Call Lane area of Leeds. The final design aims to have gross internal area of 3000 m^2 which consists of an existing building on site as well as a new build. The on-site building was once occupied by Warehouse Hill but now remains unoccupied. The site is located south of Leeds city centre with a short distance to the train and bus stations.

The brief provided by the client requires an appealing and flexible office space, 60% of which will be taken by Broken Planet Market whereas the remaining 40% will be rented.

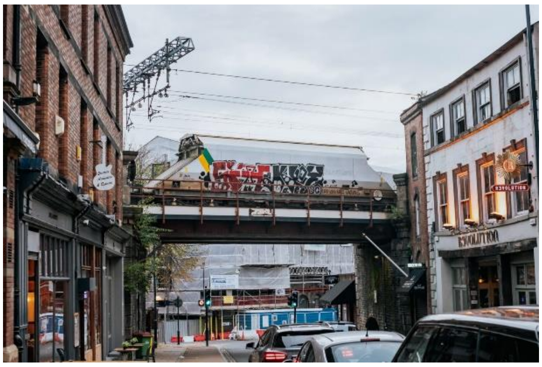


2 SITE ANALYSIS

2.1 Historic Context

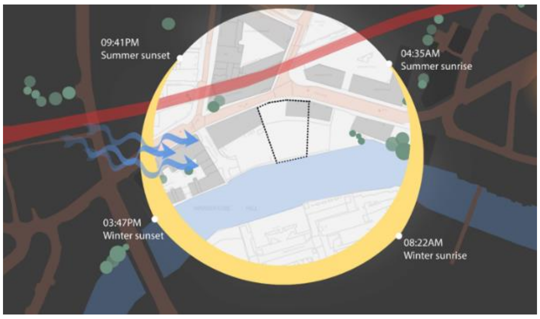
Historically the area of Call Lane was a bustling epicentre of commerce and textile industry, lined with warehouses, mills and factories, however Call Lane experienced a period of decline when these industries moved away from the City Centre. In the 21st century Call Lane went under major transformation and now hosts various restaurants and bars.

2.2 Surrounding Buildings



The site is located in one of the oldest districts in Leeds adding character to the site. Due to the industrial decline many buildings here are either demolished or repurposed. The area also has various listed buildings, this includes the front façade of the building on our site. As shown in the map below **insert map of site** Aire Bar is located to the west with Calls Wharf offices located to the east of the site. The site is also only a short distance to the city centre and the corn exchange.

2.3 Site Environmental Conditions



Due to the site being located adjacent to the River Aire, it is prone to flooding but there are no SSSI protection requirements put in place however, this does still need to be considered during the design process.

The temperatures on site vary from 2 degree C to 20 degree C as demonstrated in the graph below. Summers in Leeds tend to be partly cloudy with the temperatures averaging around 15 degrees C whilst in winter the city experiences strong wind, rain, and cloudy climate. Average rainfall in Leeds is around 40 mm. The diagram below demonstrates the sun path and wind directions on site.

2.4 Connectivity

Currently there is only one way to access the site, which is through riverside court, this is primarily used by vehicles for parking. There are no pedestrian entrances therefore improving pedestrian accessibility is of great importance. There is also a 4m height difference between the site and the road level which makes accessing the site for commuters extremely challenging so a solution for this must be developed.

There is also scope for future access via services such as uber boats if the riverside area continues to develop.

3. ARCHITECTURAL DESIGN

3.1. Design Brief

Based on the requirements of the brief, a commercial office design of 3000 m^2 is proposed integrating both existing and new construction elements.. The client wanted to repurpose the existing building and wanted to create an aesthetic and flexible space with the new building. The client wanted the space to include a shell and fit-out scheme which can be rented by various end users. 60% of the net lettable space is to be used by Broken Planet Market, therefore the scheme needs to be designed in a way that meets the company's requirements.

As the gross internal area of the proposed office structure is around $3000m^2$, there is plenty of leftover space on site by the riverfront, This area will be thoughtfully landscaped, supplemented by the addition of a limited number of parking spaces. As part of the personal brief, the proposed design must enhance the riverfront's visual appeal and accessibility for the general public. Hence, no structural elements should be positioned in close proximity to the riverside.

As the proposed building is an office space, it is important to create a space that increases productivity and reduces stress, this can be done by introducing green or outdoor spaces. Other important factors for the user's comfort include adequate lighting, heating and proper air circulation.

3.2 Broken Planet Market (BPM)

Broken Planet Market (BPM) is a relatively new streetwear brand that places great emphasis on creating the best streetwear possible whilst keeping sustainability at the forefront. The company strives to do better as it has made it a mission to provide consumers with a better ethical option. BPM is a company that considers collaboration and teamwork very important. Therefore, the proposed design must accommodate for teamwork, as well as providing with basic amenities such as breakrooms and wind down areas to encourage a healthy working environment. The design must also have designated spaces for all teams which should include stock rooms, photography rooms, plant rooms and meeting rooms.

The 10 different teams of BPM are listed below:

- HR and Administration
- Sales
- Legal
- Design Team
- Product Development
- Advertising and Marketing
- Production and manufacturing
- Supply Chain
- E-commerce and Finance
- BPM foundation

3.3 Precedent Study

3.3.1 The Pierre, San Juan Islands, Washington

The Pierre San Juan is a luxury waterfront condominium complex in San Juan. The architectural design is defined by a sleek and contemporary aesthetic that harmonizes with the coastal surroundings. The structural system relies on reinforced concrete for its durability and resistance to coastal elements. Floor-to-ceiling glass panels afford panoramic views of the ocean and promote a strong connection between indoor and outdoor spaces. The integration of sustainable technologies, such as solar panels and rainwater harvesting systems, underscores the project's commitment to environmental responsibility. The study underscores how The Pierre San Juan effectively merges upscale living with coastal tranquillity, reflecting the evolving trends in coastal residential development.

The selection of materials is meticulous, prioritizing both local context and sustainability. Reclaimed timber, sourced from island structures, enhances rustic charm and eco-consciousness, linking architecture to surroundings. Exposed glulam beams and trusses create open spaces and offer structural support, celebrating wood's strength and elegance. Floor-to-ceiling glass curtain walls seamlessly connect indoor and outdoor spaces, maximizing natural light and panoramic views. This precedent exemplifies a holistic approach to design and construction, a valuable reference for future projects.

3.3.2 529 Power Station San Francisco, California, USA

Architects: Herzog & de Meuron

529 Power Station is a successful adaptive reuse project. The transformation of the former power station into a mixed-use development showcases innovative design strategies. The integration of industrial heritage with modern amenities creates a unique urban experience. The preservation of the key architectural elements, such as exposed brick and large windows pays homage to the building’s history while fostering a sense of authenticity. Original brickwork, metal trusses, and large

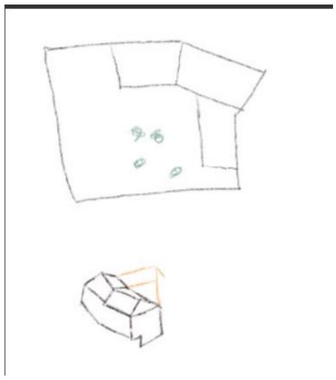
industrial windows have been preserved, blending seamlessly with modern interventions. The space now accommodates a blend of commercial offices, art studios, and public gathering areas.

The retained red-brick façade provides a visual continuity with the area's architectural history. Exposed metal trusses, repurposed from the original structure, offer an industrial aesthetic while serving as structural elements. Contemporary elements such as glass and steel complement the historical materials, creating a harmonious juxtaposition of old and new.

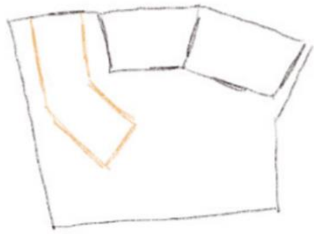
The building's structural elements, characterized by its robust steel framework, were retained to maintain its industrial heritage. The integration of large windows and open floor plans maximizes natural light and creates versatile spaces. The design emphasizes the successful blending of historical features with modern design, showcasing how repurposing existing structures can result in unique and functional spaces that resonate with the surrounding urban context.

3.4 Early Design Developments

At the beginning stages of design, the emphasis was put on form and figuring out different arrangement that will create the most efficient design. Some thoughts about the buildings structure were also brought to light. Whether the building will rely on existing structure or will it stand on its own.

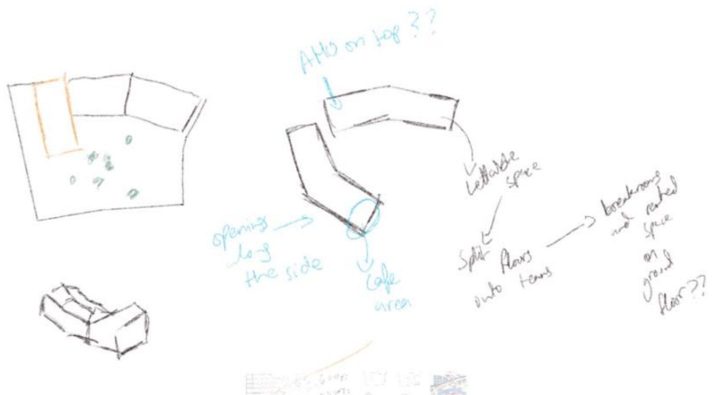


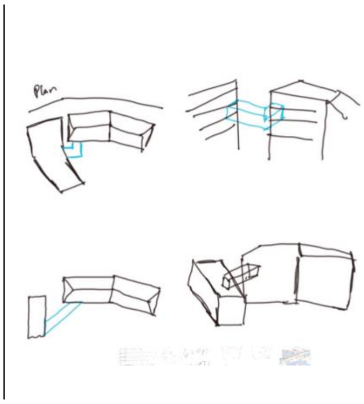
It was later decided that an almost U-Shaped geometry would be applied creating a central courtyard space. At this stage the question about the structure of the building and how the connection would be made was once again raised.



There were 2 possible solutions, the 2 buildings would be aligned, and the structure of the existed building could be altered, e.g., place temporary supports and switch out the structural elements so they can now withstand loads of both structures. However, it was ultimately decided that this would be too complicated to design.

Therefore, in the final design a truss bridge connection was chosen to create a connection between the 2 buildings. Regarding direct access from the calls to river Aire an external staircase between the 2 buildings is to be used.





3.5 Conceptual Response

3.5.1 Form

The final design consists of the introduction of a new L-shaped building which is connected to the existing structure via a truss bridge on the first floor. Directly underneath this bridge is the external staircase that allows direct access to the riverside. The introduction of the new structure to the west of the existing site leaves open space next to the waterfront.

3.5.2 Layout

The final proposed structure consists of 4 storeys. The layout of the space is separated into pre let and shell scheme, this allows the new building and the upper storeys of existing structure to be used as pre-let space whereas the lower storeys can be rented out as offices.

The main reason for the upper and lower storey split was due to the bridge connection that is located on the first floor, this ensures that the designated spaces for both clients are different. The layout now allows the BPM employees to be separated by teams whilst still keeping them connected.

The layout ensures that the lifts, stairwells, and toilets are accessible on all floors and that all cores remain positioned throughout the structure.

3.5.3 Visual

The primary visual characteristic of the office building is the deliberate juxtaposition of concrete and brick components, a design approach that reflects the evident interaction between the contrasting attributes such as traditional vs contemporary aesthetics. This contrast not only signifies the difference between the existing and the new architectural aspects but also symbolises the historical areas towards the north of the site compared to the redeveloped and renewed southern part. Positioned at the centre of these two contrasting zones, the proposed structure acts as a visual bridge, demonstrating the lively connection between the traditional and modern aspects of Leeds. It highlights their harmonious coexistence and mutual enhancement, while also emphasizing their inherent differences.

Furthermore, the visual impact of the terrace space enhances the overall aesthetic appeal of the workspace, whilst contributing to a visually pleasing and inviting environment. The presence of the green spaces here improves employee well-being as it provides a space for relaxation. Moreover, the integration of green spaces aligns with sustainable and showcasing eco-friendly practices, contributing to a healthier environment, and showcasing the organization’s commitment to responsible design.

The external staircase facilitates the connection between the two areas, maintaining their interrelation without disruption. Instead, it shapes a passageway that makes the riverfront easily accessible for the public.

4.0 Environmental Services Design

Contents

The following section of the report outlines the building physics required to meet the requirements of users with special consideration for ventilation system, thermal comfort, and circulation of end users.

The documentation used in this section of the report is stated below

- BRSIA Rules of Thumb: Guidelines for building services

Office Specifications

Occupant Density (NIA per person)	10-14 m^2
Means of escape	Part B Building regulations- 6m^2
Core elements	10-12.5 m^2
Lifts	
Wait times	<25 seconds
Time to destination	<90 seconds
NIA per person	12.5m^2
Handling Capacity	12% in 5 minutes
Depth of Landing	>1500mm
Car Loading	0.21 m^2 per person, car loading factor = 80%
Lighting	
Energy use	8-18kWh/m^2/year
Daylighting	2%-5%
Electrical load allowance	8W/m^2 for CAT A & B
Air Temperature	
Winter	20°C +/- 2°C
Summer	Shouldn't exceed 25°C for more than 5% of occupied hours
Comfort	
Occupancy	10m^2 per workspace
Airtightness	7m^3/hr/m^2
Toilet provision	
NIA per person	10m^2
Male/Female ration	60%M,60%F
Unisex	100%

4.1 Ventilation strategy

In order to save on energy costs a hybrid ventilation approach will be used, maximising use of natural ventilation. A hybrid ventilation approach is essential due to the UK climate as during the colder months having openings in the building is very undesirable and can lead to heat loss. Mechanical ventilation will be used in areas where natural ventilation is inadequate such as toilets and kitchens where extractor fans are required to filter the air.

4.1.1. Natural ventilation

As mentioned in the design brief, it is essential to maximise the utilization of natural ventilation in order to reduce carbon emissions and energy cost and consumption. Throughout most of the building open plan office spaces are located which make use of cross ventilation. Air travels in through openings on the western side due to from west side pass through the office spaces and exit through louvres that are placed within the glazing.

Cross ventilation method will not be adequate for the existing building despite the large number of windows on the north and south side therefore a stacked ventilation system will be introduced.

Single sided ventilation is to be used in spaces where the placement of internal walls imposes limitations on the number of available openings. This strategy will only be applied to the new build's northern side due to the due to the toilets and lift shafts being placed in this particular area.

4.1.2. Mechanical Ventilation

Spaces such as toilets, kitchens, and small rooms such as meeting rooms where air needs to be extracted so a mechanical extract ventilation system is to be used. Most of these spaces have been strategically placed near risers which allows all ducts to be located within the risers to the rooftop where the AHU is located.

4.1.2.1. Areas supplied with Mechanical Ventilation

Below is a list of areas that require mechanical ventilation and the reasonings behind them:

- Toilets: required to remove condensation and unwanted smells, extract ventilation rate are required at 6 l/s per WC.
- Kitchen/café: required to remove contaminated air from the room. Required extraction rate for breakroom kitchens without hobs require 15 l/s whereas the café kitchen located on lower ground floor require an extraction rate of 30 l/s.
- Storage rooms: these require mechanical ventilation as they are enclosed spaces with no access to natural ventilation.
- Seating area for café: although there is plenty of space for cross ventilation, the only openings are in the curtain walls on south side which is not sufficient to ventilate the entire area.
- Meeting rooms: these spaces are generally small and often need to be ventilated due to them being enclosed by walls and glazing and only allowing little air to be accessed.

4.1.3. Air handling units and Duct sizes

A rooftop installation will accommodate an air handling unit within the new construction, serving the purpose of circulating and revitalizing the air as an integral aspect of the building's ventilation, cooling, and heating strategy. Direct access to the lower ground plant room is available due to the risers being positioned close to the AHU. All the required duct work can run through these risers, plant rooms and through the rooftop space of both buildings.

The size of the AHU is 150 m^2 while its heigh is 4.5m.

4.2. Lifts

According to CIBSE guidance document, for offices one lift pet 3 floors is required, since the building has 4 floors 2 lifts will be provided for each component as they are both split up and act as individual structures. This reduces wait times, increases movement efficiency, and maximises circulation within internal area. The layout and dimensions of the lifts also meet the guidelines.

4.3. Solar environment

4.3.1 Site conditions

The sun path indicates that the location will receive a significant amount of sunlight throughout the day, with a focus on areas facing south. It's important to carefully consider the potential for excessive heat buildup as a result of this sunlight. The way the building is designed ensures that all parts of the structure receive natural light and are not overly shaded.

The new building's use of large glass windows doesn't raise major worries about too much solar heat gain. This is mainly because the building is mostly constructed using insulated concrete walls, which help manage the transfer of heat. The design of the curtain wall, which is set back, also creates a shading effect on itself.

In summary, while the building benefits from ample sunlight, concerns about excessive solar heat gain are mitigated by the widespread use of insulated concrete walls and the thoughtful design that creates its own shading effects.

4.4. Energy strategy

4.4.1. Heating

In order to provide maximum thermal comfort district heating will be used to heat the building as it is more economical and a more environment friendly option in comparison to other heat sources such as a heat pump. In order to heat a building using the district heating method a connection need to be made to existing networks which can be done at the plant room located at lower ground floor level. The pipes from the local network are connected to the heat exchanger which distributes heat through pumps by radiators.

Open plan offices require greater air circulation, therefore

4.4.2. Cooling

The cooling load required for the building is 158kW, due to the use of shading and natural ventilation, excessive heat gain can be avoided. Cooling in summer months will be provided using natural ventilation as the UK climate doesn't require air conditioning.

4.4.3. Building fabric

Almost all the external walls and roof of the proposed building are insulated to ensure thermal comfort and to limit heat loss, the curtain walls are also triple glazed while being panelled with shading in order to limit excessive limit gain. A cross section of the curtain wall and roof is shown on the structural boards.

4.4.4. Lighting

Both components of the structure have adequate windows and openings allowing sunlight to penetrate and naturally light the building during the day. Large, glazed areas such as the areas on the north and south side ensure maximum natural light penetration. However, on many occasions the building needs to be artificially lit such as the winter months when the sun sets early or after sunset on all days. Therefore, flush LED lights are installed in all office areas providing the workspace with cool lighting in order to maximise alertness. Additional desk lamps are installed for targeted task lighting.

The building on the west in very short distance therefore it could provide some shadowing limiting the amount of natural light that's coming into the building, however this isn't necessarily an issue as the area affected is taken up by services.

Accent luminaires such as drop ceiling lights are installed in certain areas such as the café and some meeting rooms to make these spaces more visually appealing.

In order to ensure that all pathways and stairs stand out strip LED lights are installed for pedestrian ease.

4.5. Calculations:

Gross floor area = 2963 m^2

Net floor area = 2455 m^2

Total pre let office space = 1807 m^2

Café = 87 m^2

Assuming 10 m^2 per person according to BRISA rule of thumb

$$Total\ Occupiers = \frac{1807}{10} = 181\ people$$

For café assume 3 m^2 per person $= \frac{87}{3} = 29\ people$

Plant room sizing

Required plant room size to be 8% of gross floor area for city centre offices that are air conditioned which is $0.08\ \times 2963 = 237\ m^2$. This includes internal space for vertical risers, lift shafts, electrical and mechanical equipment etc. These requirements are met in the building design as shown in the table below:

	Area m^2
Lower ground floor level plant room	100
Lifts	62

Risers	52
Total	214

Aswell as this the AHU unit on rooftop accounts for 150 m^2.

Rules of thumb guidance requires the service risers to be 1.5% of the GIA per floor, as the first floor has the largest GIA $360 + 404 = 764$, therefore the suggested riser area on each floor is $= 0.015 \times 764 = 11.46$. This requirement is met as risers take up almost 13m^2 on each floor, therefore meeting the guidelines

Calculation maximum allowable room depths for different types of natural ventilation:

All designs must meet the CIBSE rules of thumb guidance given that maximum room height is 3.5m:

Cross ventilation: room depth shouldn't exceed 5 times the room height and never more than 10m; Maximum allowable room depth = 3.5 x 5 = 17.5m

Single sided ventilation: room depth shouldn't exceed 2.5 times the room height; Maximum allowable room depth = 3.5 x 2.5 = 8.75m

Stacked Ventilation: distance from façade to skylight shouldn't exceed 5 times the room height; Maximum allowable room depth = 3.5 x 5= 17.5m

AHU and Duct sizes

Space Type	Air change rate	Floor area (m^2)	Volume (m^3)	Ventilation rate (m^3/s)
General office (including meeting rooms and individual offices)	6	1568	1568 x (3.5 x 4(height if 4 floors)= 21952	36.59
Breakrooms	15	124	434	0.723
Café	5	70	245	0.041
Café kitchen	30	17	59.5	0.1
Toilets	3	104	364	0.06
Total				37.514

*height used is 3.5m

Using figure 3 from BRISA Rule of Thumb Guidance for single air handling unit an AHU of 150 m^2 is assumed as the maximum flowrate that is required is 30 m^3/s.

Table 11 from Rule of Thumb Guidance provides main duct sizes for general offices to be 7.5 m/s. Therefore $\frac{total\ ventilation\ rate}{7.5} = \frac{37.514}{7.5} = 5.1\ m^2$.

Heating and cooling loads

$$Heating\ load = 2963 \times 0.07 = 207kW$$

$$Cooling\ load = 2963 \times 0.087 = 258kW$$

5.0 Structural design

Contents

5.1. Terms of reference

- British standards

- Eurocodes

5.2. Load combinations

Ultimate Limit State (ULS)		Serviceability Limit State (SLS)	
Permanent, favourable (γ_{sup})	1.35	Permanent, unfavourable (γ_{sup})	1.00
Variable, Leading (γ)	1.50	Variable, Leading (γ)	1.00
Variable, accompanying (γ)	1.50 ψ_0*	Variable, accompanying (γ)	1.00 ψ_0

$* \psi_0 = 0.7 \textit{ for imposed loads}$

Design approach 1 Combination 1 and 2 are used for structural design as given by Eurocode 1, with:

- DA1C1 : A1+M1+R1
- DA1C2: A2+(M1 or M2)+R4

For actions:

Action	Symbol	Set	
		A1	A2
Permanent	Unfavourable	1.25	1.0
	Favourable	1.0	1.0
Variable	Unfavourable	1.5	1.3
	Favourable	0	0

For materials:

Soil Parameter	Symbol	Set	
		M1	M2
Angle of Friction	$\gamma_{\phi f'}$	1.0	1.25
Effective Cohesion	$\gamma_{c'}$	1.0	1.25
Undrained Shear Strength	γ_{cu}	1.0	1.4
Unit weight	γ_{ε}	1.0	1.0

Resistance: given for the use of CFA piles

Foundation	Resistance	Set			
		R1	R2	R3	R4

CFA Piles	Base	1.1	1.1	1.0	1.45
	Shaft (compression)	1.0	1.1	1.0	1.3
	Combined	1.1	1.1	1.0	1.4
	Tension	1.25	1.15	1.1	1.6

Snow and Winds loads

Actions	Loads (kN/m^2)
Snow	0.36
Wind	0.55

5.3. Geotechnical Design

Soil Type	Elevation of top of layer (mAD)	Unit weight (γ) kN/m^3	Undrained shear strength (c_u) kPa	SPT value (N)	Angle of shearing resistance (ϕ)°	Allowable bearing pressure kN/m^2
Fill	0	19	-	-	-	-
Soft to Firm sand and clay	2	19	10-20	-	35	2.5 x c_u
Sandy mudstone	3	19	100-200	20-40	35	5 x N
Weathered mudstone	5	19	200	-	35	2500

The geology of the site contains a mixture of mudstone, siltstone, sandstone, and alluvium deposits. During the ground investigation, it was also found that the water has a PH level of 5 and contains 4.00mg/L^3 of SO_4^{2+}, therefore all structural elements close to the ground surface will require a protective layer.

The fill has unreliable and unknown properties due to which it is assumed that this shouldn't be relied on for any structural support. Therefore, the structural elements should penetrate the mudstone layer.

The ground water level in 0.5m below surface but we assume it to be at surface for worst case scenario.

5.4. Structural Design Statement

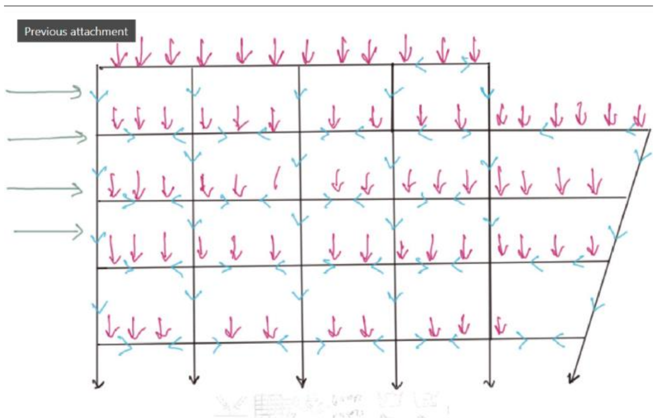
5.4.1 Structural form

The final proposed structural design is a steel framed structure compromised of steel column and beams with concrete floor and roof. All the exposed columns externally and internally will be encased in concrete to prevent chemical attacks at GWL, this is also done for aesthetic purposes. The structural floors are CFA piled ground beam foundation which will be inserted into the weathered mudstone. Additional shear walls, concrete cores and bracing is also added for lateral supports. Further details are provided on the structural engineering drawing and selected elements have supporting calculations. The selected elements are shown in the table below:

Member	Detail
Concrete floor slab	Two way spanning slabs C35 Concrete 300 mm thick T10@ 200 c/c', A_{sprov}=393mm^2
Internal Columns	203 x 203 x 71 UC, S275
Inclined Column	203 x 203 x 127 UC, S275
External Columns	203 x 203 x 71
Pile cap	1.4m thick 3m x 1.5m 10 B12 bars
CFA piles	2 per pile cap 8m length 500 mm diameter
Ground beams	600 x 300 mm 4 B32 bars
Steel Beam	406 x 178 x 54 UB S275

5.4.2. Load transfer

A cross section of the building displays the load paths and distribution to foundation are shown in the figure below. The floor slabs span 2 ways allowing the loading to be distributed both ways onto the primary beam eliminating the need for any secondary beams. The load from the primary beam is transferred onto the supporting columns and then to the piled foundations. All the wind loads are transferred to concrete cores which will provide lateral resistance. The inclined columns are connected to ties which transfer the load to the cores and down to the foundation All calculations are provided in the appendix.



5.4.3. Robustness

"Ability of a structure to withstand events like fire, explosions, impact, or the consequences of human error, without being damaged to an extent disproportionate to the original case" this is the definition of robustness in BS EN1991-1-7. Robustness of a structure protects it against unexpected accidental events where disproportionate collapse due to failure of a member can occur. In event of such failures, the overall structure must be able to remain stable until the compromised component is replaced.

As the office building doesn't exceed 4 storeys, it falls under class 2a, the lower risk group for consequence class as outlined in table A.1 of EN 1991-1-7. With reference to the document to ensure stability under normal use effective horizontal ties must be provided for framed structures. The presence of horizontal ties allows catenary action to develop which maintains a columns position.

5.4.4. Stability

To ensure stability of structure shear walls, cores and braced members are incorporated in the design, the placement of these is shown in the diagram below. For the 4-storey building a grid structure is used as bracing through these elements are sufficient to support the structure.

In order to ensure stability in the existing building part of the internal shear wall is removed to make space for lift shafts and fire escape staircase. Instability is most likely to occur during the construction, the concrete cores will be constructed first so they will offer stability to the rest of the structure. Temporary supporting should also be provided until construction is complete.

The skybridge walkway is simply supported by columns meaning that stability will be ensured without having effect on the stability of the existing structures. The columns use a warren truss system which will be stable due to its geometric arrangement and load. The figure below shows the truss connections.

5.4.5. Fire safety Design

Determining risk profiles for the building using tables from BS9999:2017

Table 2 Occupancy characteristics

- Office = A Occupants who are awake and familiar with the building
- Café = B Occupants who awake and unfamiliar with the building

Table 3 Fire growth rates

- Office, Café all category 2 medium

Table 4 Risk profiles

- Office A2
- Café B2

According to CIBSE Guide E: Fire Safety Engineering, the building design must have a maximum travel distance of 18m in one direction to the nearest fire escape, this requirement is met as demonstrated in the figure below:

Access routes for emergency and rescue services are available through both lower ground and ground floor, as well as that there is plenty of space available for fire meeting points.

The concrete cores have been designed according to the guidelines providing escape hallways and direct external exits.

As the two buildings are connected and it is highly likely that fire can travel from one building to the other, fire curtains will be provided at the connection between these buildings (located at the entrance to the bridge at level one in the new building) . The new build will also have a sprinkler system installed which will lower the risk profiles by one level:

- Office A1
- Café B1

The approved Document B and Technical handbook 2022 suggest at least 60 minutes of fire resistance for the proposed design. This has been taken into consideration as most internal columns will be encased in concrete as that will reduce damages and failure due to fire, all exposed steel will need a thin intumescent coating to protect it against fire. This is because untreated steel has a fire resistance of only 12 minutes according to the Steel Construction Handbook. The suggested nominal cover depth for the design of members has also been taken into consideration.

4.5.6. Sustainability

The design reflects a forward-looking perspective, emphasizing sustainability to cater to future generations. To guarantee the sustainability of the construction procedure, recycled materials are incorporated, along with the utilization of standardized dimensions for steel beams and columns. Allowing these components to be repurposed in the future after dismantling.

To achieve sustainability in building usage, it is crucial to incorporate sufficient insulation within the building envelope. This measure effectively mitigates heat loss, contributing to energy efficiency and reduced environmental impact.

4.5.7. Buildability

The construction approach incorporates a straightforward grid structure, with sections meeting at right angles. This design choice ensures a simple and easily manageable assembly process, as all components will be fabricated off-site. This is further supported by the use of standardized sizes and bolted connections for the framework, effectively reducing construction time. Additionally, the repetitive floor design enhances the overall simplicity of the building's construction.

For the foundation excavation will be required where pumping ground water is necessary in order to begin working. Formwork (for pile caps and ground beams) and false work (for construction above ground level) will also be required.

The concrete cores will be cast in place and will be assembled first as the structural components will be dependent on these. Access to the site will be required in order to bring in equipment such as concrete mixes.

The construction of the inclined columns and the sky bridge presents potential challenges. To mitigate these issues and ensure safety, formwork must be employed during the construction process to prevent collapse. Once the components are securely attached to the main structure, additional supports will not be necessary.

While the construction of the bridge will require workers to operate at heights, it can be anticipated that the process will be expedited due to the bridge's small size.

Setting up the curtain wall demands a specialized team due to its prefabricated panel composition. This process necessitates storage space and will also involve a certain amount of time. Given the building's central location, construction might need to occur outside regular office hours to prevent any disruptions to the nearby surroundings.

4.5.8. Durability

As indicated by the findings of the ground investigation, the potential for sulphate attack exists in areas where foundations and structural components are in contact with groundwater. This phenomenon, when affecting concrete, can result in cracking and a decrease in strength. To counteract this risk, the prescribed cover distance provided by BS 8110, is employed. This measure is adopted to mitigate potential damages and ensure the structural integrity of the elements in question. In addition to this, utilizing a higher-grade concrete with an elevated cement content is recommended. The steel members will not be exposed as they will be encased in concrete which decreases the risk of corrosion.

Despite all the measures put in place, regular maintenance is still required after construction to ensure a long life. An inspection of the entire structure should at least take place once a year if not twice, as a proactive safeguarding measure.

6.0. Construction Design

Hazard	People Affected	Likelihood (L)	Severity (S)	Risk Product (RP = L x S)	Risk controlled	Control Measure
1) Trip hazards and falling from height	S, I, M	3	3	9	D, C	- Wear PPE equipment such as steel toe capped boots and hard hats at all times. - Maintain a tidy site. - Contractor must provide safe scaffolding. - If scaffolding has been up for a while carry out inspections to determine whether its still safe or not. - Harness should be worn when working from height. - Ensure all staff has adequate training to be working at a height
2) Excavations collapsing	S, I	2	3	6		- Correct PPE must be worn - Keep all vehicles at a safe distance from excavations. - Carry out inspections as a preventative measure. - Carry out a survey to establish ground conditions.
3) Heavy moving vehicles	S, P	2	3	6	C	- Ensure there is enough space on site for any vehicle to manoeuvre safely. - Access to site must be controlled to ensure public safety.

						- Site staff must be informed when heavy goods vehicles are on site. - Avoid over loading vehicles. - Drive with care. - Reverse beeper that can alert people.
4) Contact with harmful substances or services underground	P, S, M	2	3	6	C, D	- Correct PPE must be worn. - COSHH assessment carried out - Designer must carry out research and should plan work with regards to underground services.
5) Chemical burns from concrete	S, C, I	2	3	6	C	- Correct PPE must be worn. - First aid must be available on site. - Access route for emergency services to reach the site.

Hazard	**People Affected**	**Likelihood (L)**	**Severity (S)**	**Risk Product (RP = L x S)**
1) Trip hazards and falling from height	S, I, M	1	3	3
2) Excavations collapsing	S, I	1	2	2
3) Heavy moving vehicles	S, P	1	3	3
4) Contact with harmful substances or services underground	P, S, M	1	2	2
5) Chemical burns from concrete	S, C, I	1	3	3

Key	**Meaning**
P	Public
S	Staff
C	Contractor
D	Designer
M	Contractors/ engineers carrying out maintenance work
I	Contractors/ engineers carrying out inspections
Likelihood rating	1-3, 3 being most severe

Severity rating	1-3, 3 being most severe
Risk Product	Likelihood x Severinty