



2025

Building Evaluation – Design Proposal for Medium to High Rise Student Accommodation

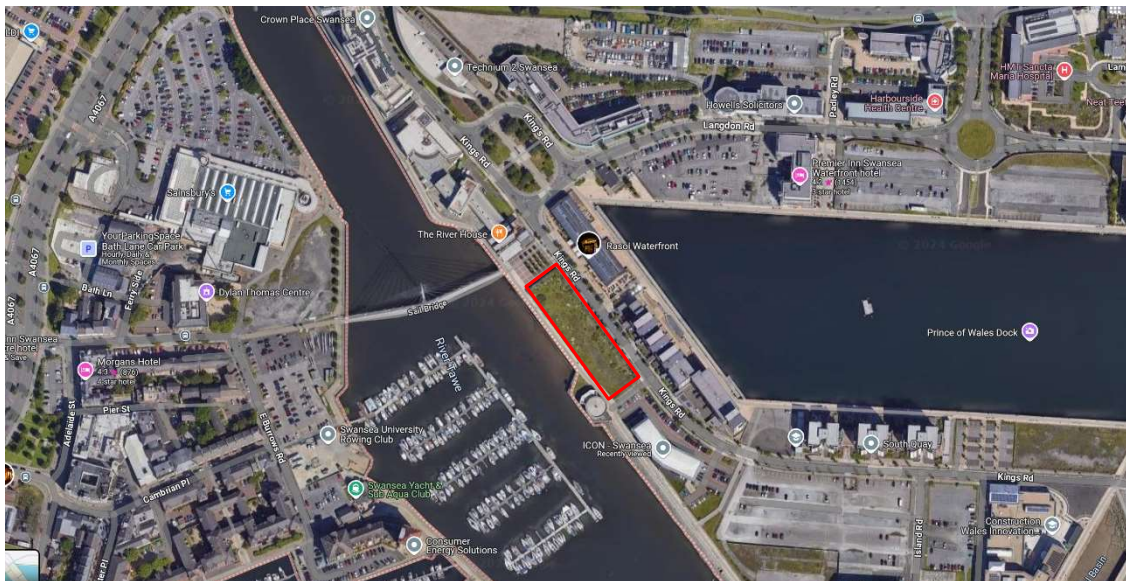
Construction Technology 2-HND & BSc in Architectural Technology, Construction Management, Quantity Surveying (Also the Higher National Apprenticeship HND Pathway for Construction Management and Quantity Surveying).

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Introduction

The demand for student accommodation has witnessed significant growth due to the increasing number of students enrolling in higher education. This report will examine the design proposal for a medium rise student accommodation building located in the SA1 site adjacent to King's Road in Swansea Bay area. Our aims are to analyse a range of materials, methodological techniques and constructional forms suited to medium rise buildings. This project will aim to provide sustainable, aesthetically pleasing, and functionally efficient housing for university students whilst including recreational spaces such as a study lounge and a café area. This report covers structural, environmental, and aesthetic aspects of the design, justified by relevant research



('Google Maps,' 2024)

Site Analysis

Effective site analysis is foundational to a successful design. The proposed site, located within the bustling SA1 area, has some unique opportunities and constraints. The area is near the University of Wales Trinity Saint David, accessibility to public transportation, and a rich historical background paired with newer modern buildings. The proposed site is a reasonably large plot, as shown in this area calculation Length x Width, $113.37 \times 30.60 = 3469.122$ meters². ('Google Maps,' 2024) or 1.3469122 ha. Area shown on the above image highlighted in red.

The existing terrain consists of relatively flat topography, with ground-level accessibility and making it ideal for medium to high-rise construction. However, the design choices must be mindful of its surroundings and echoes local architectural heritage. In terms of infrastructure, the site benefits from public transport links, including bus routes and bike lanes, which will aid in reducing the building's carbon footprint by minimizing the need for private vehicles. Utility connections such as water, electricity, and internet are readily available so the building can be connected easily to the grid.

Environmental considerations for this project include potential impacts on local flora and fauna. This will be preserved and incorporated into the landscape design by introducing natural greenery to the communal external areas on the project. Given the site's urban setting, the inclusion of noise-reducing materials will contribute to a quieter and more comfortable living environment for the students.

Foundations

Soil Type

The choice of foundation in any construction project is largely determined by the soil type. A comprehensive geotechnical investigation of the SA1 site is required, however we can use surrounding plot's bore hole data to get a better understanding, this reveals that the soil is predominantly composed of clay with pockets of sand and gravel. Clay soils generally have poor drainage characteristics, leading to issues of stability and settling. Sand and gravel pockets requires specialist surveying to prevent differential settlement. In this chart below the different bearing capacities are shown in kPa(kilopascal) this is a unit of measure, pressure in this case.

S.No	Type of Soil	Safe Bearing Capacity (kN/m2)
	Cohesive Soils	
1	Soft shale, hard or stiff clay in a deep bed, dry state	440
2	Medium clay readily indented with a thumbnail	245
3	Moist clay and Sand clay mixture which can be indented by thumb pressure	150
4	Black cotton soil/expansive clay (50% saturated) in dry state	130 to 160
5	Soft clay indented with moderate thumb pressure	100
6	Very soft clay which can be penetrated with the thump up to few centimetres	50
	Cohesionless Soil	
7	Compact gravel/sand and gravel mixture with good resistance against penetration of tools	440
8	Compact and dry coarse sand	440
9	Compact and dry medium sand	245
10	Loose gravel or sandy gravel mixture, dry state	245
11	Fine sand and silt (consists of dry lumps)	150
12	Loose and dry fine sand	100
	Rocks	
13	Hard rocks such as granite trap, diorite etc.	3240
14	Laminated rocks such as sandstone, limestone, etc.	1620
15	Residual deposits of shattered and broken bedrock and hard shale, cemented material	880
16	Soft rocks	440

(What are the Bearing Capacity Values of Different Soils, 2020b)

Considerations

Greenfield sites are untouched land that has not been built on previously, these are highly sought after and usually have much more planning constraints on them due to their nature. In this case, the proposed plot is a brownfield site, this means that it has been developed at some time in history and can cost substantially more to develop due to facing ground contamination, site clearances including demolition works, and usually in built up areas with vehicular and pedestrian traffic. Ground contamination was recorded a few plots up from the proposed building, as seen in this article from 'Sanctus' the principal contractor on the project, "following site investigation and monitoring. Asbestos fibres (<0.001% w/w) were identified within 9 / 33 samples, with arsenic, lead and PAHs also identified as exceeding the generic screening criteria" Tolfree (2021). Additional ground surveys and historical research is needed because of this. The site has a long and varied history showing mainly industrial uses. as seen

in the image below showing Swansea Bay area from the 1920's. (Swansea Docks-Old Dock Images, no date)

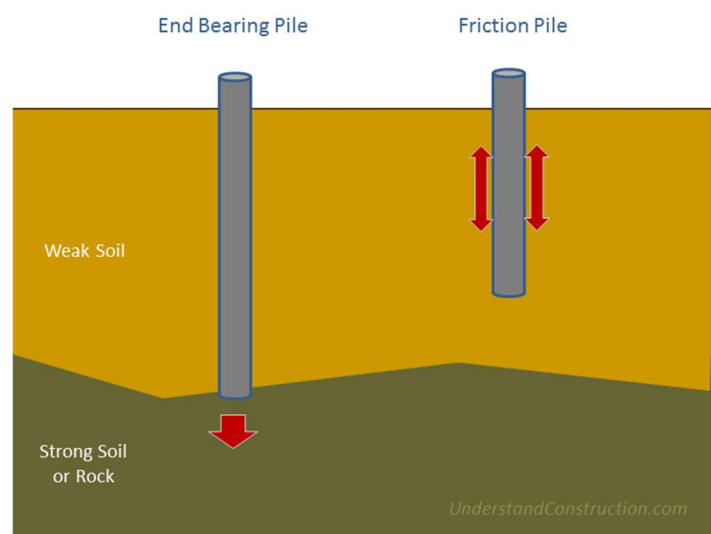


Foundation Comparisons

A foundation's function is to mobilize the weight of the structure (plus any additional loads, like those from wind or contents), when evaluating foundations for medium to high-rise buildings, there are several options, Shallow foundations, such as strip, pad foundations and raft foundations, are generally more cost-effective but are suited for strong soil strata, typically seen in low-rise buildings. Deep foundations, such as pile foundations, are more appropriate for the site conditions in SA1, allowing for the stability required in taller structures with variable soil types.

Pile Foundation

The pile foundation type is determined because this approach ensures that loads are transferred deep into the ground, bypassing the weaker upper soil layers. There are several types of pile foundations, including end-bearing piles, bored piles and friction piles. End-bearing piles transfer the load directly to a deep, stable layer of soil or rock, bored piles use a large boring machine to extract earth until solid strata is reached then the pile is constructed, while friction piles rely on the frictional force between the soil and pile surface.



(Pile foundations | Types of piles | Cassions, no date)

The cost of piles can greatly vary, the cost of the piles is also influenced by the equipment that is used to install the piles and the specialist teams that operate such equipment. The cost is first and foremost affected by what piling method is chosen.

In my opinion, for this use, the driven end-bearing use of piles are proposed, they will reach into stable substrata, providing excellent load-bearing capacity, and will ensure stability and reduce the risk of differential settlement. The piles will then be used in combination with concrete slabs spanning and spreading the load between all piles ensuring a stable footprint, to guarantee that the student accommodation is robust, and lasts for many years.

Structural Frame

Glue Laminated Beams

The structural frame for the Swansea Bay student accommodation proposed the utilization of glue-laminated (glulam) beams with cross bracing of the same material. Glulam was chosen for its strength, durability, sustainability, and aesthetic appeal. Its prefabrication reduces construction time and costs, and its flexibility allows for curved designs, enabling the building to blend naturally with the coastal environment, inspired by biomimicry. This is “the practice of designing buildings and products that simulate or co-opt processes that occur in nature” (*Nature does it better: Biomimicry in architecture and engineering*, no date). The design reflects ocean waves and currents and the shape of a wooden ship’s hull, aligning with the nautical theme of the building’s proposed location.

Glulam beams also provide excellent fire resistance, forming a protective char layer during combustion as seen by a manufacture of glulam products, Glulam Solutions “A glulam structure is much safer (predictable burn) and can be more cost effective than an unprotected steel structure. When fire encases a glulam beam, a carbonized layer forms (charring) around the structural core, which restricts the external supply of oxygen and heat and thus significantly impedes the subsequent burn-off” (*Fire - Glulam Solutions Limited*, 2013). Following this, they are thermally efficient, preventing cold bridging. They have a lower carbon footprint compared to steel or concrete, using less energy in production and relying on renewable materials.

To sum up, after comparing steel, concrete and timber, the choice of glue-laminated timber beams for the structural frame is proposed for the student residence. Offering many advantages that suit such a project, Glulam is very durable, with a long service life. It is fire-resistant when properly designed and detailed. It is an environmentally friendly product, helping lower emitted carbon and using primarily fast-growing, renewable tree species. It is also very aesthetically pleasing, and it is versatile. The flexible nature of glulam also allows large communal spaces for students. These communal areas are essential for fostering interaction, collaboration, and a sense of community among students.

Building Envelope.

Triple-Glazed Glass with Grey Aluminium and Timber Composite Frames.

The building envelope is critical for both aesthetic appeal and energy efficiency. This proposal recommends the use of triple glazed glass with grey aluminium and timber composite frames for the windows at the rear of the structure. The composite frames, treated with a grey finish, offer high durability, improved U-values, with values lower than $0.8 \text{ W/(m}^2\text{K)}$ (Why choose Composite Windows?, no date) and a modern aesthetic that aligns with the architecture of the SA1 area. (Double & triple glazed timber + aluminium windows - Sustainable construction services, 2024)



High-Performance Mineral Wool Panels

For wall and roof insulation, high-performance mineral wool panels will be used. These panels offer excellent thermal performance, sound insulation, and fire resistance. They are made from stone, silica and other materials that are extremely resistant to heat (Rockwool, no date). The mineral wool panels will help maintain a consistent indoor temperature, reducing the need for excessive heating or air conditioning and thus lowering energy costs. (Mineral Wool Insulation - Insulation Installation | TruTeam, no date)



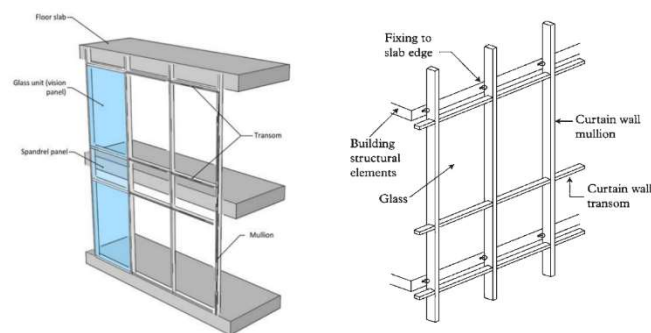
Metal Cladding

The external rear facade of the building will feature dark grey corrugated metal cladding. This choice ensures durability, extremely low maintenance, and complements the architectural style of the local area. The sheets pattern provides additional strength to the metal sheets, ensuring the facade withstands the harsh weather conditions on the coast while offering a visually appealing texture. (Facade, 2024)



Prefabricated Curtain Wall Systems

For the front and side elevations of the building, a prefabricated curtain wall system is proposed. These are “non-structural fabricated aluminium cladding system, found on the external walls of large multi-storey buildings” (Earnshaw, 2023) according to a lead manufacturer. The glass-fronted walls that can be manufactured off-site and installed quickly. They will allow for the curved facade of the design, and prefabrication ensures high precision and quality control during manufacturing, and quick assembly on site, and finally reduced labour costs.



(K-Zan, 2024) (Alicia, 2023)

Fire Safety Considerations

Incorporating non-combustible materials is crucial for the building's safety. The chosen glass and aluminium frames will be fire-rated, with additional fire-resistant coatings for enhanced protection. Intumescent seals around windows and doors will further prevent the spread of fire and smoke, ensuring a safer environment for the occupants.

Environmental Considerations

High insulation values and the use of recycled materials contribute to the building's energy efficiency and sustainability. Prefabricated components also reduce waste and energy consumption during manufacturing and construction. By prioritizing these environmental considerations, the project aims to achieve certifications such as an excellent BREEAM certification, underlining its commitment to sustainable building practices.

Prefabrication vs. On-Site Construction

Prefabrication

The proposed project heavily utilizes prefabricated elements like the glulam beams, façade panels, staircases, doors, windows, curtain wall and floor slabs, manufactured off-site and assembled on location.

On-Site Construction

Core structural components and complex junctions such as the glulam junctions, will be constructed on-site. This includes load-bearing structures like the piles and other elements requiring adjustments based on real-time site conditions such as windows, doors, and services.

Advantages and Disadvantages

The pros and cons to both methods are displayed in this document produced regarding on site/off site construction related to concrete construction. (Gong *et al.*, 2015)

Table 1
Comparison between On-site and Off-site Construction

	On-site construction	Off-site construction
Labor/time	Labor intensive Longer time for construction	Technology intensive Shorter time for construction
Environmental independence	Remarkably influenced by the ambient temperature and other factors	Prefabricated components can be directly assembled on site
Quality control	Hard to find an agreed standard for various situations	Quality can be easily controlled through joint connection with fixed size components
Shape flexibility	On-site construction is often applied for buildings with complicated designs	Buildings are relatively alike due to fixed scale
Construction management	Complex management of material stacking, human resources and safety	Lean logistics can reduce the material stacking dramatically and help simplify the management on site
Resource consumption	Low efficiency of resource usage Huge energy consumption	Industrialization of components increases the efficiency of resource usage A specified factory is usually needed
Environmental friendliness	Noise and pollution influence the ambient environment greatly	Rare noise and pollution hence more environmentally friendly
Construction function	Special processes need to be applied for water and fire protection Lower construction efficiency	Components of specified functions are precast in factory Lower construction difficulty

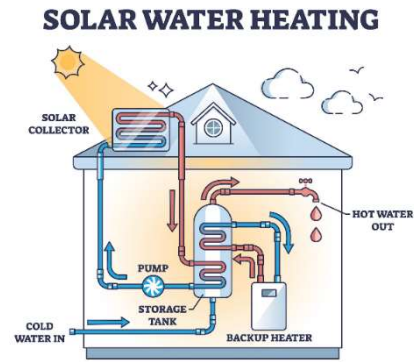
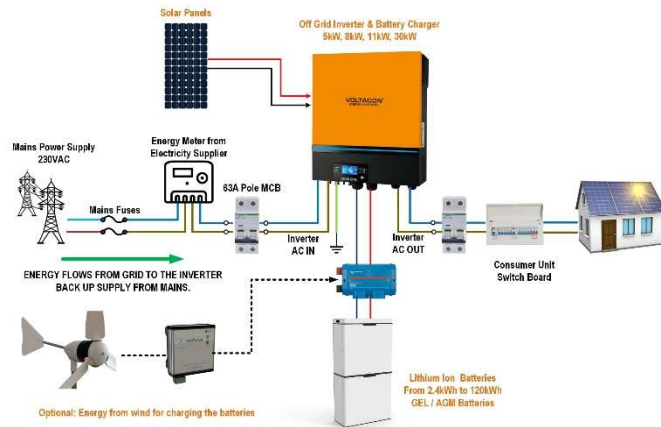
Comparison Evaluation

A hybrid approach, combining both prefabrication and on-site construction, seems to offer the best of both worlds. Prefabrication ensures rapid, cost-effective, and high-quality production of standard components, while on-site construction provides the adaptability necessary for complex elements. This hybrid system will streamline the construction process, reduce time delays, and ensures high standards of quality and safety.

Environmental Impact and Sustainability

Renewable Energy

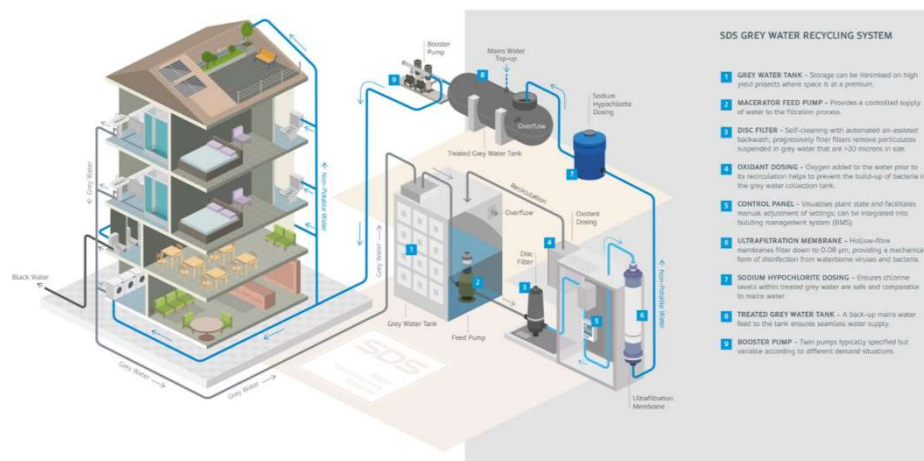
To address the growing concerns about environmental sustainability, the project will incorporate renewable energy solutions. Rooftop solar panels (PV) will be installed to harness solar energy in conjunction with an integrated battery supply. These panels will supply a significant portion of the building's electricity needs, whilst utilization of the batteries will allow power consumption during On-peak times, reducing reliance on non-renewable energy sources. Additionally, Solar Thermal (UV water heating panels) will be incorporated to allow the water to be heated before going into a communal boiler, thus minimizing energy consumption and helping toward minimizing carbon. Daigrams below show the Solar PV system and Solar Thermal in their respective systems.



(Admin, 2022)(Richards, 2024)

Water Management

Water management is vital for sustainability. This proposal includes the installation of rainwater harvesting systems and greywater recycling systems. Rainwater harvested from the large rooftop will be filtered and stored for non-potable uses such as toilet flushing and landscape irrigation. Greywater recycling will treat wastewater from showers and sinks, making it suitable for reuse in toilets and for irrigation purposes. These measures will conserve water and reduce the building's overall demand on municipal water supplies. Below is a diagram of a grey water recycling system.



(Capel, 2023) (Chan *et al.*, 2016)

Sustainable Materials

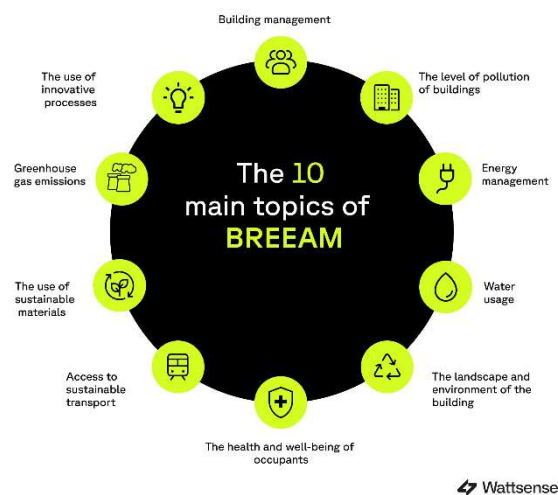
The selection of construction materials has a significant impact on the environment. This project prioritizes the use of recycled and low-carbon materials. Structural components will use glulam

beams, known for its strength and durability, and the small amount of concrete required compared to conventional construction, will be low-carbon concrete. This will further minimize carbon emissions during the construction process. The combination of these sustainable materials will reduce the building's carbon footprint, contributing to broader environmental conservation efforts.

Certifications

Aiming for an excellent BREEAM rating, the project will have to adhere to stringent environmental and sustainability standards.

BREEAM (Building Research Establishment Environmental Assessment Method) (*BREEAM | Sustainable Building Certification*, no date) is a globally recognized certification system that evaluates the environmental performance of buildings. Achieving this certification demonstrates the project's commitment to sustainability, energy efficiency, and environmental stewardship.



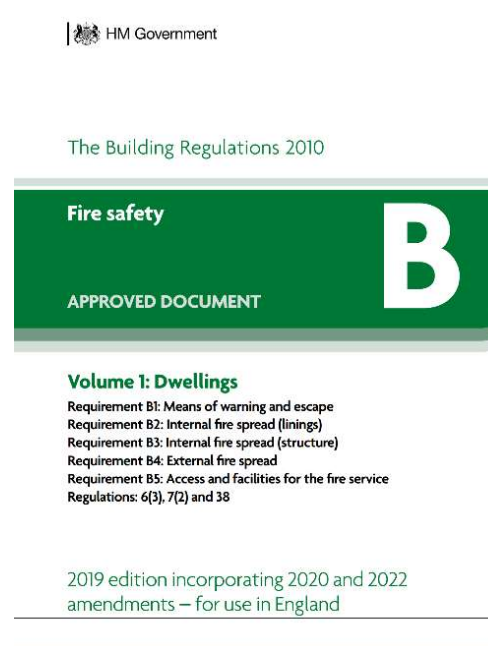
(*What is the BREEAM Certification for Buildings?* - Wattsense, no date) (*BREEAM | Sustainable Building Certification*, no date)b.

Fire Safety and Regulations

Fire-Resistant Materials

Ensuring the safety of occupants in the event of a fire is paramount. Fire-rated glass and steel materials will be used throughout the construction to enhance fire resistance. Fireproof systems will be in place to key structural elements such as elevators, stairways and hallways as per Approved Document B (fire safety) volume 2 (*Building Regulations 2010 Approved Document B Volume 2, 2019 edition, 2019*), preventing the spread of fire and maintaining structural integrity for longer periods. Fire-resistant doors and components will also be integral to the building design, providing crucial barriers against the spread of fire and smoke.

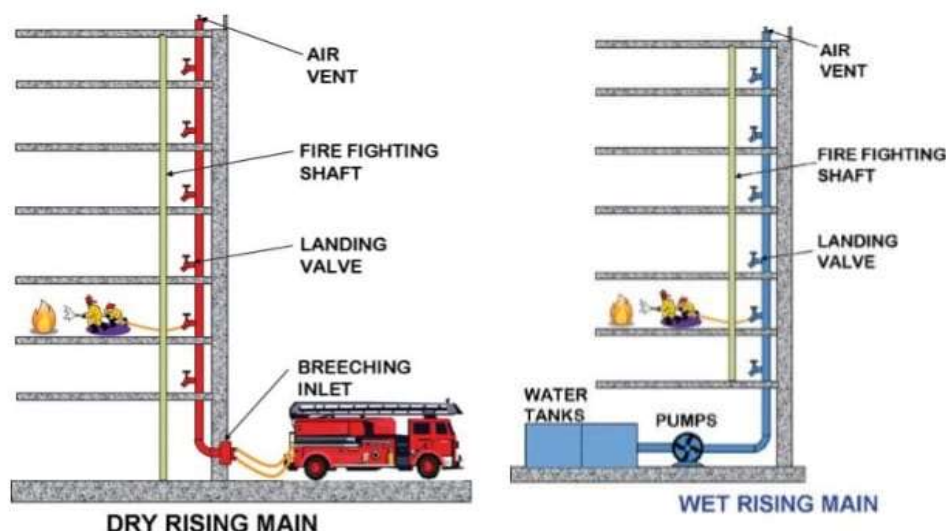
(*Building Regulations 2010 Approved Document B Volume 2, 2019 edition, 2019*),



Emergency Provisions

Emergency provisions will be meticulously planned and implemented. Clearly marked escape routes and easy-to-access fire exits will ensure efficient evacuation in case of an emergency. Fire sprinkler systems will be installed across all floors, providing automatic suppression in the event of a fire. Wet and dry risers will be installed throughout ensuring ease of access for emergency services, connected both to water storage tanks and mains water connection ensuring a plentiful supply of suppression.

Additionally, regular fire drills and maintenance checks will be instituted to keep systems functional and ensure occupants are well-prepared for emergencies.



(Firetecnic Systems Ltd, 2023) (Hood, 2024)

Regulations

Compliance with fire safety regulations is non-negotiable for high-rise buildings. This project will strictly adhere to BS 9999 standards (BS 9999: Code of practice for fire safety in the design, management and use of buildings) (BS 9999: Code of practice for fire safety in the design, management and use of buildings, no date), which “provides general recommendations and guidance for the design, management and use of buildings, ensuring effective fire protection for all people in and around buildings” (BS 9999:2017 Fire safety in the design, management and use of buildings - code of practice (Incorporating corrigendum No. 1), British Standards Institution - Publication Index | NBS, no date) stated in the publication by ‘NBS’. Ensuring compliance with these standards will involve rigorous safety checks, early consultation with fire experts, and continuous monitoring throughout the construction process. The project's adherence to these regulations will guarantee that it meets the highest safety standards, protecting the lives of students and minimizing the risk of fire-related incidents.

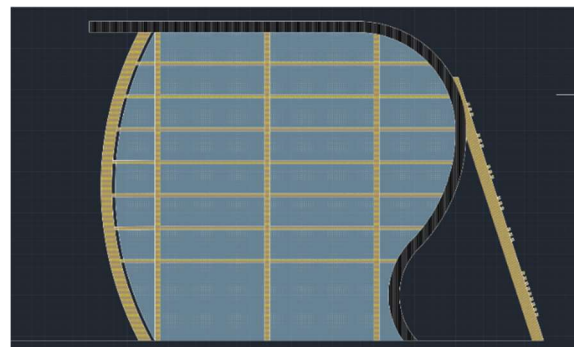
Fire resistance requirements for a few common building types are compared in the following table (Nsc, 2012) :

Building Description ⁺	Approved Document B (mins)	BS 9999 without sprinklers (mins)	BS 9999 with sprinklers (mins)
Open plan office building, 2 storey, less than 1000m ² ground floor area.	30	15*	15*
Open plan office building over 30m but less than 60m in height.	120 plus sprinklers	90#	60
3 storey Department store.	60	45	30
Department store between 11m and 18m in height.	60	75	60
Medium risk, 4 storey storage.	90	90	60
Leisure centre, 2 storey.	60	30	30

Aesthetics and Integration

Design Philosophy

The design philosophy draws inspiration from the nautical, coastal and industrial heritage of SA1, whilst focusing on functionality. The building's aesthetic merges contemporary industrial design with subtle nods to the area's natural beauty and coastal location, incorporating biomimicry, enhancing aesthetics. The use of materials like dark grey corrugated metal cladding and



aluminium frames reflects the industrial history of SA1, whilst the uses of beams in a grid pattern mimic the shape of a ship's hull, influenced by the substantial coastal industry in the area.

Student-Centric Features

Given the primary user group, the design will include vibrant common areas and green spaces that promote social interaction and collaboration among students. These spaces will be creatively designed to foster a sense of community, encouraging students to engage in both academic and leisure activities. The inclusion of study lounges, recreation rooms, and outdoor spaces will ensure that students have ample opportunities to unwind and socialize.

Accessible and Inclusive Design

The building will adhere to inclusive design principles as per the Approved Document M, "Inclusive design aims to remove the barriers that create undue effort and separation. It enables everyone to participate equally, confidently and independently in everyday activities." As stated by the 'Design Council' Fletcher et al. (2006), ensuring accessibility for all students, including those with disabilities. Features such as ramps, wide hallways, elevators, and accessible facilities will be integrated into the design. Additionally, adaptable living units will be available to meet the diverse needs of the student population, ensuring an inclusive living environment.



Conclusion

In conclusion, this design proposal presents a comprehensive approach to creating a medium to high-rise student accommodation in the SA1 area. Utilizing the site analysis, choosing appropriate foundation techniques, utilizing innovative construction materials, and adhering to environmental and fire safety standards, this project aims to set a benchmark for sustainable and student-centric living environments. The integration of prefabrication with on-site construction ensures efficient and adaptable building processes while promoting high-quality outcomes. Through careful consideration of aesthetics and accessibility, the design not only enhances the architectural character of SA1 but also fosters a thriving community for students. As the industry moves towards more sustainable and resilient building practices, this project stands as an exemplar of innovation, safety, and environmental awareness, poised to meet the demands of student life.

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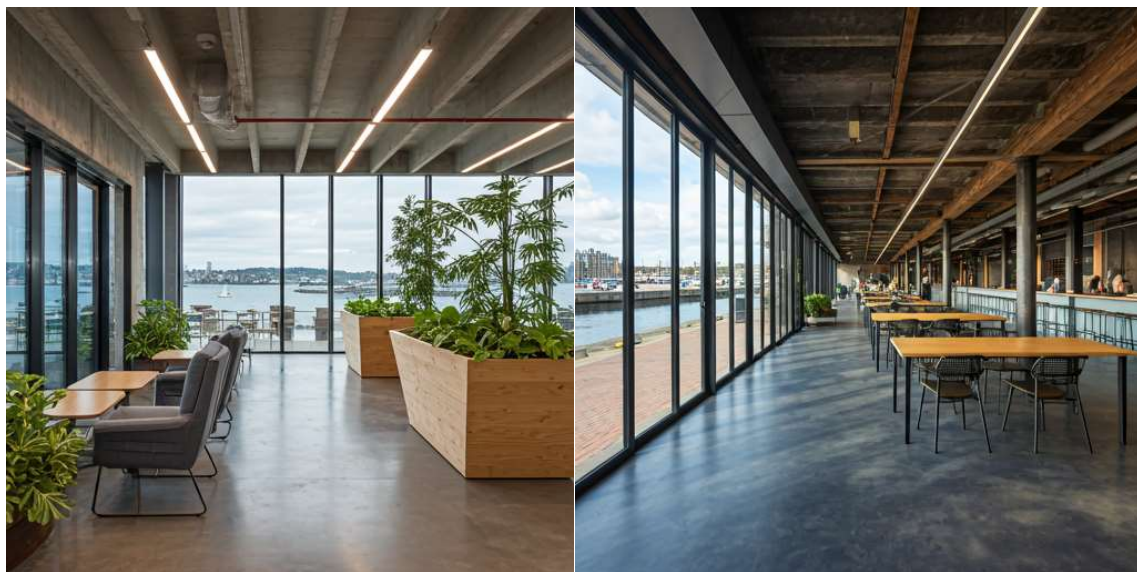
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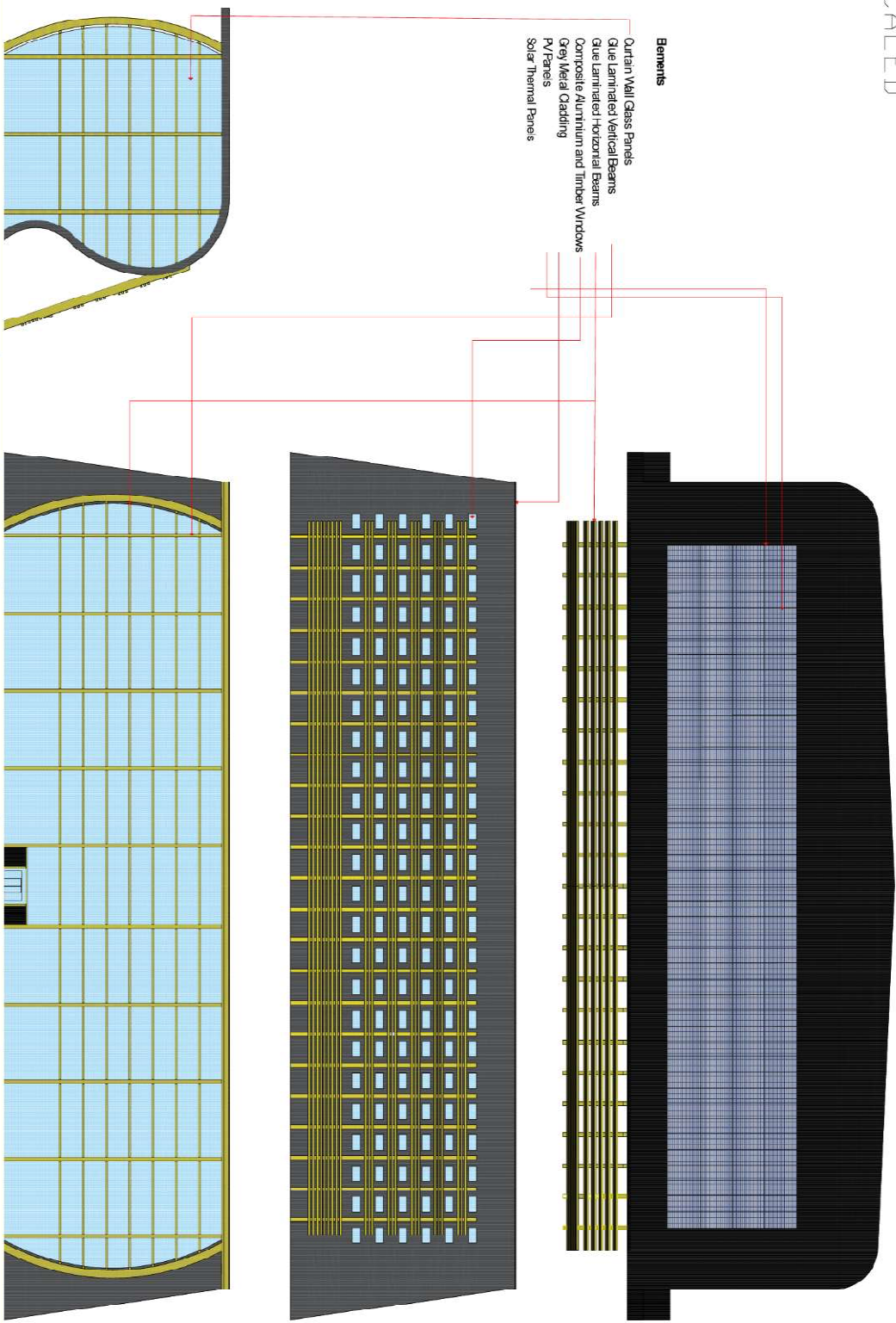
Appendices

Appendix A: Inspiration, Designs and CAD Drawings.

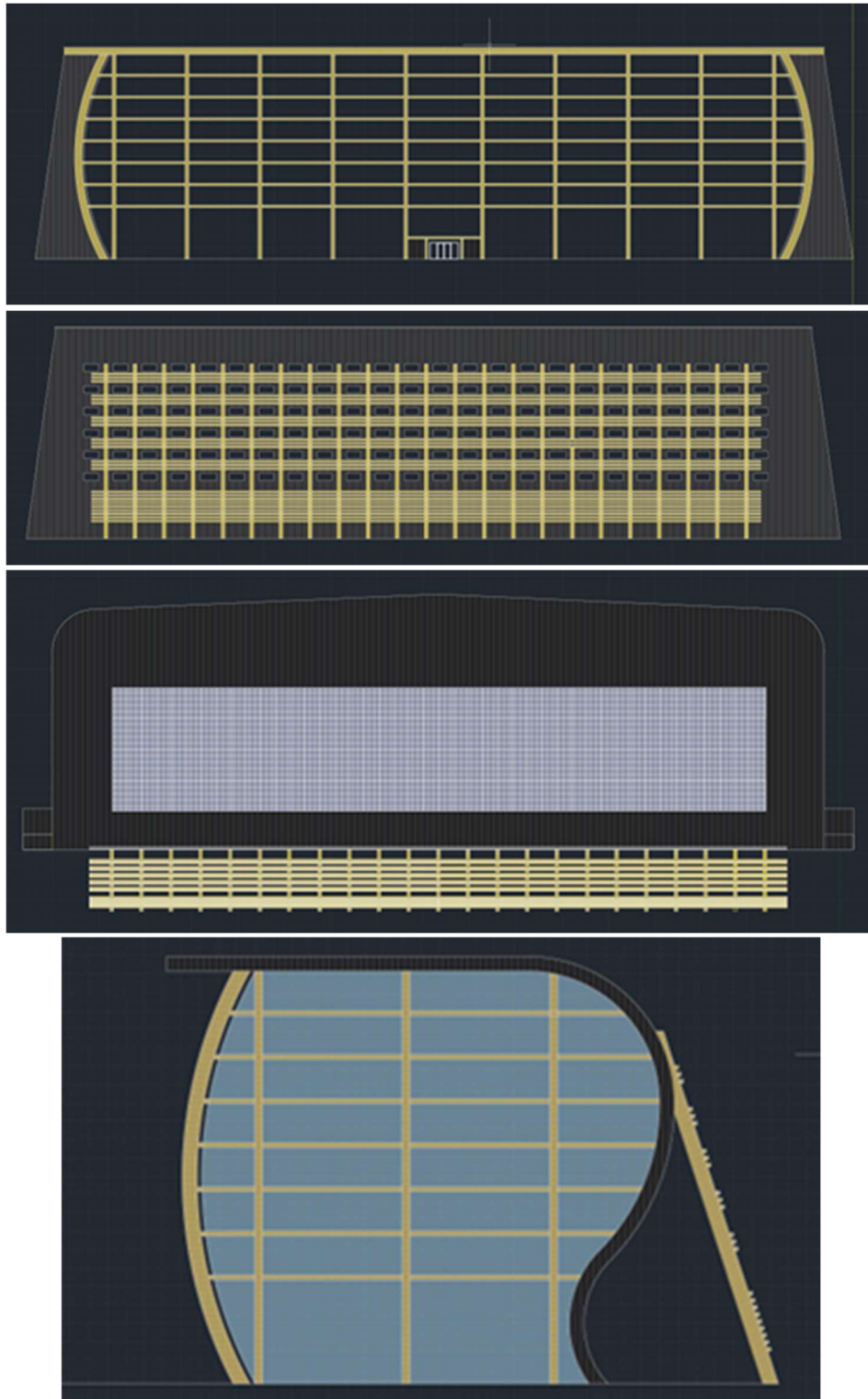
Proposed designs with inspiration for the design showing industrial nautical themes in a coastal environment, produced by Louis King(4/01/2024) showing the utilization of elements chosen in the buildings proposal.



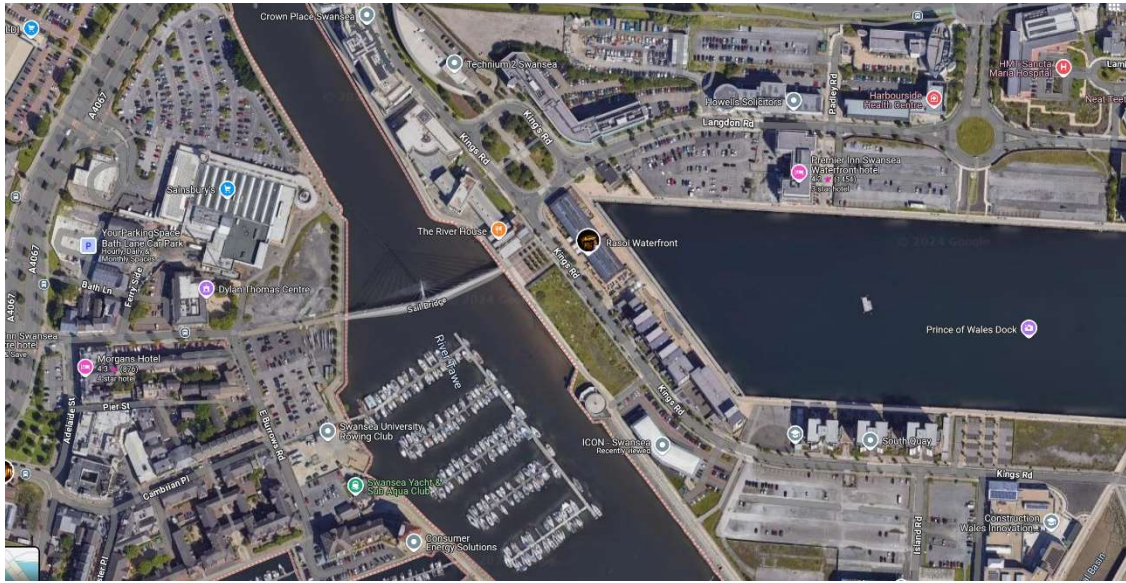
NOT SCALED



Project Medium rise building proposal design for student accommodation in SAI	Designed by	Checked by	Module Title	Date	Scale	Tutor
	Louis King		Construction Technology 2	4/01/25	Not Scaled	Rhodni Thomas
Drawing Title Medium rise building proposal design for student accommodation in SAI						
						Drawing No. No. 1



Appendix B: Site Map and Bore Hole Log.



Site map of the general area of the plot showing access routes and local amenities- ('Google Maps,' 2024)



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OSIRIS - CESCO LTD.				BOREHOLE No. 5					
SITE INVESTIGATION DIVISION				REPORT No. D83137					
LOCATION PROPOSED SECOND TAFE BRIDGE, SWANSEA SITE INVESTIGATION CONTRACT NO. 2				Ground/Bed Level 11.95m. O.D.					
Client WEST GLAMORGAN COUNTY COUNCIL				Coordinates 266224.877E 193253.217N					
Method/Diameter Shell & Auger Percussion boring using a Pilcon 1500 'Wayfarer' rig with 300mm dia equip. from GL to 7.00m and 250mm dia equip. from 7.00 to 10.00m. bgl.				Boring Commenced 3/9/83 Boring Completed 5/9/83					
Ground Water observations are given at end of log		Remarks							
Description of Strata		Scale 1:50			Samples/Coring Record				
		Depth (m)	Reduced Level	Legend	Ref. No.	Type	Depth (m) From To	N blows/0.3m	
Medium dense dark brown and grey- black silty f.m.c. SAND, f.m.c. GRAVEL and COBBLES comprising ash, brick, clinker, concrete, timber, grey-purple m.c. sandstone with fibrous plant debris. (MADE GROUND)		1.50	10.45		1	B	0.00	0.50	
					2	C/D	1.00	1.45	
Dense brown and grey-brown, mottled orange-brown silty f.m.c. SAND and f.m.c. GRAVEL comprising angular to subrounded grey-orange m.c. sand- stone with black coal lenses, purple m.c. sandstone, nodular ironstone. (RIVER GRAVEL). Becoming slightly clayey at 1.50m, 6.00-6.45m, 7.50-10.00m. bgl.					3	B	1.50	1.95	28
					4	C/D	2.00	2.45	
					5	B	2.50	2.95	
					6	C/D	3.00	3.45	
					7	B	3.50	3.95	
					8	C/D	4.00	4.45	
					9	B	4.50	4.95	
					10	C/D	5.00	5.45	
					11	B	6.00	6.45	
					12	C/D	6.55	7.00	
					13	D	7.50		
					14	C/D	8.00	8.45	
					15	D	9.00		

Key: SAMPLES: U=Undisturbed. B=Bulk Disturbed. D=Disturbed. P=Piston. W=Water.
STANDARD PENETRATION TEST: S=Hollow shoe. C=Cone point. R=Refer to text or explanatory data sheet.
() No. of blows to drive U sample.
f = fine. m = medium. c = coarse.

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OSIRIS - CESCO LTD. SITE INVESTIGATION DIVISION					BOREHOLE No. 5 Continuation Sheet No. 1 REPORT No. D83137						
LOCATION PROPOSED SECOND TAFE BRIDGE, SWANSEA					REPORT No. D83137						
Description of Strata			Scale 1:50		Samples/Coring Record						
(As above)			Depth (m) 10.00	Reduced level 1.95	Legend 	Ref. No. 16	Type C/D	Depth (m) From 9.55 To 10.00		N blows/0.3m 41	
GROUND WATER OBSERVATIONS											
Inflow observed at (m)		Visual rate of inflow		Water sealed off by casing at (m)							
NOT ENCOUNTERED											
Date	Time	Hole Depth (m)	Casing Depth (m)	Water Level (m)							
Hole completed at 10.00m bgl.											

Key: SAMPLES: U=Undisturbed. B=Bulk Disturbed. D=Disturbed. P=Piston. W=Water.
 STANDARD PENETRATION TEST: S=Hollow shoe. C=Cone point. R=Refer to text or explanatory data sheet.
 () No. of blows to drive U sample.
 f = fine. m = medium. c = coarse.