

A report focussing on:

Modern and Traditional

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1.0 Executive Summary

This report will focus on the foundation requirements of the building with consideration to the location through a desk top study. The report will also include an estimation of excavation works required with a deep analysis on the most suitable choice of materials for the substructure with particular considerations to factors such as fire safety, aesthetics and environmental impact. The report will

conclude with a critical comparison between another widely used construction material to certify it as the most suitable material for the substructure. This information will be set out in a report format.

2.0 **Procedure**

This section highlights the research methods used.

2.1 Primary research from archival materials and geotechnical data that'll be set out in the appendix and references. Estimating the excavation works required through sketches and Microsoft Excel.

2.2 Secondary research from online sources and extensive research.

3.0 **Research**

3.1 Estimating the excavation works required

Estimating the excavation works required based on the information given was rather challenging as seen in 'sketch 6.1' where the depth required further calculations. 'Figures 6.2 and 6.3' formed the measurements for 'figure 6.4'. However, given the scarce measurements in the entrance foyer it was assumed that the internal walls are measured 5000mm width each and 12,000mm in length where the total length and width is assumed to be 72,000mm and 33,372mm respectively. However, these measurements represent the internal walls only. Further calculations in 'image 2.3' calculated the measurements through the masonry walls (blockwork, brickwork and cavity) to the external walls. Therefore, measuring to the external walls allowed for greater accuracy in estimating the excavation works required to the foundation of the trench. Furthermore, these calculations were based off an RFI where a different section drawing was used through Microsoft Excel. However, through several calculations, the estimated excavation works required based on this information is 900mm across the 178,744mm substructure.

3.2 Ground conditions in the local area

When researching into the classification of soil for the University, a borehole log was recorded at Fabian way which is the A483 road located just outside of site. This report stated that the made ground comprises of "yellowish brown gravelly fine to medium sand with many cobbles and greyish brown fine sandy gravel with some cobbles." Therefore, 'figure 6.5' further supports a raft foundation choice where other shallow foundation types usually don't work well under coarse-grained soils. The spread of the weight equally across the building will prevent the structure from subsiding under the normal level. (CISM, 2019)

3.3 Strata composition

“As well as establishing the classification of the soil, designers will be interested in trying to create a visual picture of the strata composition of the ground. When viewing this, we can see how far the loads are likely to penetrate the various soil layers and in particular which layers are to be affected.” Simply put it, the bearing capacity of the soil is one of the most useful pieces of information in relation to the design of the foundation. The three prime factors which are inseparably inter-related is the loads imposed from the superstructure, the bearing strength capacity of the soil, and specified area of transmission for the foundation choice to make contact with the soil. These factors allow the designers to create a foundation area of transmission which can safely transmit the load of the superstructure to the ground without exceeding the bearing capacity of the soil. Therefore, to develop a greater understanding of the innovative matrix geological history, the website BGS Geology will be utilised to identify the geological landscape through 2D and 3D projections. The findings stated that Swansea docks is classified as a middle coal measures formations which in essence, consists of grey fossiliferous mudstones, siltstones and sandstones located at the base of the marine docks. However, the formation of strata is mostly dominated by low permeability mudstone which has a low bearing capacity meaning it may be suitable to install a deeper foundation to support the imposed load. This can be achieved by piling slender columns to a deeper foundation so that the load can be consigned to deeper layers that have a higher bearing capacity. (Riley, M., 2013)

3.4 History of the proposed location

Coal mines

Swansea's historic background was renowned for its rich in coal deposits where; “twenty-two coalmines were sunk along the canal corridor or in the tributary valleys and by the 1890s over 400,000 tons of coal were carried annually.” These mines were typically operated by women and were classed and referred to as ‘tip girls’. Many of these coal mines are located north of the proposed location where the closest mine that was observed through old survey maps is Danygraig coal mine. This mine opened in 1875 to its eventual closure 5 years later in 1880. The coal mine is situated just under a mile away from the Innovative Matrix and therefore, there's serious concerns for any boreholes or deep mining tunnels existing under the proposed site. This is potentially hazardous as the underlying strata may not be sufficient in safely supporting the high loads. Ultimately, the foundation choice must be carefully chosen with consideration to potential underground construction such as chambers, shafts, tunnels and passageways. (Swansea-Valley-History-Society, 2022)

Docklands

When researching into the historic background of the docklands site, it become apparent that Swansea docks played its part in the war effort in WW2. Swansea “was bombed more than 40 times between 1940 and 1943 in World War Two. Additionally, around 56,000 incendiary bombs and 89 tonnes of high-explosive bombs were dropped during the raids”. From the sheer number of incendiary bombs unleashed on Swansea docks there's a high chance that the remains of unexploded/undetected explosives are buried under the strata. Given the composite of incendiary bombs used in WW2; it contained an equal mix of trortyl and amatol. Trortyl commonly referred to as TNT contains lethal impurities such as nitric and sulphuric acids. Once trortyl collides with an area of land, it's incredibly difficult for vegetation to recover from this type of pollution as plants can't digest this illegal toxin. Therefore, given the scale of the raids in WW2 it's fair to assume that the vegetation in Swansea docks is poor. (BBC, 2021)

Additionally, “Swansea Docks was the site for the testing of experimental tank ramps in April 1943.” Therefore, it's important to take into consideration that old artifacts may be buried in the ground which can simply contaminate and decay the subsoils around the specified object. (Swansea-Docks, 2017)

3.5 The most suitable foundation choice given the location

Therefore, given the risk of undetected bombs, the risk of chemicals, poor vegetation and the potential of old artifacts in the soil. It may be worth retaining to a raft foundation to separate the load safely across the less stable areas of the superstructure without any major piling. Raft foundations are particularly useful when the ground conditions are poor. This foundation choice can equally distribute the weight of a building by preventing the substructure from sinking by lowering the pressure on the ground. Given the scale of the substructure, establishing a reinforced concrete beam below the raft foundation to help support the heavy uniformed loads is advised. Therefore, the raft foundation “will possess sufficient strength and rigidity to ensure that it’s capable of withstanding the loads imposed upon it without bending, suffering shear failure or ‘punching through’ at the point of the loading”. (Riley, M., 2013)

3.6 Aesthetics, Strength, Fire Protection, Eco Friendly and Sustainability

Design aesthetics

Beyond its functional attributes, steel is undoubtedly a favourite for architects; where “its multitude of different alloys make it perfect for a range of different applications, and its clean, shiny appearance makes it a wonderful addition for many professional settings”. In application, the choice of steel portrays almost a robust feel to the building which certainly goes hand in hand with the form and IQ buildings neighbouring the innovative matrix. (Dahlstrom, 2021)

Strength/ Durability

Despite its aesthetic appeal, the scale of this commercial building will reflect a heavy live and dead load acting on the building. However, the choice of steel will assist with the vertical shear stress of the building and in application, steel is very adaptable to its surroundings by enduring heavy loads without crumbling under stress. These load bearing walls will help transfer the stress to the very foundation to other essential steel frame members. In addition to this, “steel is highly tensile meaning it can withstand significant impacts without breaking”. Additionally, with regards to the services of the superstructure, steel can easily be moulded into thin sheets without shattering as the material is malleable. To add to this, steel is inherently ductile making it a very adaptable material for building services. Thus, its resistance to termites, corrosion and mould simply adds to steel's advantages as a credible structural material. (Pare, 2022)

Fire Protection

Although there are many advantageous properties of steel, there are certainly some key considerations such as fire protection in steel. It's important to note that, steel on its own, is a non-combustible material meaning that it does not burn when exposed to fire. On the other hand, when steel is exposed to intense heat, the very nature of steel's strength will diminish. Nevertheless, a method of expanding the thickness of steel can be by including intumescent coatings; which will essentially “expand the original steel's thickness up to 100 times its original size through a process called sublimation.” The purpose of protective coatings is when steel is exposed to an intense amount of heat, a chemical reaction will take place which will expand the steel's thickness. Ultimately, this grants steel a protective layer against a formidable fire. At the end of the day, fireproofing steel can be the difference between the decimation or the continuation of the building and therefore, it's essential that fireproofing steel is installed correctly to uphold its physical integrity. Where the purpose of the building is to enable further learning studies; student's safety is the utmost priority where any further adequate protective coatings, fire-resistant cladding or by integrating any fire-retardant materials can certainly enhance the steel's fire safety. (Nullfire, 2022)

Eco friendly and Sustainability

Steel can be recycled, re-used and re-purposed and is the most recycled material worldwide. Additionally, it's not only eco-friendly but it's also economically strategic with regards to the overall longevity and durability of the material.

To further support this with evidence, the use of electric arc furnaces can "generate 2X more steel and up to 75% less greenhouse gas emissions, compared to traditional production processes". This process is also controlled, which elevates productivity and time proficiency through reducing carbon emissions in steel production and rendering it as highly sustainability and eco-friendly material for construction application. (Optimus, 2022)

Furthermore, choosing local steel sources can help reduce transportation emissions and promote a more sustainable and eco-friendly approach to construction projects. Fortunately, in this case, tata steel is located only 11 miles away from site; meaning that transporting steel to site will influence minor impact on the environment as the materials are produced locally.

3.7 Critical evaluation through a case study

When critically evaluating with another widely used material; we can further support the identification of steel being the more appropriate material for the innovative matrix. This will then be supported with a case study to further complement the evaluation.

For example, concrete, commonly used worldwide and considered both a modern and traditional material of construction. Despite this, the most popular and relevant case to date is the concrete crisis that's impacted "more than 150 schools, colleges and nurseries in England". In abundance, many structures from this case are unsound due to RAAC concrete. It's important to note that RAAC concrete is a non-conventional form of concrete that's far lighter, cheaper, easier to construct and provides excellent thermal insulation. However, the issues didn't completely reside over the choice of material, but instead the RAAC concretes expiration date without any regular treating and inspections. RAAC concrete lifespan is limited to 30-50 years respectively. On the other hand, when comparing to steel, most steel buildings range between 50-100 years. Depending on the quality of steel and the lifecycle assessment, steel can easily achieve the higher end of this range. Fundamentally, Swansea Trinity Saint David's University was formed in 2010 where a more durable material such as steel is highly advised to maintain the University's longevity. (Weiss, S., 2023)

Furthermore, the table below compares the properties between steel and concrete through visual representation:

<u>Steel Structures</u>	<u>Concrete Structures</u>
High compressive strength and tensile strength	High compressive strength but low tensile strength
Sustainable in small cross sections	Sustainable only in large cross sections
Prone to corrosion	Less prone to corrosion
Doesn't require a formwork	Requires a formwork
Can be prefabricated offsite in modular construction and transported to site	Can be prefabricated offsite and made on site
Higher strength to weight ratio	Lower strength to weight ratio
Not fire resistant, but can be fireproofed	Fire resistant

Source: (Riley, M., 2013)

When reflecting on the table above, steel out ways concrete's material properties given the specification of the project. Where the prime focus is durability and sustainability in modern day construction. However, concrete is still a credible material for other construction related projects.

3.8 Critical comparison with concrete

Moreover, both steel and concrete are 100% recyclable. Although concrete is 100% recyclable, it's much harder to recycle than steel if any contaminants are present. In contrast, any impurities in steel can simply be removed through oxidation where limestone can be added to a blast furnace to purify and retain the overall quality of steel without any major defects.

When considering the lifecycle of a steel super-structure, whether this is extracting the materials to the eventual demolition or re-purposing of the super-structure, it's crucial to maintain the material's sustainability. Eventually, when the super-structure will require re-purposing or is no longer needed for use; the components can simply be melted down and re-purposed several times without any significant degradation in quality. Ultimately, this prevents the need for excavating new raw materials where recycling steel "efforts save more than 75 percent of the overall energy used in production from raw materials. This holds significant benefits in the fight to save natural resources and prevent excess greenhouse gas emission". With regards to sustainability, environmental impact and longevity of the building; steel is undoubtedly first choice for the innovative matrix. (Rubicon, 2022)

When considering construction materials, steel has the highest strength-to-weight ratio. Subsequently, Young's modulus measures the resistance of a given material under load to determine if the material has high elasticity. Steel soars high with a typical value of 200 Gigapascals meaning that steel is undeniably a very stiff material where in propensity, it aims to retain its shape under a heavy load. Therefore, when the material is pulled, compressed, stretched or twisted; steel will resist the initial force and retain back to its original shape despite being under extreme strain. If steel had low elasticity, the building would suffer from continuous deformation under both the live and dead load acting on the building. In due course, the super-structure would eventually cave in and collapse. On the contrary, elasticity is rather low in concrete as it represents an average of 20 Gigapascals. This reflects a tenth of the elasticity in steel due to a low coefficient of thermal expansion in concrete and therefore, steel would be a far suitable material for application with the innovative matrix.

4.0 Conclusion

Given the portal frame design for the superstructure, steel is inertly a far better material to provide long spans through an open area without the inclusions of many large structural support columns given its high strength to weight ratio. With consideration to the scale of the building, steel would be a more appropriate material to address the design requirements of the superstructure. There are only a few materials that can compare with the versatility and durability of steel, where the addition of high tensile strength steel being a high-quality product will certainly support the requirements for a strong steel portal frame.

5.0 References

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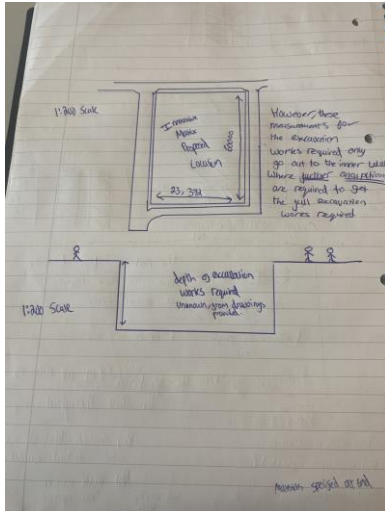
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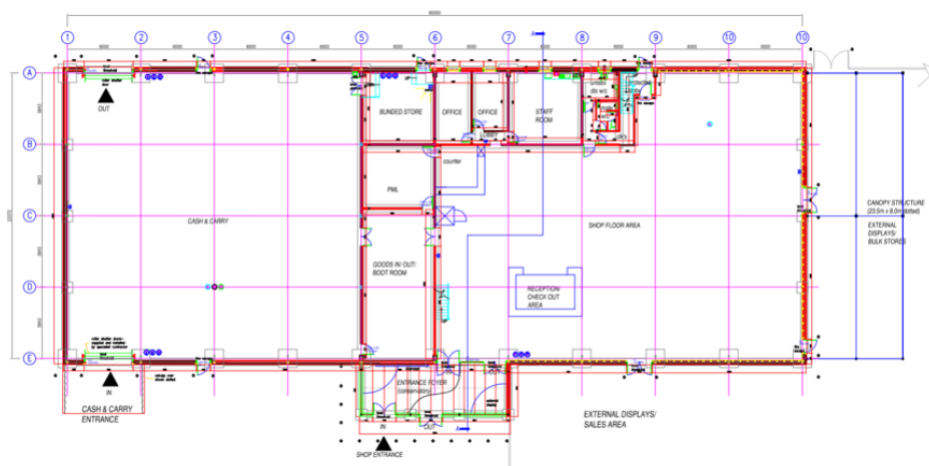
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6.0 Appendix

6.1 Sketch of the innovative matrix

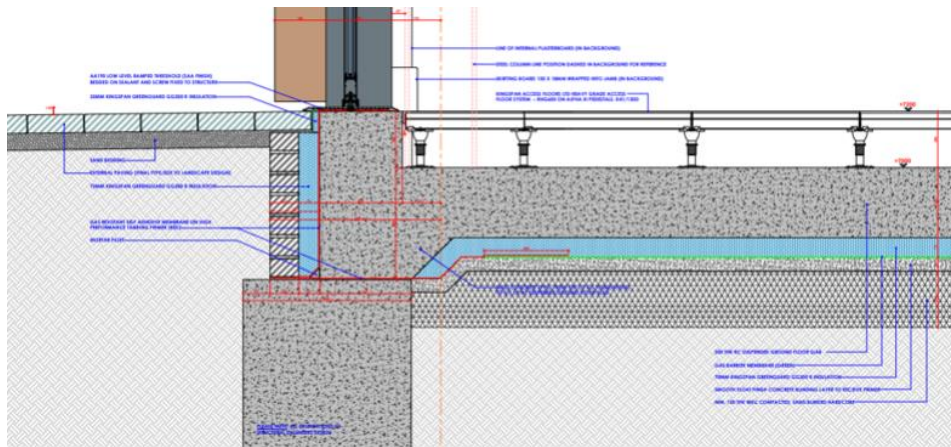


6.2 Floor Plan



Source: (Swansea, 2023)

6.3 Section plan



Source: (Swansea, 2023)

6.4 Excel take-off

<u>Wall Thickness</u>	
Block (inside)	0.100
Cavity	0.075
Brick (external)	<u>0.103</u>
	<u>0.278</u>
 <u>Foundation Spread</u>	
Concrete Foundation	0.700
Total Wall Thickness	0.278
Spread (trench)	<u>0.423</u>
Half Spread (trench)	<u>0.211</u>
 <u>Total Length</u>	
Length	72.000
Wall Thickness x2	0.555
Spread (trench)	<u>0.423</u>
	<u>72.978</u>
 <u>Total Width</u>	
Width	33.372
Wall Thickness x2	0.555
Spread (trench)	<u>0.423</u>
	<u>34.350</u>
 <u>Foundation Trench</u>	
Depth	0.900
Less Top Soil	0.150
Total Depth	<u>0.750</u>
 <u>Centerline of Trench</u>	
Length	72.000
Width	<u>33.372</u>
	105.372
x2 for total perimeter	<u>210.744</u>
Add 4/2/0.5/0.278	<u>1.112</u>
	<u>211.856</u>

6.5 Borehole log

WSP		BOREHOLE LOG				Hole No. BH103					
Telephone: Fax:		Project Fabian Way, Swansea				Sheet 1 of 2					
Job No 37721		Client Leadbitter				Date 02-07-13 04-07-13					
Contractor / Driller Apex		Method/Plant Used Dando CP		Logged By MCL		Co-Ordinates (NGR) E 70196.000 N 92922.000					
						Ground Level (m AOD)					
SAMPLES & TESTS				STRATA							
Depth	Type	Test Result	Grain Size (mm)	Grain Size (mm)	Grain Size (mm)	Grain Size (mm)	Grain Size (mm)				
1.00-1.50	SPT	3.6, 11 23, 30, 0 N=47	0.25(2)								
1.50-2.00	B	6.6, 8 7.7 N=25(C)									
2.00-2.50	SPT	3.6, 11 23, 30, 0 N=47	0.25(2)								
2.50-3.00	B	6.6, 8 7.7 N=25(C)									
3.00-3.50	SPT	3.6, 11 23, 30, 0 N=47	0.25(2)								
3.50-4.00	B	6.6, 8 7.7 N=25(C)									
4.00-4.50	SPT	3.6, 11 23, 30, 0 N=47	0.25(2)								
4.50-5.00	B	6.6, 8 7.7 N=25(C)									
5.00-5.50	SPT	3.6, 11 23, 30, 0 N=47	0.25(2)								
5.50-6.00	B	6.6, 8 7.7 N=25(C)									
6.00-6.50	SPT	3.6, 11 23, 30, 0 N=47	0.25(2)								
6.50-7.00	B	6.6, 8 7.7 N=25(C)									
7.00-7.50	SPT	3.6, 11 23, 30, 0 N=47	0.25(2)								
7.50-8.00	B	6.6, 8 7.7 N=25(C)									
8.00-8.50	SPT	3.6, 11 23, 30, 0 N=47	0.25(2)								
8.50-9.00	B	6.6, 8 7.7 N=25(C)									
9.00-9.50	SPT	3.6, 11 23, 30, 0 N=47	0.25(2)								
9.50-10.00	B	6.6, 8 7.7 N=25(C)									
Boring Progress				Water Strikes							
Date	Time	Depth	Casing Dpt	Water Dpt	Date	Time	Strike	Minutes	Standing	Casing	
03-07-13	15.45	2.50	200	2.50	03-07-13	15.45	2.50	20	1.00	2.50	
04-07-13	15.45	5.30	200	5.30	04-07-13	15.45	5.30	20	1.00	10.00	
Chiselling				Water Added				General Remarks			
From	To	Hours	Tool	From	To	From	To	From	To	From	
0	1	1.8	0.45	Hammer	0	1	0.45	Hammer	0	1	
Notes: All dimensions in metres. Logs should be read in accordance with the provided Key. Descriptions are based on visual and manual identification.											

Source: (CISM, 2019)

