MATERIAL

ESSAY

CONCRETE

CONTEMPORARY BUILDING – ARHCITECTURAL HISTORY – ENVIRONMENTAL IMPACT

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The choice of materials for UCL East Marshgate plays a pivotal role in shaping the building's character.

UCL East Marshgate is a striking addition to London's Queen Elizabeth Olympic Park, it's a building that effectively combines its chosen materials, aesthetic properties and its cultural significance. Next to that it defies the expectations one might have for a concrete building, modern and minimalistic. The building designed by Stanton Williams is an academic space for research and teaching that promotes innovation through flexible spaces and collaborative zones, it opened recently to the public in spring 2023.

One of the most remarkable things about the UCL East Marshgate building is the way that it is designed to encourage interactions with the public. Arriving in front of the building you find yourself on a public plaza, a gathering space where people can meet, sit and interact looking up at the façade of the building.



Image 1. UCL East Marshgate, Front view.

"To heighten the façade's sculptural character, several textures were applied to the concrete. Referencing the board-marked infrastructure of East-London" (SCHILLACI, 2023) the texture of the exterior concrete on the lower section of the building mimics the appearance of wood, while the higher levels transition to a pebbled texture.

This surprising use of material effectively reflects the building to its surroundings; the Queen Elizabeth Olympic park offers modern architecture, green outdoor spaces and water features. In addition, the use of a transparent façade makes it feel more approachable and inviting.

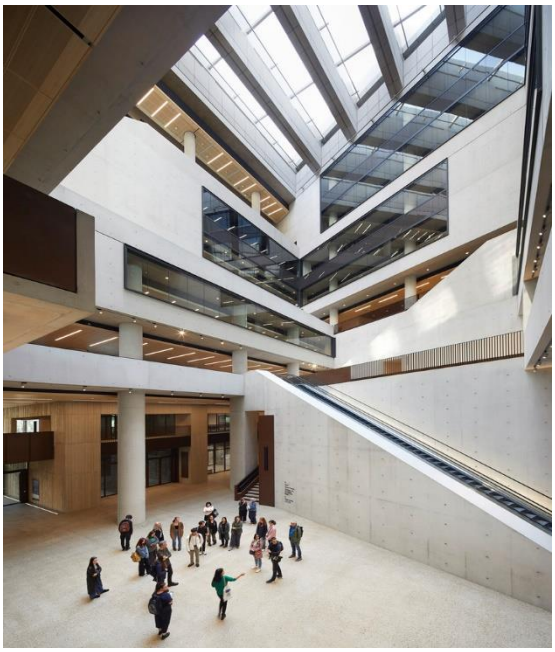


Image 2. UCL East Marshgate, Atrium Perspective.

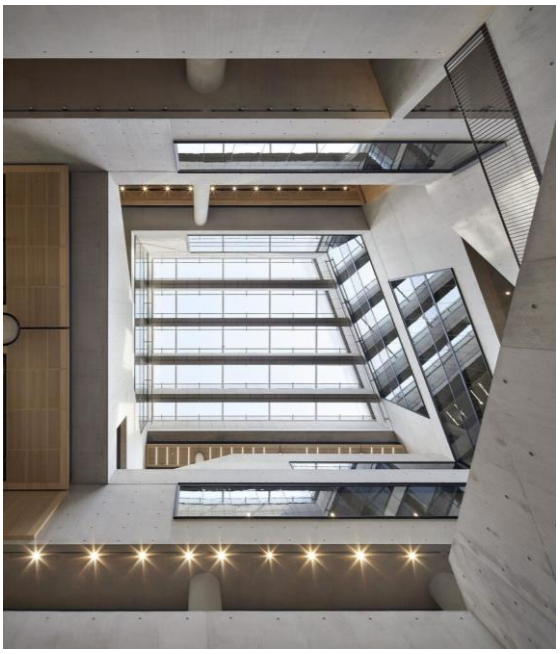


Image 3. UCL East Marshgate, Atrium Perspective.

Upon entering the UCL East Marshgate, one experiences a transition from a narrow hallway with a cozy feeling to a more open and expansive atmosphere. This important moment occurs as one arrives in the heart of the building – the central day-lit atrium. "This atrium connects the building activities and highly visible circulation routes including stairs and escalators create further opportunities for chance encounters and interactions." (WILLIAM, 2023).

The atrium itself is a non-adaptable design, featuring concrete deep beams and sturdy columns. It connects all the eight floors of open and adaptable teaching, research and collaboration spaces. "Different floors are clustered into a series of 'neighbourhoods', each with its own double-height collaboration space for informal meetings or exhibitions." (PINTOS, 2023) The straight lines and simple geometry of the interior are given complexity by the layers of space that surround it.



Image 4. UCL East Marshgate, Café Perspective.

While visually striking, the concrete on the interior of the building revealing the structure creates a somewhat cold and impersonal ambiance. They created this by treating the concrete walls on the lower floors with an abraded finish to reveal the aggregate and its detail… intriguingly, some interior walls in the hallways mirror the wooden texture of the exterior, blurring the lines between the inside and outside.

In addition to the aesthetic properties, the building features publicly accessible spaces like a café and a public art display on the lower levels. The spaces create opportunities for visitors and students to linger, socialize and engage with the building, further blurring the boundaries between the interior and the exterior. For the communal spaces, the architects used birch plywood for the walls, giving the feeling of a more warm, welcoming space in comparison to the atrium.



Image 5. UCL East Marshgate, Material Palette.

The designers have meticulously combined the concrete structure with a mix of pleasant and personal materials, ensuring that the space feels welcoming and comfortable rather than cold and impersonal. It primarily consists of sand-coloured concrete, rust-coloured steel, birch plywood and smoked oak; creating an industrial material palette evoking the site's industrial history and authenticity.

One of the materials that they used to show the site's industrial history is weathering steel, incorporated as accents both on the exterior and the interior of the building, including window frames.

The harmonious colour combination between weathering steel, birch plywood and the different concrete textures is truly remarkable. Stanton Williams achieved a skilful balance between materials, aesthetics and functionality, making UCL East Marshgate a true architectural concrete masterpiece.

Word Count of writing: 626

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Image 1. Schillaci, T. (2023). From: The Architect's Newspaper Article

Image 2. Peacock, A. (2023). From: Dezeen Article

Image 3. Pintos, P. (2023). From: Archdaily Article

Image 4. Pintos, P. (2023). From: Archdaily Article

Image 5. Von Sternberg, M. (2023). From: Stanston Williams Website

Concrete's use during the history has significantly changed over time.

Although not the first, the Ancient Romans are known for their use of concrete, the earliest recordings date back to 6500 BC by the Nabataea traders in regions of Syria and Jordan creating concrete floors and housing structures. The Romans, however, were first to utilize this material using a mixture of volcanic ash, lime, and seawater to form the concrete mix. By 200 BC they implemented the use of concrete in the majority of their construction.

Following this period, concrete fell into obscurity for some time. John Smeaton discovered in 1793 a more modern method for producing hydraulic lime for cement. "Smeaton used limestone containing clay that was fired until it turned into clinker, which was then ground into powder." (HEARNS, 2022) In the rebuilding of the Eddystone Lighthouse in Cornwall, England, this material played a pivotal role.

In 1824, Joseph Aspdin then revolutionized the industry by inventing Portland cement, involving burning finely ground chalk and clay to a temperature of 1450°C until the carbon dioxide was removed. "Aspdin named the cement after the high-quality building stones quarried in Portland, England." (HEARNS, 2022) By the early 20th century, it became the most widely recommended binder for concrete.



Image 6. Eddy Stone Lighthouse – Joshep Aspdin, Drawing.

Portland cement was reliable which meant that the potential of concrete could be accomplished, yet another major difficulty remained; its strength. Concrete is hugely strong under compression, but weak at withstanding stresses, bending and twisting causing it to fail.

Groups of engineers worldwide simultaneously developed the solution for this, one of these pioneers of reinforced concrete was François Hennebique. “He conceived the idea of using metal encased in concrete to create béton armé, a system that used concrete as fireproof protection for wrought iron beams.” (SAYERS, 2019) Unknown to him at the time was that the use of inexpensive steel rods as reinforcement within the concrete would give it high tensile strength. Further developing the idea economically, he noticed that the iron should only be used where the slab was in tension. In 1892 Hennebique patented his own revolutionary reinforced-concrete construction system, working with only existing leading contractors, and licensed their use of his system. At the beginning of the 20th century, his reinforced concrete system had been implemented in almost 20.000 structures marking a transformative milestone in the history of concrete.

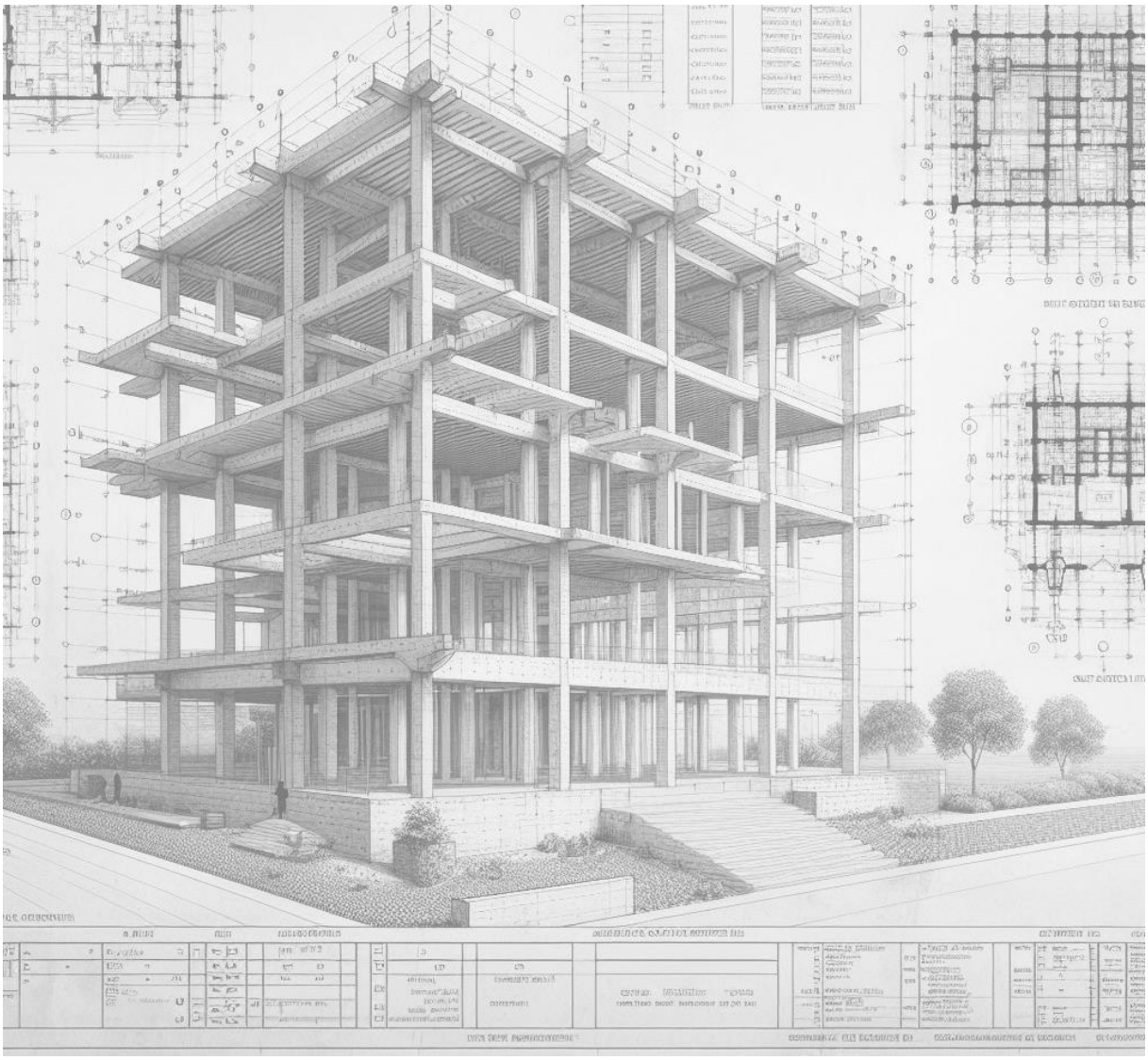


Image 7. Building based on Hennebique system, Drawing.

After the second World War the role of concrete changed. Most countries had to rebuild fast complicated by a shortage of traditional materials, including bricks and wood, as well as skilled labour. The vast reconstruction programme in Britain was state-controlled, led by the national and local government. Their solution for this building problem was reinforced concrete, being low cost and relatively quick to construct, most buildings looked generally mundane and functional.

A distinctive type of architecture emerged in the 1960s and 1970s, it was a socially progressive decade of strong economic growth after the austerity of the 1950s of idealism. “Monumental buildings such as universities and high rise flats were constructed, this uncompromising dramatic style was versatile and cheap, changing the face of urban Britain.” (HUGHES, 2022) Certain types of this new radical architecture came to be known as Brutalism. After it became associated with urban decay and social problems Brutalism fell out of flavour. It progressively became reviled by the public, and many important concrete brutalist buildings were demolished.

Concrete can, however, be designed to create extraordinary forms as well as take on different textures and colours. Despite public critique a few famous architects showed concrete’s potential.



Image 8. Salk Institute – Louis Kahn, Perspective view.

Modern examples illustrate how concrete, when skilfully used, can create enduring architectural masterpieces. Concrete has produced some of the world’s well-known architecture and is a crucial material used in virtually all construction projects across the globe today, from modest houses to the tallest towers.

Word Count of writing: 621

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Image 8. Nemeskeri, T. (2021). From: ArchEyes Article

For a variety of reasons the concrete industry is not sustainable.

First, concrete consumes huge quantities of virgin materials, annual approximately 10 billion tons of aggregates (rock and sand). These are usually gathered by mining where coarse and fine aggregates are mined separately. Mining for concrete aggregates in large quantities poses environmental challenges; it leads to habitat destruction, water and air pollution, high energy consumption, and social impacts like displacement and conflicts.

“Occasionally, aggregates are obtained as a by-product of some other process such as slag or recycled concrete.” (STRUBLE & GODFREY, 2004) Due to the process of manufacture: crushing, washing, separating into various size fractions, reconstituting and drying a modest amount of energy is involved in all these processes. “The principal wastes are dust and water, neither of which is especially damaging to the environment, as the water can be re-used in other processes.” (STRUBLE & GODFREY, 2004)

Next it consumes annual approximately 1 billion tons of water, which is normally ordinary tap water with no further processing. This is only an environmental issue as it has very little embodied energy and no waste.

In the concrete, supplemental cementing materials may also be used as mineral admixtures, which most of the time are by-products of other manufacturing processes and as such have minimal embodied energy.



Image 9. Impact of concrete, Drawing.

Secondly, the principal binder in concrete is portland cement, consuming annually approximately 1.6 billion tons. The production is a major contributor to greenhouse gas emissions that are implications in global warming and climate change. Portland cement is a mixture of limestone and shale, usually manufactured in a kiln to a high temperature, approximately 1500°C, then intergrinding the resulting clinker with gypsum to form a fine powder.

It is not surprising that the portland cement has a rather high embodied energy, the production constituting approximately 5% of the global emission of CO2 worldwide. This is because the reaction between limestone and shale to produce clinker produces CO2. "Furthermore, the fuel used in the kiln and the electricity in the grinding mills themselves produces some amount of gaseous waste, principally CO2 and CO. These gases are non-toxic and are released to the atmosphere, where they contribute to global warming." (STRUBLE & GODFREY, 2004)

"The production of one ton of Portland cement generates approximately one ton of carbon dioxide and requires up to 7000MJ of electrical power and fuel energy. It's evident that the concrete industry significantly impacts the ecology of our planet." (WANG, 2004)

Third, the lifetime of the structure has a direct impact on sustainability, when the structure deteriorates, it must be destructed and rebuild. "Many concrete structures suffer from a lack of durability which has an adverse effect on the resource productivity of the industry." (MEHTA, 2001) Traditionally, most concrete structures are designed for a service life of 50 years. The lifetime is directly controlled by the durability of the materials and further influenced by the adaptability of the design to repair and renovation which have environmental impacts. Improving the concrete durability and adaptability of the design, presents a long-range solution and a breakthrough for improving the resource productivity of the concrete industry, by building structures that will last for 500 years.

High-performance concrete is a solution, "known as high-strength concrete in the late 1970s is now referred to as high-performance concrete because it has been found to be much more than simply stronger." (MEHTA, 2001) It's a specially engineered low water/binder concrete, generally less than 130 kg/m³ (range between 100 -130 kg/m³), with an optimized aggregate-to-binder ratio to control its dimensional stability. Ideal for transportation structures, e.g., bridges and pavements creating more long lasting structures and pavements that require strength and durability properties.

It is important for this material to be sustainable it needs to contain a high-volume fly ash, which may be used either as a component of blended portland cement or as a mineral admixture in concrete. "Depending on the quality of fly ash and the amount of cement replaced, up to 20% reduction in water requirements can be achieved." (MEHTA, 2001) With 50% or more cement replacement by fly ash, it is possible to produce sustainable, high-performance concrete mixtures that show high working, high ultimate strength, and high durability.

Such elevated proportions of fly ash are known to have a slower rate of strength development at early stages, and are not accepted by the construction industry. They only use higher amounts of fly ash on the order of 25%-30%, when there is a concern for thermal cracking, alkali-silica expansion, or sulphate attack.

In conclusion, the concrete industry currently faces sustainability challenges characterized by high consumption of virgin materials, high embodied energy of portland cement and lack of durability. These three factors conclude the industry's current non-sustainable status.

Word Count of writing: 742

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