Fundamentals of Construction Technology

Student: Keiran Rees
Module: ACBA4022
Date: 30/04/26
Lecturer: Allan Nantel

Introduction 2
The Site Pre-1900 to modern day. The Mumbles Railway 2
Recommendations for Detailed Site Investigation 2
Ground Conditions and Compressible Soils (High Risk) 3
Groundwater and Tidal Fluctuations (High Risk) 3
Contamination Risk / Made Ground (Moderate Risk) 3
Chemical and Corrosive Environment (Moderate Risk) 3
Regulatory Compliance and Authorities 4
Codes of Practice and Building Regulations 4
Local Authority and Agency Involvement 4
Foundation Design 5
References 7

Introduction

This report presents a geotechnical study and foundation design for a new mixed-use development on the Swansea foreshore. The site sits directly on the promenade between County Hall and the Swansea Marriott Hotel, sharing parts of their existing car parks.

The 2,000 square meter building will feature ground-floor commercial spaces, including a restaurant, cafe, and fully fitted kitchens, with a manager's apartment and staff facilities on the second floor. A major architectural requirement is a continuous glass facade opening directly onto the promenade.

The site's coastal location and history with the Swansea and Mumbles Railway present significant geotechnical challenges. Standard shallow foundations are unsuitable due to the heavy structural loads, weak beach soils, tidal groundwater, and the high sensitivity of the glass front to ground movement.

To address this, the report will outline the site's history and geology, recommends a detailed ground investigation, reviews relevant building regulations, and proposes a continuous flight auger (CFA) piled foundation to safely support the structure and protect the glass facade from settlement.

The Site Pre-1900 to modern day. The Mumbles Railway

Historically, the Swansea foreshore was defined by the presence of the Swansea and Mumbles Railway. Operational from 1807, it was the world's first passenger railway (Welsh Railways Research Circle, n.d.). Ordnance Survey maps from the late 19th century indicate that the proposed site area was situated immediately adjacent to, or directly upon, the railway's path (Ordnance Survey, 1880).
Throughout the first half of the 20th century, the railway was electrified and saw heavy use. The foreshore area was heavily modified with retaining walls and track ballast (BBC, 2010). The continuous operation of steam, diesel, and eventually electric trains along this specific strip of land (Ordnance Survey, 1938) introduced the potential for localized ground contamination (such as ash, clinker, and oil). In 1960, the Mumbles Railway was officially closed and dismantled, fundamentally altering the landscape of the site (BBC, 2010).
Following the removal of the railway, the land was redeveloped into the modern Oystermouth Road dual carriageway. The immediate site area was repurposed to accommodate public car parking, pedestrian promenades, and coastal landscaping. Modern aerial imagery confirms that the site is currently an undeveloped patch of vegetation situated between the hard-standing car park and the sandy beach foreshore.

Recommendations for Detailed Site Investigation

Given the historic background and the coastal geology of the site, a specialized geotechnical investigation is required. I advise that geotechnical contractors check all elements that lie in the highly compressible beach deposits, the tidal groundwater fluctuations, and potential historical contamination. All site investigation works must be planned and executed in accordance with industry best practices, such as those outlined in Chapter 4.1 of the NHBC Standards (National House-Building Council, 2024).

Ground Conditions and Compressible Soils (High Risk)

According to standard geological mapping of the Swansea area, the superficial geology of the foreshore consists of recent marine beach and tidal flat deposits comprising sands, silts, and clays (British Geological Survey, n.d.). Geotechnically, these unconsolidated deposits typically possess low, variable load-bearing capacity and present a high risk of structural settlement.

- Recommendation: The contractor must execute deep boreholes (using Cable Percussion or Rotary Core drilling techniques) to establish the depth to a competent, load-bearing stratum, such as stiff glacial till or bedrock. Standard Penetration Tests (SPTs) must be conducted at regular intervals to determine the relative density and bearing capacity of the granular deposits.

Groundwater and Tidal Fluctuations (High Risk)

Due to the immediate proximity to the sea, as highlighted by coastal risk mapping (Natural Resources Wales, n.d.), the groundwater table will be shallow and heavily influenced by tidal movements. This poses a severe risk of trench collapse, running sands, and flooding during construction.

- Recommendation: Standpipe piezometers must be installed within the boreholes. Continuous monitoring over a minimum of a two-week period is required to map peak tidal groundwater fluctuations. This data is critical for determining safe excavation depths and calculating uplift pressures on the foundation.

Contamination Risk / Made Ground (Moderate Risk)

Given the historical presence of the Swansea and Mumbles Railway, there is a risk of localized 'made ground' containing ash, heavy metals, or hydrocarbons left over from over a century of rail operation.

- Recommendation: Environmental soil sampling must be undertaken during the borehole drilling in accordance with the Environment Agency's Land Contamination Risk Management (LCRM) guidance (Environment Agency, 2023). Samples should be sent to an accredited laboratory for Waste Acceptance Criteria (WAC) testing to ensure safe off-site disposal of any excavated spoil.

Chemical and Corrosive Environment (Moderate Risk)

The marine environment indicates that the groundwater will likely be saline, posing a severe corrosion and degradation risk to buried foundation materials.

- Recommendation**:** Soil and groundwater must be tested for aggressive chemical properties. Specifically, laboratory testing for pH, chloride levels, and water-soluble sulfates must be conducted to dictate the appropriate concrete class to be used in the foundations, strictly following the site preparation guidance in Approved Document C (Welsh Government, 2017) and the concrete durability requirements in NHBC Standards Chapter 2.1 (National House-Building Council, 2024).

Regulatory Compliance and Authorities

The recommendations provided for the site investigation and subsequent foundation design are derived from the following core regulations and codes of practice.

Codes of Practice and Building Regulations

Geotechnical design and site investigation: The site investigation and foundation design will follow the free frameworks provided in the NHBC Standards. The ground investigation will be guided by Chapter 4.1 (Land Quality - managing ground conditions), and the piling design will follow the rules in Chapter 4.4 (Pile foundations) (National House-Building Council, 2024).

Contamination: The methods for testing the soil for any historic railway contamination will follow the Land Contamination Risk Management (LCRM) guidance published by the Environment Agency (Environment Agency, 2023).

Building Regulations (Wales): The project legally must follow the Building Regulations 2010. For the foundation design and site preparation, the work will specifically stick to the Welsh Government's Approved Document A (Structure) to make sure the building is supported safely, and Approved Document C (Site preparation and resistance to contaminants and moisture) (Welsh Government, 2017).

Local Authority and Agency Involvement

- Swansea Council (Cyngor Abertawe): The local Building Control department must be engaged to approve the foundation design, inspect the works, and ensure strict compliance with the Building Regulations.

Contact Details: Building Control, Swansea Council, Civic Centre, Oystermouth Road, Swansea, SA1 3SN.

- Natural Resources Wales (NRW): Because the site is situated directly on the foreshore, it is located within a designated flood risk zone. The development must comply with the Welsh Government's TAN 15: Development and Flood Risk policy (Welsh Government, 2004). NRW must be consulted regarding potential coastal flooding impacts, sea-level rise projections, and the integrity of existing sea defenses adjacent to the site.

Contact Details: Planning Policy Branch, Welsh Government, Cathays Park, Cardiff CF10 3NQ.

Foundation Design

The proposed development is a substantial mixed-use structure situated on the promenade next to Swansea's Marriott Hotel and the County Hall. The building has a Gross Internal Area (GIA) of 2,000 m^2 at the ground floor level. This ground floor will accommodate highly concentrated dead and live loads from a commercial restaurant, café bar, fully fitted kitchens, and dense food stores. The second floor will impose further structural loads from a self-contained manager's apartment, meeting rooms, and staff welfare facilities.

Crucially, the architectural brief mandates a continuous glass opening directly onto the promenade. Glass possesses virtually zero tolerance for structural deflection. Therefore, the primary engineering constraint for this foundation design is the absolute mitigation of differential settlement, as even minor

uneven ground movement would induce stress fractures and catastrophic shattering of the glass under limit state design principles (National House-Building Council, 2024).

To establish a predictive ground model, archival borehole log data from the preparatory ground investigation of the nearby Meridian Tower (Swansea Marina) has been utilized as a representative stratigraphic sequence. Based on this established local geology, the 2,000 m² footprint is anticipated to sit above the following sequence (British Geological Survey).

1. Made Ground (historical reclamation and railway sub-base).
2. Blown Sand / Beach Deposits (unconsolidated and highly permeable).
3. Alluvium and Peat Layers (highly compressible).
4. Glacial Till / Boulder Clay (stiff, load-bearing stratum).
5. Carboniferous Bedrock (Pennant Sandstone/Mudstone at depth).

This stratigraphy presents a severe geotechnical hazard. If traditional shallow foundations (such as a raft or strip footings) were utilized, the heavy structural loads combined with the tidally fluctuating groundwater would cause uneven consolidation of the underlying peat and alluvium, leading to unacceptable differential settlement. Furthermore, excavating shallow trenches in water-bearing beach sand would result in running sands and trench collapse.

To ensure the absolute structural rigidity required for the glass frontage and to bypass the incompetent superficial deposits identified in the Meridian Tower sequence, a deep foundation solution is mandatory. I recommend the use of Bored Cast-in-Place Piled Foundations, specifically utilizing a grid of Continuous Flight Auger (CFA) piles (Keller UK).

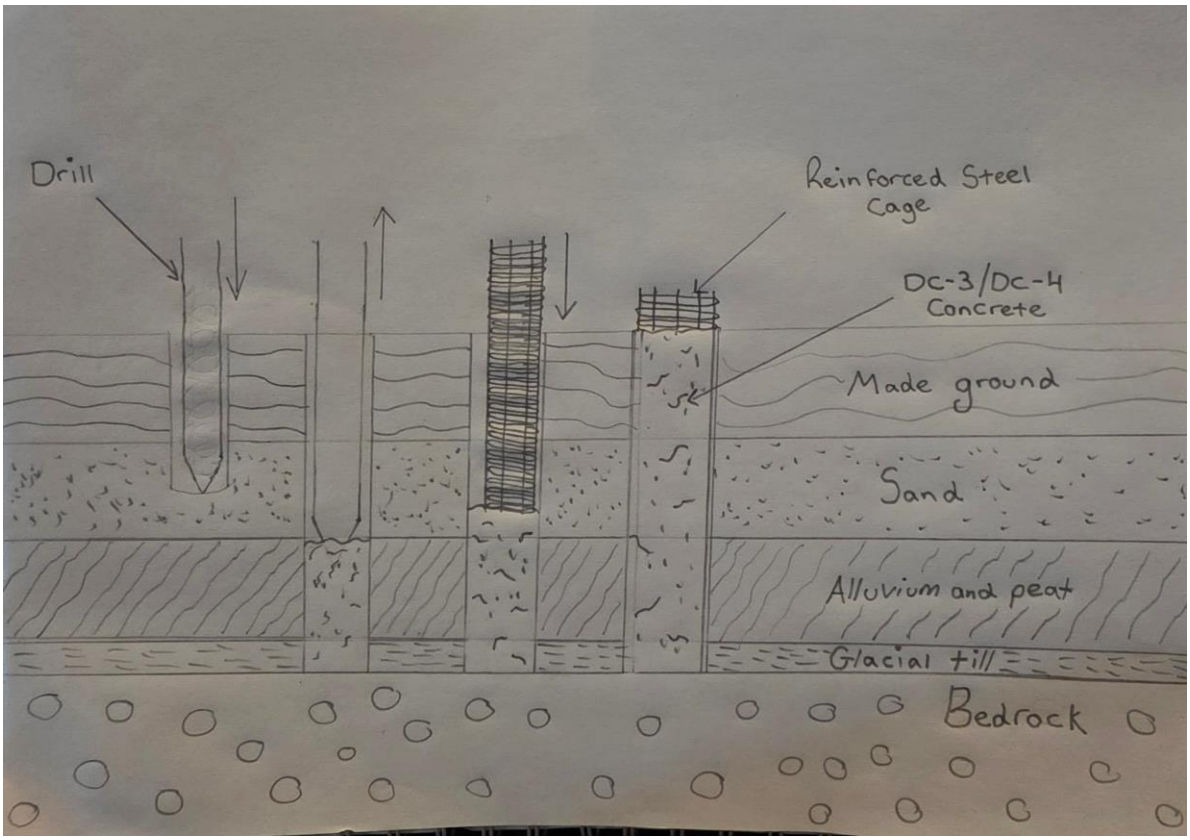
According to Keller UK, CFA piling is a highly efficient, low-vibration solution ideal for water-bearing, alluvial coastal soils where temporary casings are not practical. A hollow-stemmed auger is drilled into the ground, plunging entirely through the weak made ground, beach sands, and compressible peat layers, until it sockets firmly into the stiffer underlying Glacial Till or bedrock. As the auger is slowly withdrawn, high-workability concrete is pumped under static head pressure down through the hollow stem (Keller UK).

This method ensures that the sides of the bore are constantly supported by either the soil-filled auger or the pressurized wet concrete. It completely eliminates the risk of groundwater flooding, the bore or the sandy hole collapsing. Crucially, it is a virtually vibration-free technique, allowing for rapid and safe installation immediately adjacent to the existing Marriott Hotel and County Hall car parks without undermining their existing foundations. (Keller UK).

The heavy structural loads of the 2,000 square meter building will be transferred deep into the ground. Most of the weight will rest on the bottom of the piles sitting on the hard bedrock (end-bearing capacity), with some extra support from the friction along the sides of the concrete piles (skin friction). This meets the safety rules in Chapter 4.4 of the NHBC Standards (National House-Building Council, 2024).

To connect the building to the piles and make sure the glass front doesn't flex or crack at all, the tops of the piles will be tied together using a stiff grid of reinforced concrete ground beams. Also, because we can't trust the loose beach sand to hold up heavy buildings, the ground floor needs to be a

suspended reinforced concrete slab that stretches across the ground beams. This keeps the whole weight of the building completely separated from the unpredictable beach sand.



Since the concrete piles will be sitting permanently in salty groundwater that moves with the tide, the concrete mix needs to be specially designed to handle that harsh marine environment. Following the durability rules in Chapter 2.1 of the NHBC Standards (National Hou

se-Building Council, 2024), the concrete for the foundations needs to have a high design chemical class, like DC-3 or DC-4 (Cemex UK. 2023). It should use high sulfate-resisting cement to stop the salt water from getting in and rusting the steel reinforcement cages inside the piles.

References

Ordnance Survey (1880) *Glamorganshire XXIII (includes: Swansea)*. Six-inch to the mile. Southampton: Ordnance Survey. Available at: National Library of Scotland, https://maps.nls.uk/view/102342502

Ordnance Survey (1938) Glamorganshire XXIII.12 (Swansea). 25-inch to the mile. Southampton: Ordnance Survey. Available at: National Library of Scotland, https://maps.nls.uk/ (Accessed: 29 April 2026).

Welsh Railways Research Circle (no date) Swansea & Mumbles Railway. Available at: https://wrrc.org.uk/s&mrrc.php

BBC (2010) Swansea - Mumbles Railway 1807 to 1960. Available at: http://news.bbc.co.uk/local/southwestwales/hi/people_and_places/history/newsid_8439000/8439904.stm

British Geological Survey (no date) BGS Geology Viewer. Available at: https://geologyviewer.bgs.ac.uk/

Natural Resources Wales (no date) Flood Risk Map for Wales. Available at: https://flood-risk-maps.naturalresources.wales/

Welsh Government (2010) The Building Regulations 2010. Available at: https://www.legislation.gov.uk/uksi/2010/2214/contents/made

Welsh Government (2004) Technical Advice Note (TAN) 15: Development and Flood Risk. Cardiff: Welsh Government.

Keller UK (no date) *CFA piles*. Available at: https://www.keller.co.uk/expertise/techniques/cfa-piles

Welsh Government (2017) *Approved Document A: Structure*. Cardiff: Welsh Government. Available at: https://www.gov.wales/approved-document-structure

https://nhbcprod.blob.core.windows.net/shared/CC2981-NHBC-Standards-2024-aw-digital-version-lr-151223.pdf

Environment Agency (2023) *Land contamination risk management (LCRM)*. Available at: https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm

Cemex UK. (2023). *British Standard Designated Concrete Mixes*. [online] Available at: https://www.cemex.co.uk/products/readymix-concrete/bs-designated-mixes.