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Task 1:**Sub-structure and deep basement design and construction recommendations:****1.1 Top down construction basement with permanent lateral support:**

For this 20-storey building (4-floor basement sub-ground floor and 16 floors above ground) in Cardiff City Centre to be successful, the initial design concept and construction of all the fundamental elements of the basement levels has to be impeccable. My initial recommendation for the basement type for this multi-storey sub floor construction is the 'top down' basement construction with permanent lateral support. The way in which the top down basement construction with permanent lateral support is achieved is the opposite to how the common conventional construction method takes place. It builds from the top downwards, compared to starting at the bottom and building up your sequence chronologically (S. Basarkar, 2017).

Firstly, boreholes are excavated from the ground, which are then refilled firstly with in-situ concrete to create a bored pile foundation. With a standard steel column with a steel plate attached is set in the concrete foundations (S.P. Marchand, 1993). The reinforced concrete ground floor slab and beams are then cast against earth and into trenches which instantly provides a permanent lateral support to the walls top edges. An access hole otherwise known as a void remains accessible at ground level to provide an access route entrance and exit to the basement for both men and materials. There are horizontal steel reinforcements secured within the ground floor slab to reinforce the concrete and add support to the entire structure. The subsoil below the reinforced concrete slab is then excavated down to the first floor basement formation level to create a sub-ground level. A reinforced concrete slab proceeds to be poured again on this level, once again leaving a void for men and materials. This is completed before the excavation process takes place again to excavate down to the second basement floor level. This process is repeated until all of the basement levels have been completed, with the basement levels concrete slabs acting as lateral bracing for the perimeter wall system. With lowest floor sitting just above the interior bored pile foundations that were piled initially before the rest of the construction processes took place (Y. Ikuta, 1994).

There are several advantages to using the 'top-down approach' compared to other basement construction methods which are especially key within the construction of the project in question. Such as; the structures that are being constructed above ground can be built simultaneously to the basement structures being formed below ground level. Due to the permanent columns and slabs in place, these can be utilised to carry the loads during construction and therefore emits the cost of framework being required.

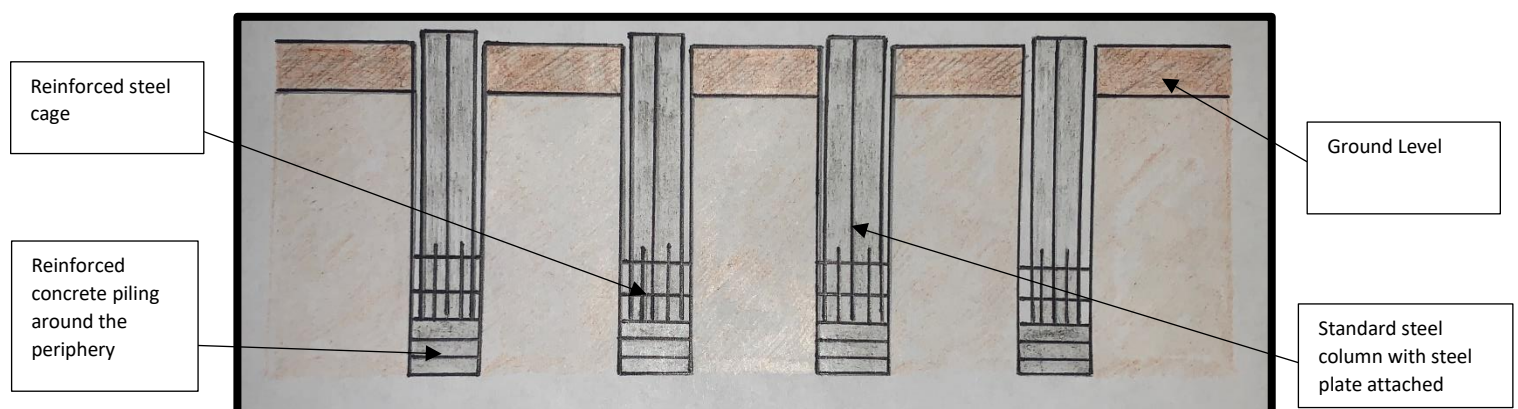


Figure 1: Showing a diagram of part 1 of the 'top-down' process where diaphragm walls and plunge column piled foundations are formed.

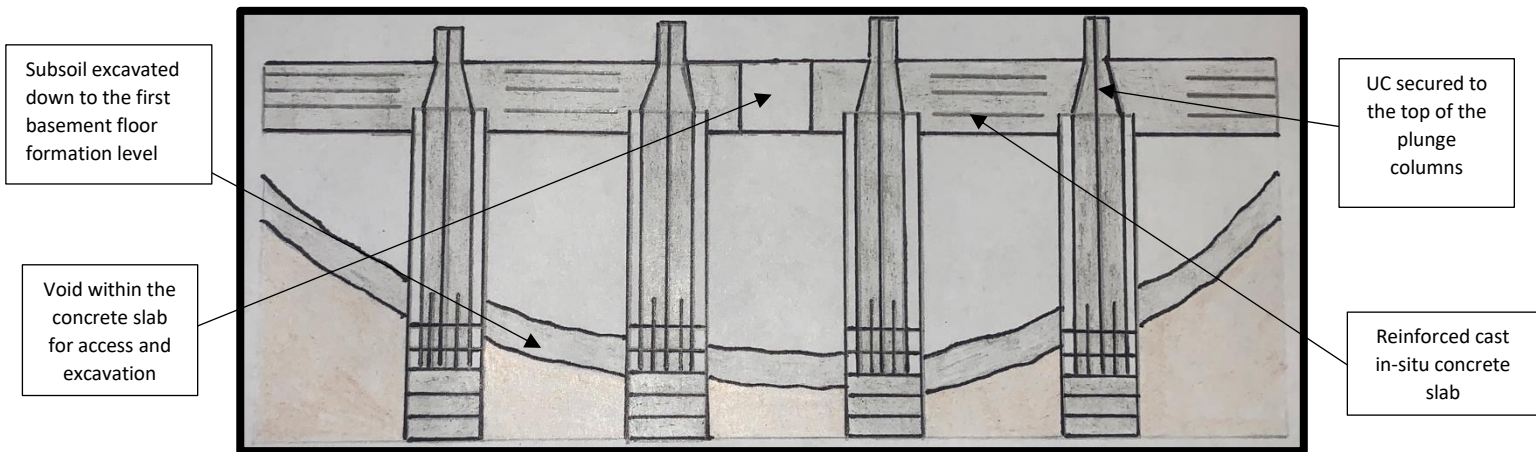


Figure 2: Showing a diagram of part 2 of the 'top-down process, where the reinforced ground floor slab is cast with access voids remaining for excavation and access for men and materials.

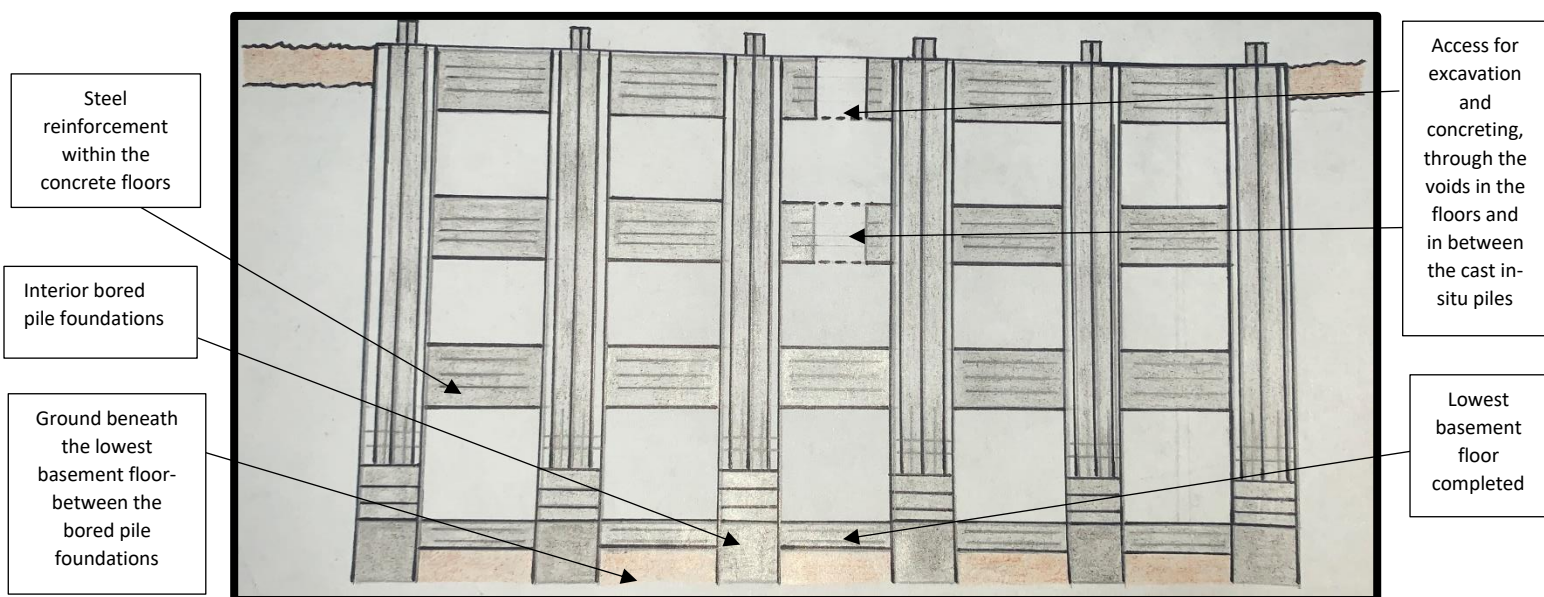


Figure 3: Showing a diagram of part 3 of the 'top-down' process where the sub-floors are concreted whilst the works above ground proceed.

The 'Top-down' method of construction is most commonly used for urban structures like multistorey buildings that require deep basements, exactly like the building that is in question within our example. The reason that this method is most commonly utilised is that because the use of tieback or anchor installation is simply not possible.

1.2 Considerations taken to prevent any impacts affecting neighbouring buildings:

The deep basement construction method that I have recommended to be used for the sub-ground floor levels of this project takes into consideration reducing the impact that the construction of these levels has on any neighbouring buildings. It does this simply with the initial installation of the sub-ground retaining walls to support the excavation progression, with the movement of soil in and around our plot of land needing to be kept to a minimum due to the neighbouring buildings, this helps to prevent the surrounding neighbouring buildings and their foundations from subsiding or sustaining faults within their building due to the construction of our building.

1.3 Waterproofing measures:

Waterproofing is a necessity for a significant number of elements in all types of structures, however the importance of basements being waterproofed is vital for the success of the whole construction. Mastic asphalt has the capability of creating a seamless and uninterrupted waterproof lining, otherwise known as 'tanking' not only to the floors but also the foundations (P.S. Jalal, 2018). Both the floors and the foundations are continuously in direct contact with the earth surrounding. Therefore, it is vital that they are appropriately protected from the foundations and the floors (R.Coates, 2020). External mastic asphalt systems are primarily used within underground structures, which is why this is a suitable waterproofing system for the building in question. There are numerous advantages to using mastic asphalt as a way of 'tanking' basements including; it being an environmentally friendly option, due to it having a carbon zero rating (Tukalov. E.S, Inoyatav.D.T, Kurbonav.A.S, 2019). Mastic asphalt is commonly referred to as "the king of waterproofing" within the construction industry due to the outstanding proofing properties it possesses and the positive success rate it has over past decades. This shows that they have surpassed many of the other 'tanking' systems that are available (M.Kubal, 2008). Another significant advantage that mastic asphalt has is the speed in which it can be laid. Therefore, reducing this element cost within the whole project costings. With the building in question located within a terraced setting, the risk of fires spreading is a concern for neighbouring buildings. This material however prolongs, if not prevents the spread of fires, due to it being non-flammable as well as non-toxic. Therefore minimising the risk for the neighbouring buildings. The installation costs of mastic asphalt are significantly lower than numerous other types of membrane, allowing this to be a highly-cost effective solution to the waterproofing dilemma (Douglas, 1998).

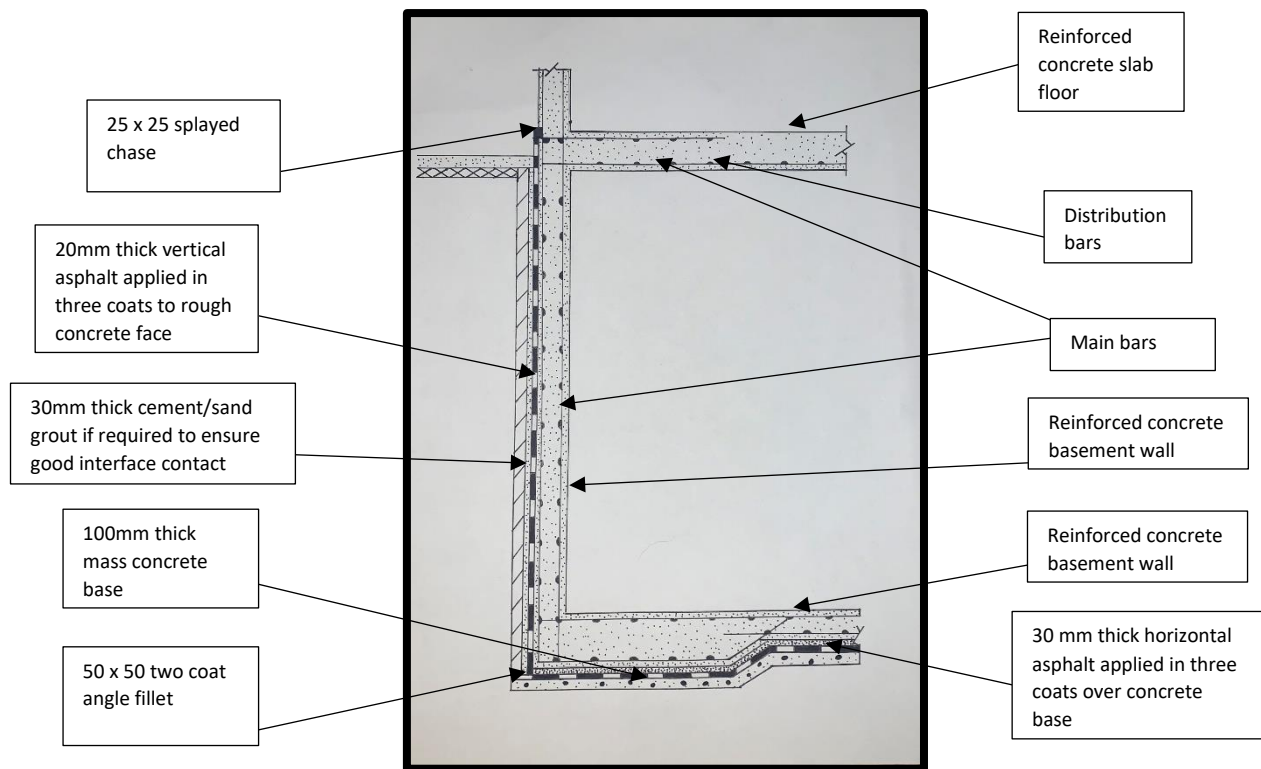


Figure 4: Showing a diagram of an example mastic asphalt tanking system and details that I recommend should be used

Under the British Standards Institute's BS 8102:2009, there are regulations which categorise the waterproofing of basement levels into three different grades and three different types of waterproofing. The three different grades are defined as '1, 2 and 3' with the types being defined as 'A, B and C' (Janesky, 2001). The use of the mastic asphalt tanking system as was recommended above in figure 4, would have the waterproofing levels sufficient to gain a grade 2 waterproofing grade system. This meaning that "No water penetration is acceptable. Damp areas are tolerable depending on the end use." Therefore this would be sufficient level of waterproofing for the sub-levels which are housing the building services and the underground car-park levels. However, for the basement levels to be able to house the 'gymnasium and spa', then the basement levels need to be waterproofed enough to gain a grade 3. Therefore, there is an additional need for the use of a sump pump located below the surface of the basement floor. The way it needs to be constructed is by digging a man-made pit through the floor, this is commonly referred to as a 'pit', with the pump sitting within this once it has been installed. The sump pump works by removing any water and moisture that collects within the basement. Therefore, keeping the basement dry and moisture free. This pump, combined with the mastic asphalt tanking system is enough to satisfy the regulations to be granted a 'grade 3' rating of "no dampness or water penetration is acceptable" most commonly used for residential or commercial areas, which covers the use of the gymnasium/spa that is proposed within these sub-floor levels (Wise Basement Systems, 2020). Therefore, my overall recommendation for waterproofing the basement levels is to use the mastic asphalt tanking system alongside the use of an additional sump pump to extract any extra water or moisture that seeps through the tanking system.

Task 2:**Suitable structural frame:****2.1 A skeleton frame**

A skeleton frame is commonly used within the construction of multistorey buildings. Structural steel is commonly used to form the 'skeleton' frame of the building. The steel frame usually consists of horizontal beams and vertical columns which are fastened, welded or bolted together to produce a rectilinear grid (A.B Sabbagh, 2010). This network of columns and beams, work conjointly to support the exterior walls and internal floors of the multistorey building whilst carrying all of the loads down to the foundations (P. Martinez, 2019). The steel that is commonly used within this type of construction is mild steel, due to its chemical composition and its flexibility. Mild steel has the capability of bending without snapping, due to its molecular arrangements. This allows the whole structural steel frame to flex when there is a large force being applied to one side of the building such as strong high winds.

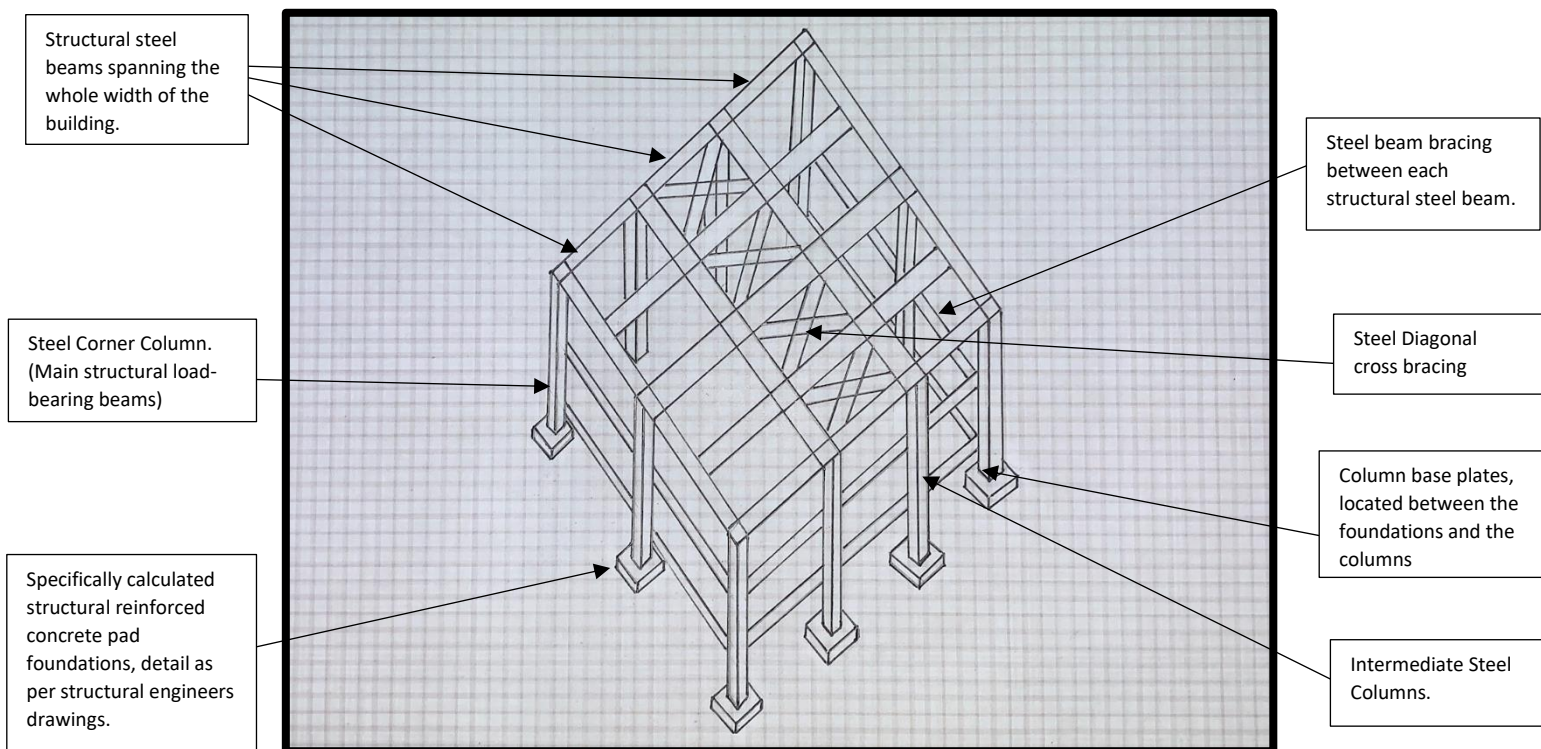


Figure 5: Showing a section drawing of the mild-steel structural skeleton frame.

The use of steel framing is becoming an increasingly popular viable option of framing buildings. Steel framing has the additional benefits of the positive aesthetic qualities as well as the environmental advantages that it possesses. There is a significant reduction in the level of excess waste with the use of steel framing compared to its close comparative material of precast concrete framing. The small amount of excess waste that is produced whilst creating the steel frames can be recycled and reused therefore enabling it to be the most environmentally friendly structural framing process (R.M. Lawson, 2010). With the increased development of 3D modelling technologies, the guarantee that the construction of the steel framing will be precise and comply with not only the buildings specifications but also the building regulations therefore reducing the risk factor. It also

provides a faster construction of the product which reduces the duration of the overall construction process. A steel frame is also commonly seen as generally the cheaper option when it comes to constructing a frame of a building compared to its competitors of concrete and timber. With its overall life-cycle costs also being significantly lower.

2.2 Internal Layout and Space:

The internal walls of a skeleton frame building are non-load bearing. Therefore, this allows possibilities for the client to request the layout of the floors to be open-plan or to have internal walls to segregate certain areas or rooms. As a result of this, the flexibility of the use of the floors of the building is of considerable possibilities, due to there being no requirements for internal walls to be in any specific area. Another benefit gained from using steel skeleton frame construction, towards maximising the internal space efficiently is that due to the internal walls being non-load bearing, there is no minimum requirement for the thickness of the walls and therefore can be constructed thinner to maximise the potential internal space (R. Mateus, 2013)

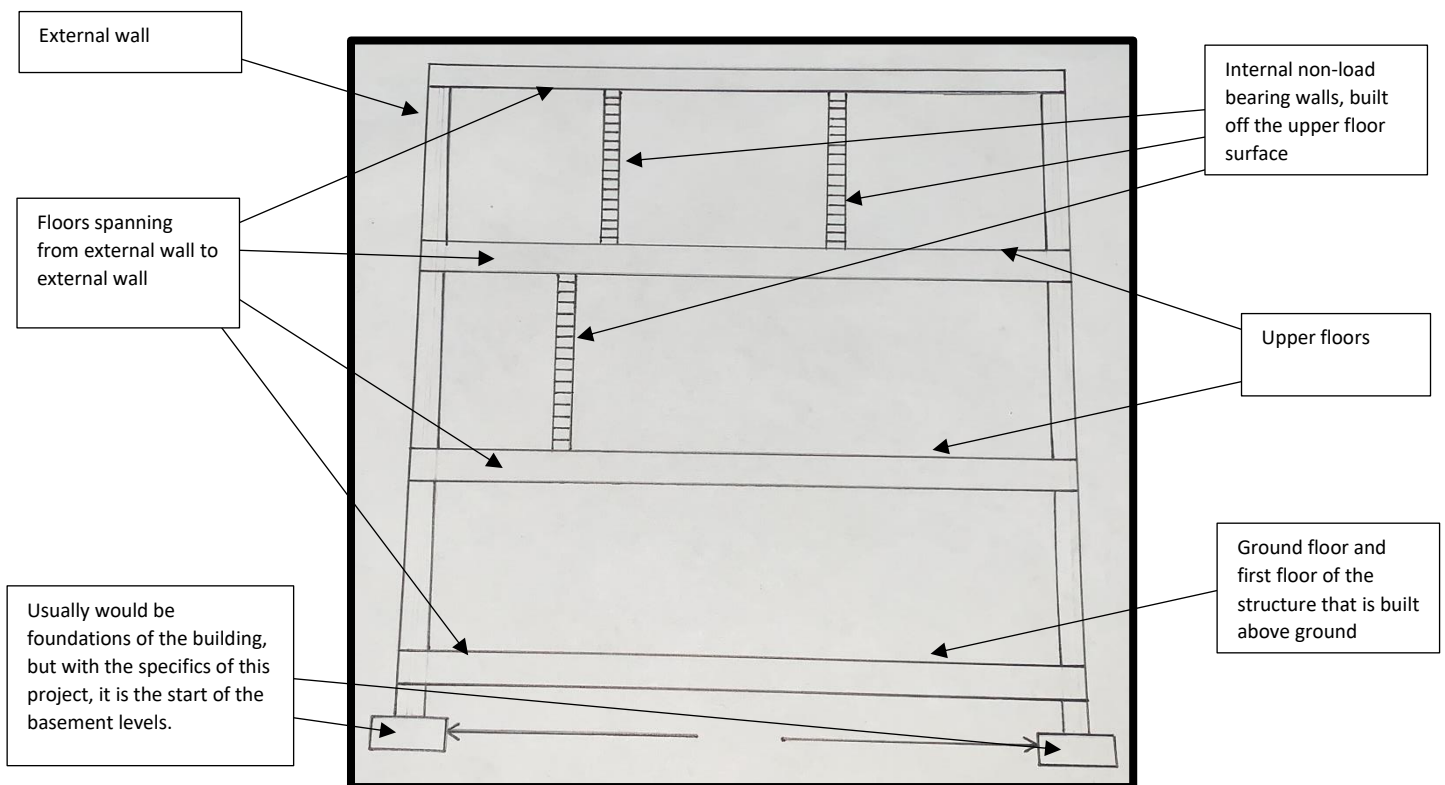


Figure 6: Showing a 2-Dimensional sketch of a section of the steel skeleton frame, highlighting the freedom of choice that the client has in terms of the internal non-load bearing walls, with them having no structural dependency for the building.

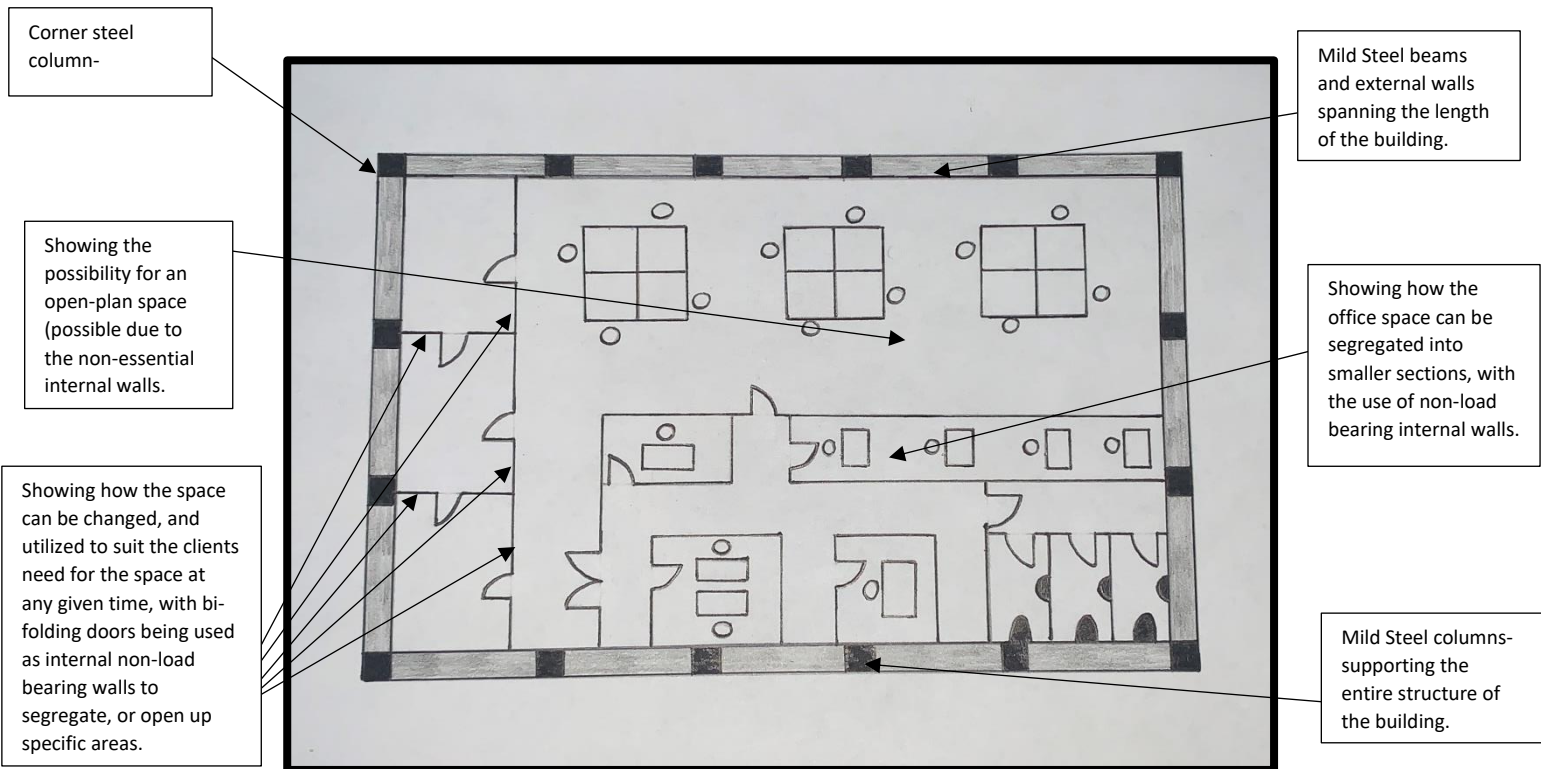


Figure 7: A sketch showing a potential office floor plan, outlining the use of internal non-load bearing partitions to segregate different areas within the office.

Due to the internal walls not being of load-bearing nature, there is a great opportunity for changing the uses and general flow of the floors of the building. These walls can simply be demolished and re-erected in a different area to suit the design layout for the new occupying usage. Not only is this option available, there is a high recommendation to use bi-folding movable partitions within the office space floors of this building especially. With the use of these partitions, there is opportunity to open up the rooms as one large area, or split them up with these partitions to create smaller segregated areas. The best part about using this type of partition is that nothing is 'set in stone' and the floor layouts of the offices can be altered on a daily basis to suit the need for the spaces required on any specific day. The use of the internal non-load bearing walls is simply used as a segregation and altering the aesthetic tool rather than a structural element (Y.Mexis, 2020).

The amount of space for the three floor multi-storey car park has been maximized by using the steel skeleton framing system, allowing the maximization of the volume of vehicles it can hold. On these floors, there is little need for any elements to be included, other than a concrete floor, safety barriers and lighting throughout, therefore maintaining a vast amount of space to accommodate the buildings occupiers and residents vehicles.

The layout of the residential units, especially due to them being flexible, short-term rental apartments is likely to be a generic format. With each floor mirroring the layout of the floors above and below. The benefit of these residential units being a 'mirror image' of each other is that the design is the same, meaning that the design costs will overall be lower as less time is needed as there is not the need to design alternative floor layouts. Overall this is another way of keeping the costings for the whole project as minimal as possible, to coincide with the clients brief of making sure the design and build remains "cost effective".

Task 3:**Recommendations for weathering the external envelope:**

The external envelope of a building encompasses the structure to shield it from damage, protecting it from the elements, as well as enabling the interior to remain safe from external forces and also being of assistance within the mechanical support load. There are also aesthetic benefits from externally enveloping a building, with the endless finishes that can be produced to match the requirements or preference of the client. There are two different types of building envelopes, loose and tight. The latter of these two options being the most beneficial of the two and therefore is the first recommendation that I've made is that it is a tight building envelope that is used. The tight building envelope holds benefits including; less mold and mildew, lower maintenance demands, overall lower energy usage and subsequent costs.

Every building ages as time passes and as a result of this, it can become weathered not only its appearance but also in the functions of the building. Certain levels of weathering are inevitable and simply cannot be avoided, but if steps are taken to prevent the weather from damaging the building, then it will be significantly beneficial for reducing the life-cycle costs over time.

For a buildings' walls to meet the regulations concerning weather resistance and perform to the expectations required, it must be able to resist moisture from the ground (usually with the use of damp proof courses) and it also needs to adequately resist the penetration of any weather from the outside of the building to the inside of the building.

The external cladding that I suggest would be the best match to assist in the weathering of the external envelope of the building in Cardiff City Centre 'the rainscreen principle' can be seen below in both a diagram and written version form.

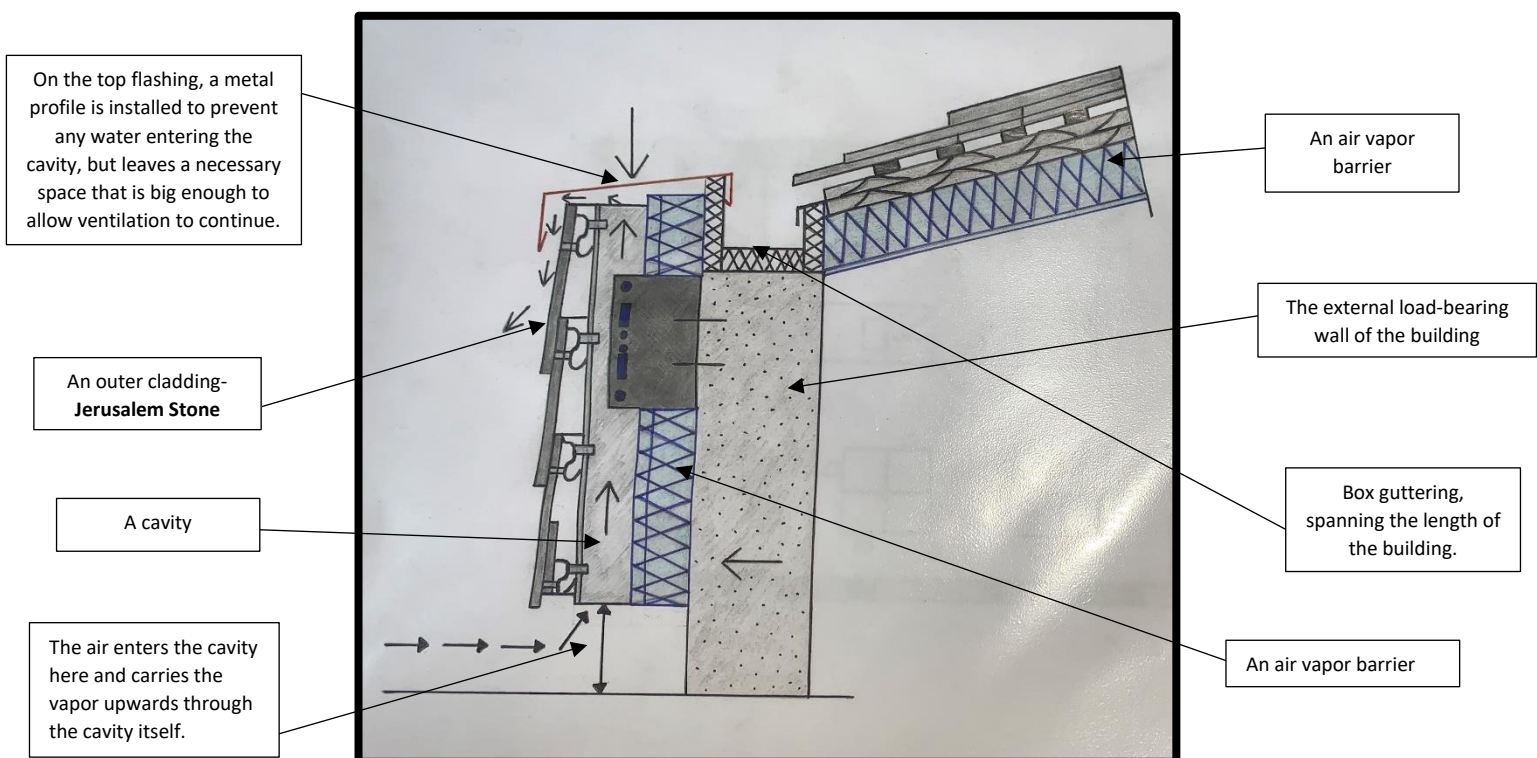
3.1 The Wall Cladding:

Figure 8: A diagram outlining and portraying the rainscreen principle wall cladding system.

The rainscreen system as seen in figure 8 above, prevents moisture from penetrating through the exterior walls and into the building, It does this by providing a guard against snow, rain and ice. The rainscreens are comprised of multiple layers to complete the high performance feature. These layers include; an outer cladding, a cavity and a vapor and air barrier. The rainscreen cladding system has the additional benefit of not only can it be installed onto new build projects, but also can be installed onto building renovations. For this to occur, the existing cladding on the existing building has to be completely removed and any moisture or imperfections on the load-bearing wall has to be dealt with accordingly (J.Falk, 164-176).

The Outer Cladding:

The cladding is primarily the outer skin that prevents water penetration. It is commonly referred to as the “rainscreen” itself, however without the additional aid of the air and vapor barrier as well as the cavity behind it, then the overall system would not be as effectual. The outer cladding takes the brunt of the external weather forces such as; wind, rain, hail and snow. Between the outer cladding panels, there are specifically engineered joints that have the responsibility of enabling proper ventilation. The outer cladding has additional benefits such as providing U.V protection as well as shading.

The material that I suggest should be used for the outer cladding of the 20-storey building (16 floors above ground accompanied by a four-storey basement) is Jerusalem stone. There are numerous advantages to using this stone as an external cladding material, especially within the environment and surroundings that our building is situated in Cardiff City Centre. The stone itself is made up from a pale form of limestone and dolomite. This therefore makes It very dense and impenetrable, allowing it to be a far better material for resisting weathering compared to other types of limestone. This is a significant advantage in Wales, where the weather is commonly poor. The aesthetic qualities of Jerusalem stone with it being a pale stone allows it to also has the ability to blend in with the surrounding buildings located around the 1970’s structure that links Westgate Street and St. Mary’s Street, but also adds an aspect of fresh, new and clean construction to the area.

The Cavity:

The cavity which is situated between the outer cladding and the air and vapor barrier (positioned on the outer-skin of the load-bearing wall) is an essential element within the success of the ‘Rainscreen Principle’ as a way of successfully weathering the external envelope of the building in question (T.G. Theodosiou, 2015)The way the cavity works is that as the air circulates throughout the cavity, it picks up the vapor and proceeds to carry it up through the cavity to the outside of the cladding. Therefore, removing the moisture away from the air and vapor barrier, keeping the cavity and subsequently the load-bearing wall dry (J. Langmans, 2015).

The air and vapor barrier:

The last layer of the cladding protection included within the ‘Rainscreen Principle’ working together towards the protection that the building has against the elements is the air and vapor barrier. This final layer of protection has the responsibility of preventing any moisture from penetrating the walls of the building. This element can also be referred to as an air and water barrier (AWB) (Lstiburek, 2006).

3.2 The Roof Covering:

Roofs are commonly the largest part of a building that are exposed to the natural elements that occur such as wind, rain and snow. Therefore leaving them susceptible to damage. In the instance where a pitched or flat roof over an enclosed area adjoins a wall, the use of cavity trays attached to the flashing should be utilised to prevent any water from penetrating an enclosed area (A.F. Kemalov, 2014). The use of horizontal flashing should assist in providing weathering to 75mm minimum above the intersection with the roof. The stepped flashing that is linked to the stepped cavity tray should be 65mm wide at a minimum and should be cut from a strip a minimum of 150mm wide. Where slates or tiles are used, such as the roofing material () are used, soakers (otherwise known as 'secret gutters') should be installed (M. Goncalves, 2008)

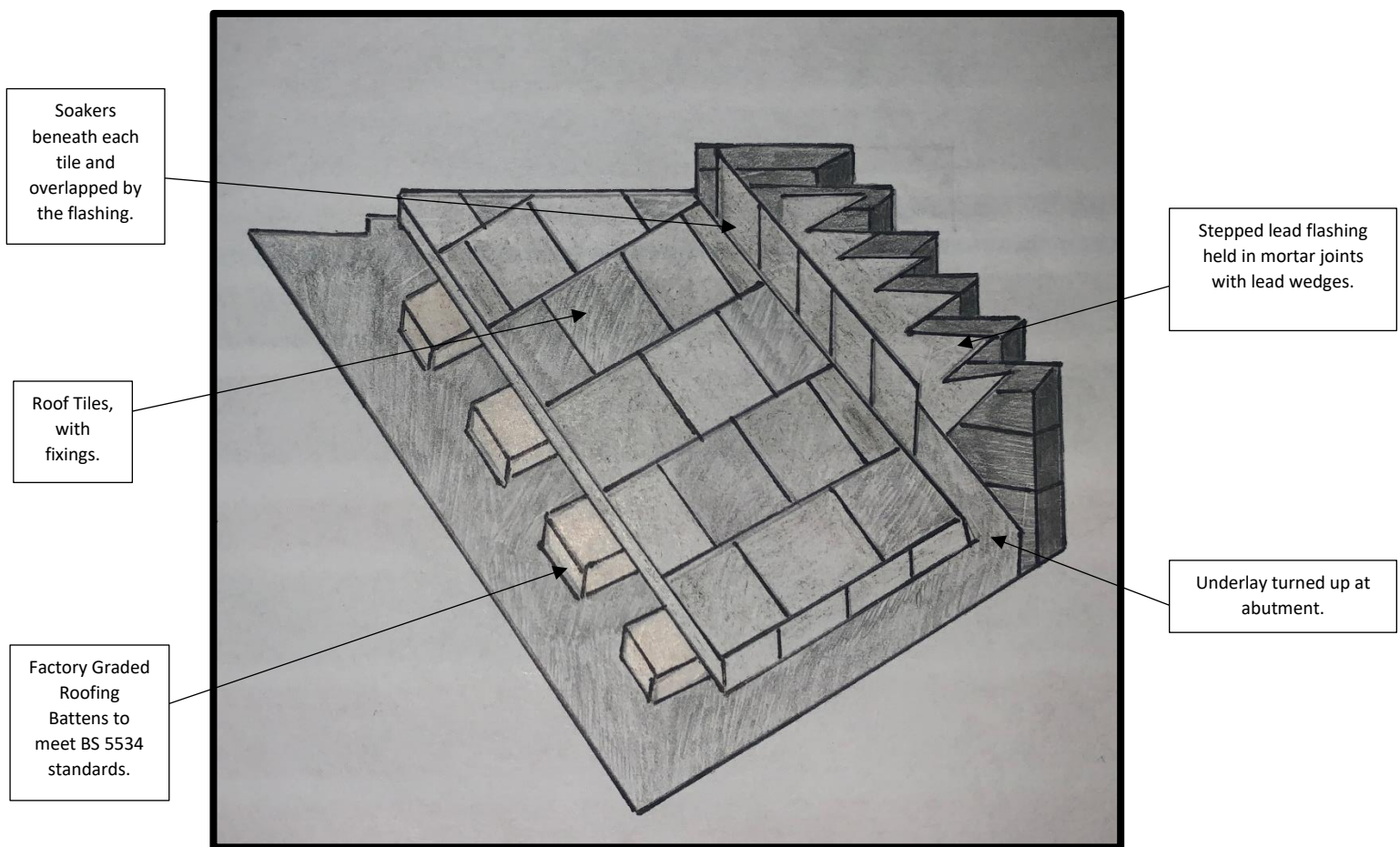


Figure 9: A diagram showing a sloped roof and steps that can be taken to assist in weatherproofing the roof structure.

Due to the ever increasing extreme weather conditions that we are experiencing, our building practices have had to adapt to manage the weather proofing of our roofs, to ensure that the roofs remain in place during strong winds. The changes in the weather patterns that we are experiencing have already meant that there has been a significant alteration in the 'fixings required' calculations for roof coverings. It has been determined that the more fixings used, the more secure the roof covering is. It has been specifically calculated that each standard roof tile needs to be 'mechanically fixed', either by nail or clip, with any tiles at the perimeter of the roof requiring a minimum of two-fixings to ensure that they stay in place.

The underlay that is used within the construction of the roof covering, is just as important as any of the tiles and fixings that are used. Under the new BS 5534 standards there is a new test method which determines the wind resistance of unsupported underlay. The test measures the potential movement of the draped underlay, with the purpose of the test being to ensure that the underlay doesn't move to a point where it can make contact with the roof tiles and move or displace them. There is now a labelling system on underlay when purchasing it, to help inform you of the type that is suitable for the area in which you intend to use the underlay, and how is best to install it (LABC, 2016).

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5.1. A map extracted from google maps depicting a broad view of the surroundings for our allocated site to assist with calculating the impact this construction would have on neighbouring buildings.

