Construction Technology 2

University of Wales Trinity Saint David

School of Architecture, Construction and Environment

Construction Technology 2

Module Code: ACBA5019

Assignment Title: Building Evaluation Report

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Programme: BSc Quantity Surveying

Word Count: – 2674 / 2750

Submission Date: 12 January 2026

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1. Introduction

This report looks to evaluate a construction technology strategy for a medium-to-high rise hotel near Singleton Hospital, Swansea. The site's coastal exposure, variable ground conditions, and adjacency to sensitive hospital infrastructure highlight the importance for low-vibration foundations, a corrosion-resistant frame along with a durable and low maintenance envelope (Met Office, 2024). In terms of this specific site a steel-concrete frame with a reinforced concrete core has been proposed for its high stiffness-to-weight efficiency and resistance level to lateral wind. Continuous Flight Auger (CFA) piles are selected in terms to mitigate vibration and manage groundwater ingress (ICE, 2020) , whilst unitised aluminium rainscreen facade with a mineral-wool insulation ensures for fire safety , thermal compliance and long-term durability under the coastal conditions (Approved Document B, 2022).The client , being inexperienced in construction technology , requires an evidence-based evaluation of three major elements. (1) structural frame and foundations , (2) building envelope systems , and (3) prefabrication vs on-site construction. Through this paper each will be critically assessed with respect for their design integrity , stability , fire performance , cost , and environmental impact. The analysis employs UK Building Regulations, BS EN standards , and Welsh Net Zero 2050 objectives (Welsh Government, 2021) to justify practical , sustainable solutions. The aim is to show the client a technically robust and economically resilient approach aligned with Quantity Surveying and lifecycle value.

2. Site Context and Constraints

The hotel will be located near the Swansea seafront, across from Singleton Hospital, it combines tourism potential with large environmental constraints.Being classified as Exposure zone 4 under BS EN, as severe wind, rain and salt deposition is high which means the building requires a façade capable of resisting high lateral loads and corrosion (BS EN 1991-1-4:2005). The consistent south-westerly winds and open coastal terrain necessitate improved stiffness and strong coating to allow for long-term service (Met Office, 2024).Subsurface investigations (BGS, 2023) show ground over glacial till, with weathered mudstone at around 8–12 m depth and a high groundwater table, this increases uplift and waterproofing demands. These conditions favour low-vibration CFA piling with corrosion-resistant reinforcement in order to protect operations of nearby buildings, such as Singleton Hospital.

Purely from a regulatory perspective, the 12–15 storey classification uses the Approved Document B (2022) high-rise requirements for non-combustible façades with protected escape cores (Approved Document B, 2022).Neutral-toned finishes are highlighted to work well with Swansea's marine skyline whilst also ensuring long-term resilience.

(Figure 1: Site context diagram showing location, prevailing winds, and nearby constraints.)To be in line with Planning Policy Wales and Future Wales: National Plan for 2040, the proposed hotel development reflects the Welsh Government's sustainable placemaking principles and low-carbon ambitions (Welsh Government, 2021).Through locating the development within an existing urban area near public transport links and key services, this proposal supports the policy’s aim to reduced travel emissions and promoting sustainable tourism along the Swansea Bay corridor (Welsh Government, 2021).

Furthermore, the project's focus on low-vibration foundations, non-combustible façade materials, and a steel-concrete structure shows compliance with Policy 9 and Policy 17 of

Future Wales 2040, ensuring that construction technology decisions align with Wales's transition to a net-zero-carbon built environment (Welsh Government, 2021).

3.1 Structural Frame Options and Comparison

The proper frame for the 12-15 storey frame for the Swansea hotel needs to account for stiffness , fire integrity , buildability , and sustainability within a marine environment. Evaluating the composite steel frame with an RC core is the best suitable choice. It is faster to construct with off site fabrication compared with RC alternatives (Buildoffsite, 2023) and improves lateral stiffness and ductility.

The other two options have their limits in the chosen environment , RC frames give fire resistance and strength but have longer curing cycles and higher embodied carbon 500-600kg CO2e/m2 than hybrid steel offering 340-380kg (LETI 2020).Timber hybrids are the other choice which are sustainable but are restricted in Approved Document B which limits combustible materials above 18m.

With this information , the steel-concrete idea delivers a balance between structural efficiency, speed, fire safety and environmental impact, which betters the project's technical requirements and sustainability targets in line with Net Zero.

Comparing this project to other high-rise buildings in the area reinforce this idea. The Meridian Tower in Swansea , constructed on similar coastal ground conditions, adopted a piled foundation system with concrete core to withstand strong winds shows that this is the best choice in performance for Swansea's marine environment.

(Figure 2: Typical composite frame with RC core and column grid.)

3.2 Lateral Stability, Fire Safety, and Foundation Strategy

An important factor when constructing a coastal high rise that is exposed to strong wind

levels is ensuring structural stability and fire integrity is top priority. Wind tunnel data from nearby Swansea projects report pressures of 1.5kPa at 50m , this shows the need for a reinforced concrete core with composite steel framing . This strategy hits Eurocode fire criteria, achieving 60-90 minutes resistance through intumescent coating and protected floors (Approved Document B, 2022). Steel provides ductility , whilst concrete offers mass and fire separation.

Lifecycle modelling shows that GGBS concrete and recycled steel can lower embodied carbon up to 35% (UKGBC, 2023; Concrete Centre, 2021). Steel has a recyclability od 96% and coating cycles under BS EN ISO 12944-5:2018 ensure predictable long term costs and corrosion protection in C5-M conditions. The composite frame lower self weight lowers axial loads by 25% , this then improves efficiency and programme certainty.

Ground investigation data from the British Geological Survey (BGS, 2023) shows that the Swansea Bay and Sandsfield area is built up of superficial deposits (See Appendix 4) over glacial till with a high groundwater table, conditions which are unsuitable for shallow foundations for a 12-15 story structure. (see Appendix 2 for detailed borehole interpretation).

Quantitative Comparison of Structural Options

Table 2 compares the three frame systems in terms of cost, embodied carbon and programme duration. The reinforced concrete frame has higher embodied carbon with a slower construction time. The hybrid timber option being sustainable is desirable , it is height limited and non compliant above 18m. The steel-concrete frame offers the best balance at around £2,400/m2 with the fastest programme, this reinforces the cost suitability with materials to fit Swansea's coastal location.

New Angle , Adaptive Reuse and Value Resilience

(Figure 3: Cross-section showing CFA piles, raft, and groundwater level.)

For future preparedness there may be a rise in urban pressures which focuses the need on functional conversion of the hotel structures into residential or mixed use assets , for example when Covid19 had hit many hotels turned into makeshift hospitals for emergencies (Smithers, 2020). The use of steel-concrete grid with open spans and demountable connections allows for easy reconfiguration , this also improves residual value and lowers demolition waste. In a QS viewpoint this is in line with RICS WLCA 2023 principles by safeguarding embodied value and extending the building's service life.

(Figure 3: Cross-section showing CFA piles, raft, and groundwater level.)

4. Building Envelope: Materials and Method Choices

The coastal context needs a weathertight, noncombustible, acoustically resilient and low-maintenance envelope. Swansea's high winds and rainfall being over 1200mm per year with a high level of salt places this location in Exposure Zone 4 (Met Office, 2024). To comply with Part L (2021) and Approved Document B (2022), facades above 18m must achieve or better U<0.26W/m2K and A1/A2-s1,d0 fire ratings. These strict requirements can restrict viable systems to non combustible drained and ventilated items such as curtain walling.

4.1 System Selection and Performance

Two systems were assessed - improvised curtain walling and ventilated rainscreen cladding. Curtain walling being prefabricated gives it the benefit of factory precision and airtightness levels but requires C5-M coatings for chloride protection. The other system being rainscreens offer improved hygrothermal and maintenance performance . The selected hybrid approach uses curtain walling to public areas and A2-rated aluminium rainscreens to guest room elevations (Approved Document B, 2022).

To further improve the heat retention in the building Triple-glazed low E units lower glare and overheating (CIBSE TM52, 2021) , limiting glazing to 35% balances solar control and comfort (LETI,2020). Acoustic laminated glass maintains hotel-appropriate noise levels. Airtight SFS walls limit drafts, while the drained cavity controls moisture and supports overall comfort. An example that supports this approach is the Celtic Manor Resorts aluminium rainscreens demonstrated durability under moisture cycling , then reinforcing suitability for marine exposure.

4.2 Fire, Durability, and Maintenance

All envelope components must be non -combustible when creating this hotel. Slab edge EI60 fire barriers and fire rated panels maintain compartmentations whilst aluminium panels coated to 80um or anodised to provide 25 years of life before needing serious maintenance. Modular fixing zones allow isolated panel replacement and support WLCA principles.

The Grenfell inquiry highlighted dangers of combustible cladding and missing cavity barriers, reinforced the need for A1 and A2 systems above 18m. Glulam is an option for mass producing sustainability and strong beams/ columns is a good choice despite its predictable charring; it has a high level of combustibility and is therefore unsuitable for high facades under Approved Document B.

A relevant building facade failure in a location near can be seen at the Great Hall on Swansea campus , this shows extensive algae staining developed onto the rendered external walls within a short period from construction or maintenance. This failure is mainly attributed to the use of smooth cementitious render in a highly exposed coastal microclimate, which is against the elements of continuing saline wind (NASA, 2026). These conditions increase moisture retention at the surface, creating an ideal environment for biological growth.

The biggest issue that is known in the Great Hall is the absence of a drained and ventilated cavity , this means that moisture was retained at the surface, creating favourable conditions for algae to grow and to accelerated aesthetic degradation with consistent maintenance. In the hotel example the hotel design needs to avoid rendered facade systems and must include a ventilated aluminium rainscreen assembly with a drained cavity and rear ventilation.

From using this approach it will promote rapid moisture dissipation , lower the surface being wet time , and limit bio-growth risk , these are considered a need in Exposure Zone 4 conditions. From a whole life cost perspective , this design decision will mitigate premature cleaning cycles , lower the amount of maintenance to the facade , less moisture in the structure meaning more durable long term , more visually appealing due to less staining.

4.3 Sustainability and Carbon Impact

Lifecycle assessments (UKGBC, 2023) show how recycled aluminium and GGBS-enhanced concrete are able to reduce levels of embodied carbon up to 30-35%. A side benefit of this is improved airtightness which lowers heating demand by 25% and supports BREEAM's ''EXCELLENT'' rating for the building which is desirable for building standards. Integrating predictive maintenance cycles will improve whole-life value and aligns with Welsh Net Zero 2050.

This approach supports the Building Safety Act 2022, which requires digital traceability, and aligns with Wales's Carbon Budget 2 and the Well-being of Future Generations Act. RICS WLCA 2023 gives a continued QS framework for comparing embodied impacts and cost-carbon optimisation.

4.4 New Angle – Future Facade Adaptability

(Figures 4–5: Typical façade section showing drained cavity, fire-stop detail, and C5-M coating specification.)

Projected increases in coastal wind and salinity , this may lower the coating's lifespan. A way to counteract this is through designing upgrade ready interfaces and modular replacement zones that allow for future involvement of photovoltaic or advanced composite panels without changing the structure easily. (Watt et al., 2023)

5.0 Prefabrication versus On-Site Construction

Through the use of prefabrication strategy it can utilise the precision of factory level material and build into the building to improve programme certainty , quality and sustainability. Modern Methods of construction , especially category 2 volumetric pods and Category 3

panelised systems show gains in speed and less waste reduction.(UK Gov MMC Framework, 2021). This is measurably improved to the reliability of on site construction where it can depend on weather , skill level and accurate placements.

5.1 Hybrid Construction Approach

Off-site fabrication of facade units, bathroom pods and MEP risers can cut site labour by 35% and shorten the programme by 25% (Buildoffsite, 2023). Reduced deliveries and quieter operations lower hospital disruption levels , while factory environments deliver ISO 9001 quality assurance. However, late-stage design changes and cranage limits in coastal winds necessitate selective deployment. A hybrid DfMA strategy achieves optimal performance without constraining flexibility *(DesigningBuildings, 2024).*

5.2 Component Application and Benefits

Prefabricated building components can improve construction efficiency, quality and safety. For example, pre-made MEP risers simplify the processes and can reduce the need for hot works, then lowering fire and health and safety risks. Similar to this the use of bathroom pods can lower the time for installation from two weeks to two days per unit while also cutting defects by up to 80% , demonstrating clear productivity and quality benefits (BRE,2020).

With this , unitised facade panels allow for rapid building enclosure and improved airtightness, supporting both programme certainty and building performance. These modules are craned directly into position with minimal on site finishing , this then reduces reliance on traditional sequential construction methods. As a result, accident exposure can be reduced by up to 45% with a 60% reduction in waste (Construction Innovation Hub, 2022). From a sustainability viewpoint, factory based production can align strongly with Net Zero 2050 objectives as it lowers the energy demand.(UKGBC, 2023).

Regulatory and Policy Alignment

The proposed design complies with both building regulations and the building safety act 2022, which describes clear dutyholder accountability and traceable design decisions for higher-risk buildings. Each major system , frame , foundation and facade is able to be digitally verified within BIM models to support Gateway 2 approval. Furthermore, the strategy aligns with the Welsh Government Net Zero Wales Plan(2021-2050) and the RICS Whole Life Carbon Standard (2023) ensuring transparent reporting of embodied carbon of operational emissions. Through embedding performance verification and lifecycle cost forecasting at design stage ,the proposal exceeds statutory minimums, moving the projects as a model of compliant and future-proof construction delivery.

Limitations

Although on the other hand , the widespread adoption of MMC within coastal welsh contexts continues being constrained by limited regional manufacturing capacity and supply-chain maturity (CIOB ,2022). This creates a risk in procurement lead times and cost escalation if local capability does not expand in line with policy ambitions

Recommendations

In order for this project to progress , it is recommended that detailed wind-tunnel and geotechnical investigations confirm design assumptions for lateral stability and pile capacity. Early contractor involvement should support DFMA integration and logistics planning for prefabricated modules. A stage 3 digital model incorporating embodied-carbon tracking under the RICS Whole-Life Carbon Assessment (2023) is advised to refine sustainability outcomes. Finally , procurement under NEC4 Option C with performance-based clauses will allow for balanced risk allocation and transparency across the design-for-manufacture

workflow. Through completing this it will also benefit the surrounding economy by promoting local employment and Welsh manufacturing supply chains.

Conclusion

Through this paper it has critically evaluated the structural, envelope and construction methodology options for a medium-to-high rise hotel in Swansea. In response to the site's marine climate, high winds and variable subsoil, a steel-concrete frame with CFA piled-raft foundations was identified as the optimal solution. This system delivers high lateral stiffness, lowered settlement risk and fire resistance whilst minimising programme duration and embodied carbon. Although the steel-concrete hybrid system asks for a higher starting cost compared with reinforced concrete, its superior structural efficiency, speed and long-term sustainability make it a future-proof strategy.

For the building envelope, a hybrid facade strategy combining unitised curtain walling for public zones and A2-rated aluminium rainscreen cladding achieves weather protection, durability and compliance with Approved Document B and Part L (2021).

The construction methodology uses selective off-site manufacture of bathroom pods, MEP risers and facade panels, this improves quality and sustainability. These technologies align with the Welsh Net Zero 2050 goals (WelshNetZeroTargets 2022). The design takes into account engineering rigour, sustainability and commercial realism. Continued innovation in low-carbon materials, modular systems and digital lifecycle modelling will allow greater resilience and environmental performance.

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Appendix -

Appendix A

Figure 1 : Risk Register - table 1

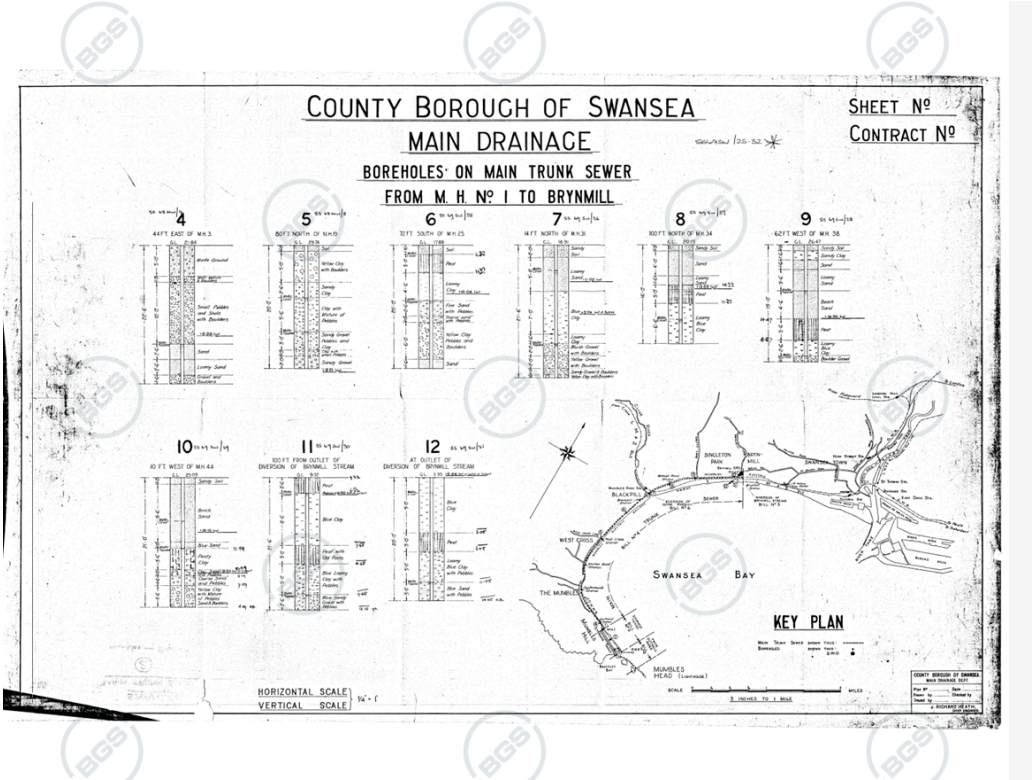
Risk	***Likelihood***	***Impact***	***Mitigation***
Fire barrier discontinuity	*Medium*	*High*	*Factory QA & site inspection log*
Wind uplift on facade panels	*Low*	*High*	*Verified fixings, pull-out tests*
Groundwater uplift	*Medium*	*Medium*	*Raft tie-down & drainage*
Late design freeze (MMC)	*Medium*	*High*	*Early DfMA workshops*
Coating degradation (C5-M)	*Medium*	*Medium*	*Maintenance plan, QA test reports*

Figure 2 - Table 2

Frame Type	Cost (£/m2 GIA)	Embodied Carbon (kgCO2e/m2)	Programme Duration	Notes
Reinforced Concrete	2,700	560	Long	Robust but heavy
Steel Concrete Composite	2,400	380	Fast	balance of performance
Timber Hybrid (Glulam)	2,300	300	Moderate	Limited fire compliance over >18m

-(Adapted from LETI 2020; Concrete Centre 2021; Buildoffsite 2023)

Appendix 2



/https://api.bgs.ac.uk/sobi-scans/v1/borehole/scans/items/370520

British Geological Survey borehole data (BGS ID: 370520; Reference SS69SW28) shows that ground conditions across Swansea Bay and Sandsfield area are normally made ground and superficial deposits overlying glacial till, with weathered mudstone found at depths of 8-12m underground. The borehole records also confirm a consistently high groundwater table, often within 1-2m of ground level , reflecting the site's coastal proximity and low-lying topography. These conditions clearly show a risk of excessive settlement and bearing failure if shallow foundations were adopted especially for a 15 storey structure. Comparing these ground profiles near Swansea is Port Talbot which has similar issues with similar stratigraphy , and the need to reinforce the regional consistency of weak near-surface soils and variable groundwater pressures. The adoption of CFA (Continuous Flight Auger) piled foundations is justified , as piles can transfer structural loads well to competent strata within weathered mudstone whilst also minimising vibration. From a structural risk perspective , the BGS data is vitally important to look at before construction and the correct foundation solution to ensure long term durability and stability is important especially when dealing with a large number of the public.

Appendix 3 - Great Hall , Swansea University

Appendix 4 - Swansea Bay ground/sand conditions