



UWL REPOSITORY

repository.uwl.ac.uk

Perceptions and Reuse of Concrete Building Structures

Balodimou, Efcharis ORCID: <https://orcid.org/0000-0003-1249-3941>, Rizzuto, Joseph and Shabaan, Ibrahim (2023) Perceptions and Reuse of Concrete Building Structures. In: The 8th International Conference on Urban Planning and Architectural Design for Sustainable Development (UPADSD), 24 -26 Oct 2023, Florence, Italy.

This is the Published Version of the final output.

UWL repository link: <https://repository.uwl.ac.uk/id/eprint/10473/>

Alternative formats: If you require this document in an alternative format, please contact: open.research@uwl.ac.uk

Copyright: Creative Commons: Attribution 4.0

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy: If you believe that this document breaches copyright, please contact us at open.research@uwl.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.

The Academic Research Community Publication

Received: 23 November 2023, Accepted: 29 January 2024, Published online: 31 January 2024

DOI: 10.21625/archive.v8i1.1050

Perceptions and Reuse of Concrete Building Structures

Efcharis Balodimou¹, Joseph P. Rizzuto², Ibrahim G. Shabaan³

¹Senior Lecturer in Built Environment, School of Computing and Engineering, University of West London, Ealing, London, United Kingdom

²Head of School of the Built Environment and Geography, Professor of Civil Engineering, Faculty of Engineering, Computing and the Environment, Kingston University, London, United Kingdom

³Head of Civil Engineering, Associate Professor of Civil Engineering, School of Computing and Engineering, University of West London, Ealing, London, United Kingdom

Abstract

Concrete has gone through significant changes in popularity in the United Kingdom. This paper explores factors associated with shifts in the perception and reuse of concrete buildings. and how these changes have influenced the use of concrete in Architecture and Design in the UK. The popularity of concrete has fluctuated over the past few decades. This is driven by a combination of cultural, aesthetic, and sustainability factors. In the 1980's and 90's fairfaced, textured, bush-hammered concrete acquired a reputation that took some three decades to reverse. UK public opinion on concrete 'Brutalist' buildings of these decades is mixed, but tends to often be negative, where terms used include 'Depressing', 'Hideous', 'Monstrosities', and 'Eyesores'. There is currently a growing appreciation for the history and cultural significance of concrete and specifically 'Brutalist' architecture. Although these buildings were previously despised, they are now recognized as part of the UK's architectural heritage and efforts are made to preserve them for future generations. Buildings and complexes, which were once run-down urban environments, are now changed into more desirable housing complexes often leading to drastic social changes in the area. Concrete has been generally seen as a material that has a significant environmental impact, especially in terms of carbon emissions. Concrete's durability, thermal mass, and fire protection properties paired with advances in technology that can improve the appearance and consistency of finishes, have all improved the popularity of concrete. Strides are also being made to improve the sustainability of concrete constituent materials. The positioning of concrete as a sustainable, energy-efficient building material that can also have an aesthetic appeal, combined with its versatility and durability, makes concrete once again a popular choice for contemporary architecture and Interior design.

© 2024 The Authors. Published by IEREK Press. This is an open-access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords

Architecture; Concrete buildings; Aesthetics; Sustainability

1. Introduction

Concrete has gone through significant changes in popularity over the past few decades. These changes are particularly evident in the United Kingdom. The popularity of concrete has fluctuated over the past few decades. This is driven by a combination of cultural, aesthetic, and sustainability factors. Although concrete buildings were previously despised by many, they are now recognized as part of the UK's architectural heritage and efforts are made to preserve them for future generations.

2. Methodology and Research Design

This paper explores the factors associated with shifts in the perception of concrete buildings by the British public and how these changes have influenced the use of concrete in Architecture and Design. The UK's architectural use of concrete and heritage will be studied. Different aesthetic and sustainability approaches will be looked at through case study examples. These focus on 'Brutalist' architecture and how perceptions have changed.

2.1 Architectural use of concrete

Concrete is a versatile material that has been used in Construction for thousands of years. However, until the twentieth century, it was considered to have no aesthetic qualities and was used mainly in utilitarian structures, such as water reservoirs and foundations (Smith 1993, p.2). The Millbank Penitentiary, built between 1817 and 1822 by Sir Robert Smirke, was one of the first known major uses of concrete. A unique raft concrete foundation was constructed on muddy, marshy land to eliminate subsidence (RICS, 2019; Historic 2023).

Reinforcing concrete helped make the material more widely used in the construction of buildings and structures. Concrete is very good under compression but does not perform well under tension. A key person in the development of reinforced concrete was Francois Hennebique. His system introduced steel rods within concrete thus giving the composite material tensile strength. The 'Hennebique' system became very successful in Europe at the start of the 20th century. He used this system to construct his own home, 'La Maison Hennebique', between 1901 and 1903 as well as buildings in England, for example –Weaver's flour mill in Wales (Historic England 2022). (Figures 1, 2)



Figure 1. La Maison Hennebique 1901-1903 (Historic England 2022)

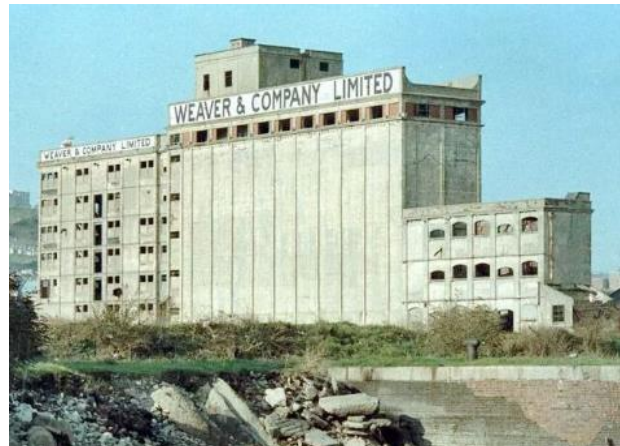


Figure 2. Hennebique building in England; Weaver Company 1898 (Historic England 2022)

One of the advantages of the use of concrete is that it can be used to form any required architectural shape and is finished to provide a variety of textures and colors. However, concrete is not always used 'fairfaced' but often covered or disguised.

2.2 Disguising and covering concrete

Widespread use of concrete increased in the early 20th century. Initially, it was used in houses, factories, and churches. The expressive potential of the material was demonstrated but nevertheless, the concrete structures were disguised to look like other materials such as stone or brick, or covered using other materials. For example, August Perret's **Rue Franklin** apartment block was clad with terracotta tiles [Giedion 1941] so the concrete structure, using the 'Hennebique' system was not exposed. The tiles however were not just for decoration but were there to cover the concrete surfaces which Perret believed were more susceptible to damage and decay [Invisible Paris 2013]. (Figure 3)



Figure 3. Perret's **Rue Franklin** reinforced concrete building clad with terracotta tiles (Invisible Paris 2013)

2.3 Rendering and painting concrete

New ideas about architecture started to emerge in Europe after the First World War, arising from a desire for the creation of an architectural movement not based on styles of the past. The 'New' world required a 'New' Architecture. Concrete provided the tool for the creation of an architectural language that tried to demonstrate the superiority of the future to the past. Streamlined designs and the introduction of curves and shapes started appearing using the potential of reinforced concrete and introducing new aesthetics and designs. However, at this time concrete surfaces were usually either rendered or painted [Frampton 1996] Main representatives of this expression were Swiss architect Le Corbusier with Villa Savoye in 1931 while in the UK architects such as Mendelsohn and Chermayeff with **De la Warr Pavillion 1935**, Lubetkin /Tecton - **Penguin pool in 1934** and **Finsbury Health Centre** in 1938 were advocates of this new aesthetic [Balodimou 1998] (Figures 4, 5 and 6)



Figure 4. Le Corbusier's Villa Savoye 1931 (Archdaily 2023)



Figure 5. De la Warr Pavilion by Mendelsohn and Chermayeff 1935 (Sussex Modern 2023)

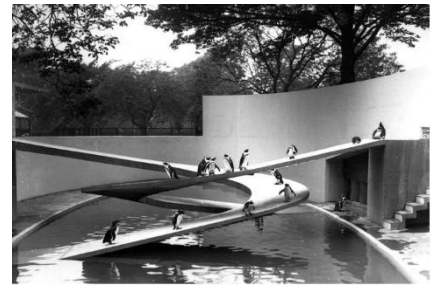


Figure 6. Penguin pool, London by Lubetkin / Tecton 1934 (Victoria and Albert Museum 2023)

2.4 Exposing concrete

During the Second World War, mass and reinforced concrete was extensively used for the construction of air raid centers and airfield runways. After the war ended further new architectural ideas developed in Europe and the UK due to the need for fast and economical re-construction of war-affected zones (System building).

Concrete in the 1950s to '70s began to be used in the plainest state, untreated and unrendered (**Brutalism**) The term 'Brutalism' derived from the French term 'Beton Brut' which refers to concrete that is not smoothed down after casting and is left showing the patterns of the formwork and often blemishes and imperfections. Examples of Brutalism include the **Unite d 'Habitation** in Marseille by Le-Corbusier and in the UK the **National Theatre on South Bank** by Sir Denys Lasdun (1964-68). Architects Allison and Peter Smithson created 'Brutalist' buildings in the '50s and 60's that have now been recognized as important buildings (Harwood 2022) (Figures 7, 8, 9).



Figure 7, (8, 9) Royal National Theatre (1969-76) Sir Denys Lasdun Listed Grade II* (Harwood 2023)



Figure 8. Surfaces



Figure 9. Textures

3. Negative perception of Concrete Building Structures – ‘Concrete jungle’

Social pressures in Britain for re-housing that took priority after the war associated concrete with council estates and mass housing. Especially in Britain, those living in high-rise buildings and estates were those who had no choice (Balodimou 1998).

Although a great number of council estates in Britain have a brick finish, it is concrete which is associated with the ‘inhuman’ nature of these estates. The phrase ‘**concrete jungle**’ is widely used to describe an urban context that involves concrete in tower blocks, council estates, deck access, or ‘**sky roads**’ and the absence of any color. The strong dislike people have for these environments and the various social problems that seem to stem from them in a way condemned concrete, although in most cases problems were due to the mismanagement and planning of these buildings and complexes (Moustaka 2023, Balodimou 1998). Examples of how ‘Brutalism’ was seen in the 1970s are clearly depicted in films such as ‘A Clockwork Orange’ (1971) and ‘Get Carter’ (1971) where Brutalist complexes appear as a background to “dystopian, violent and malevolent associations” (Smith 2022) (*Figures 10, 11*)



Figure 10. ‘Brutalist’ Lecture theatre at Brunel University designed in 1966 by John Heywood.



Figure 11. Ludovico Medical Clinic, A Clockwork Orange. Building in the background is the ‘Brutalist’ Lecture Theatre at Brunel University designed in 1966 by John Heywood. Now Grade II listed (MovieLocations.com, 2023, Historic England 2023)

In the 1980’s and 90’s this negative association extended to public buildings, such as the **South Bank Centre** and later the **Barbican**, even though those operated in a different social and cultural context. (*Figure 12*) Fairfaced, textured, bush-hammered concrete had acquired a ‘bad name’ that took around three decades to shed. Even nowadays, when the public is asked about their opinion on concrete ‘Brutalist’ buildings the reaction is very mixed but more often negative, using words such as ‘Depressing’, ‘Hideous’, ‘Monstrosity’, ‘Eyesore’ (Harwood 2023) (*Figure 13*)

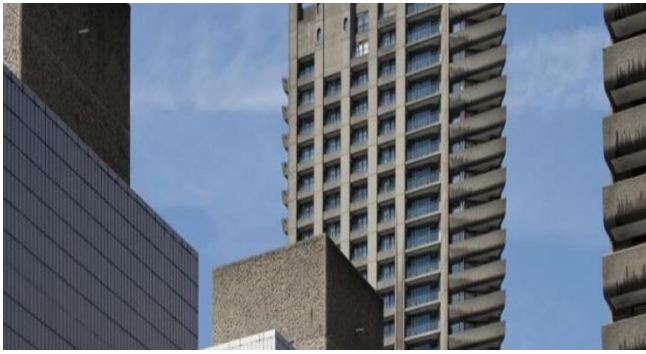


Figure 12. Barbican center Chamberlin, Powell, and Bon –Grade II listed (Barbican 2023)



Figure 13. Park Hill Estate, Sheffield – Roads in the sky (Moustaka 2023)

4. Concrete and the rise of ‘Minimalism’ and ‘Sustainable chic’

4.1. Design and Aesthetics

In recent years, there has been a renewed interest in concrete as a building material. Contemporary architects such as Tadao Ando, Frank Gehry, Zaha Hadid, and Daniel Liebeskind have used the structural potential of concrete to create unique, and highly expressive forms and spaces. Concrete is also increasingly used in interior design to provide a minimal and industrial aesthetic in the form of polished concrete floors, countertops, and walls or exposed ceilings. (Figure 14)



Figure 14. Trelick Tower, Kensington Erno Goldfinger (1968-73) Grade II* Listed (Harwood 2023)



Figure 15. Barbican Centre Interiors (Harwood 2023)



Figure 16. Trelick Tower, Kensington Erno Goldfinger (1968-73) (Harwood 2023)

4.2 Sustainability of Concrete Buildings

Concrete has been generally seen as a material that has a significant environmental impact, especially in terms of carbon emissions (Shaaban et al., 2020). However, it is now recognized that it can be used in more sustainable ways, i.e. made of recycled materials or mixed with materials that reduce its carbon footprint. Concrete’s durability, thermal mass and fire protection properties paired with advances in technology that can improve the appearance and consistency of finishes have all improved the popularity of concrete in the past couple of decades (Jahren & Sui 2014).

The Sustainable Civil and Structural Engineering research group at the University of West London (UWL) is currently active in research work towards producing durable and sustainable concrete buildings. Several studies were carried out towards using waste materials in concrete mixes, replacement of cement with friendly environment materials, and producing self-healing concrete (Shaaban et al., 2020; Rizzuto et al., 2020; Paschalis et al., 2023) (Figure 17) This research and developments can help the considerate and sustainable repair and reuse of existing concrete buildings.



Figure 17. Self-Healing Concrete Samples (Shaaban et. al 2023)

4.3 Appreciation of the past / Listing, protecting, and improving Concrete buildings

There is a growing appreciation for the history and cultural significance of concrete and specifically ‘Brutalist’ architecture. Although these buildings were previously despised, they are now recognized as part of the UK’s architectural heritage and efforts are made to preserve them for future generations [Harwood and Davies 2015, Hopkins 2017].

Additionally, buildings and complexes, which were once run-down urban environments, i.e., council estates, are now revamped into more desirable housing complexes and even ‘high-end’ apartments, often leading to drastic social changes in the area. Good examples of such transformation are Park Hill in Sheffield, and Erno Goldfinger’s Trellick Tower in Kensington (*Figure 16*)

Changing the function of concrete structures may need retrofitting and repair of such buildings. Strengthening using advanced composites or fiber-reinforced polymers (FRP) is a promising approach to improve or regain the load-carrying capacity of structures to extend their serviceability (Shaaban and Seoud, 2018). FRP gained wide acceptance as a promising technique for retrofitting structural members for its high strength-to-weight ratio, its damping capabilities, its high resistance to corrosion, its fatigue resistance, and the short time scale for repair (Panahi et al., 2021). Glass fiber reinforced polymer (GFRP) and Carbon fiber reinforced polymer (CFRP) are the widely explored types of FRP which have been used in strengthening of structural elements (Montaser et al., 2022).

An international example of successful repurposing and giving a Brutalist building a new life is the **Pirelli Tyre** building in New Haven Connecticut, originally designed by Bauhaus-educated Marcel Breuer in 1969 and owned by ‘Armstrong Rubber’ (Forre n.d.; Stouhi 2021) (*Figure 18*)

It was later sold to tyre company ‘Pirelli’ in 1988 and to furniture company IKEA in 2003. During the following two decades, it was neglected, and part of the ground floor building was demolished to create a car park. In 2019 it was acquired by the Architecture and Development company Becker+Becker Associates, who converted the building into a 165-room, passive design hotel and conference center (Feniak 2023; Stouhi 2021). (*Figure 19*)



Figure 18. Pirelli Tire Building original form (Forre n.d.)



Figure 19. The building under refurbishment (Stouhi 2021)

It is interesting to note that the Brutalist Pirelli tyre building, voted in 2018 as the ‘State’s ugliest building’, was transformed into the first Passiv Haus Hotel with more than 100 rooms, and upon its completion in 2022 received the highest LEED (Leadership in Energy and Environmental Design) Platinum certification. This was achieved by using locally sourced, recycled materials for the refurbishment of the building, providing airtight construction, and using 100% Solar energy for electricity, heating, and hot water requirements. (AtlasObscura 2021; Stories from Hilton 2023). (Figure 19)

However, a critical factor in this success was the reuse of the existing concrete structure, which saved a vast amount of embodied carbon. Considering the discussions regarding concrete’s high carbon footprint, it is a great achievement for a Brutalist concrete structure, to become exemplary on the grounds of sustainability.

5. Conclusions

The popularity of concrete has fluctuated over the past few decades. This is driven by a combination of cultural, aesthetic, and environmental factors.

The positioning of concrete as a sustainable, energy-efficient building material that can also have an aesthetic appeal when used fair-faced, combined with its versatility and durability, make concrete once again a popular choice for contemporary architecture and Interior design.

Changing the function of concrete structures may need retrofitting and repair. Strengthening using advanced composites or fiber-reinforced polymers (FRP) is a promising approach to improve or regain the load-carrying capacity of structures to extend their serviceability.

A critical factor to this success is the reuse of existing concrete structures, saving a substantial amount of embodied carbon. Brutalist concrete structures with their high carbon footprint become exemplary on the grounds of sustainability when reused.

Changes in how concrete buildings are perceived can be also reflected in the recent growing appreciation of concrete buildings which are now seen as an important part of the UK’s Architectural Heritage.

Acknowledgments:

The abstract of this paper was presented at the Urban Planning & Architectural Design for Sustainable Development (UPADSD) Conference – 8th Edition which was held on the 24th-26th of October 2023.

Funding declaration:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors/individuals.

Ethics approval:

Not applicable.

Conflict of interest:

The authors declare that there is no competing interest.

References

- Archdaily (2023) *Architecture Classics; Villa Savoye / Le Corbusier*. Available at: <https://www.archdaily.com/84524/ad-classics-villa-savoye-le-corbusier> (Accessed 25th July 2023)
- Atlas Obscura (2021) *Pirelli Building, New Haven Connecticut*. Available at: [Pirelli Building – New Haven, Connecticut - Atlas Obscura](#) (Accessed: 16 December 2023)
- Balodimou, E (1998) *Prediction of weathering effects on Concrete buildings using computational methods*. PhD thesis. Oxford School of Architecture, Oxford Brookes University.
- Barbican (2023) *Our Building; Our Architecture*. Available at: <https://www.barbican.org.uk/our-story/our-building/our-architecture> (Accessed 23rd April 2023)
- Feniak, H. (2023) Rehabilitating Brutalism: How Colossal Concrete Buildings Made Their Big Comeback. [Architizer] Available at: Rehabilitating Brutalism: How Colossal Concrete Buildings Made Their Big Comeback (architizer.com) (Accessed: 16th December 2023)
- Forre, A. (n.d) 'Pirelli Tire Building' [PinInterest] Available at: [9eb294ca3f9f772777ef8b3ed6e7af73.jpg](https://www.pinterest.com/pin/9eb294ca3f9f772777ef8b3ed6e7af73.jpg) (618×488) (pinimg.com) (Accessed: 15 December 2023)
- Frampton, K. (1996) *Studies in Tectonic Culture; the Poetics of Construction in 19th- 20th Century Architecture*. Cambridge, Massachusetts: MIT Press.
- Giedion, S. (1941) *Space, Time and Architecture; the growth of a new tradition*. Harvard University Press: Cambridge, Massachusetts.
- Hammad, N.; Elnemr, A.; Shaaban, I. State-of-the-Art Report, 2023: The Self-Healing Capability of Alkali-Activated Slag (AAS) Concrete. *Materials* 2023, 16, 4394. Available at: <https://doi.org/10.3390/ma16124394>
- Harwood, E. (2023) Listing Concrete Buildings in Britain (mainly Britain). Keynote 'Bold and Unapologetic'; Workshop on the Modernist and Vernacular 20th Century Architectural Heritage of the Mediterranean. 10/03/2023. School of Science, Engineering and Environment. University of Salford.
- Harwood, E. (2022) *Brutalist Britain; Buildings of the 1960's and 70's*. London: 20th Century Society.
- Harwood, E., Davies, J. (2015) *England's post-war listed buildings; including scheduled monuments and registered landscapes*. London: Historic England
- Historic England (2022) Historic England Blog; A brief history of reinforced concrete buildings; Reinforcing concrete made large concrete buildings possible. Available at: <https://heritagecalling.com/2022/09/22/a-brief-history-of-reinforced-concrete-buildings-in-england/> (Accessed 15th August 2023)
- Historific (2023) Millbank Penitentiary; the prison that once stood at London's Millbank. Available at: <https://www.historific.co.uk/millbank-prison-london-millbank/> (Accessed 15th August 2023)
- Hopkins, O. (2017) *Lost Futures; the disappearing Architecture of Post-War Britain*, London: Royal Academy of Arts.
- Invisible Paris (2013) The homes of August Perret; Rue Franklin. Available at: <http://parisisinvisible.blogspot.com/2011/09/homes-of-auguste-perret-rue-franklin.html> (Accessed 10th August 2023)
- Jahren, P., Sui, T. (2014) *Concrete and Sustainability*. Miami: Taylor & Francis.
- Montaser, W. M., Shaaban, I. G., Zaher, A. H., Khan, S. U., and Sayed, M. N. (2022) "Structural behaviour of polystyrene foam lightweight concrete beams strengthened with FRP laminates" *International Journal of Concrete Structures and Materials*. ISSN 1976-0485, Available at: <https://doi.org/10.1186/s40069-022-00549-1>
- Moustaka, A (2023) The Networks of Concrete. 'Bold and Unapologetic'; Workshop on the Modernist and Vernacular 20th Century Architectural Heritage of the Mediterranean. 10/03/2023. School of Science, Engineering and Environment. University of Salford.
- Movie-Locations.com (2023) *A Clockwork Orange*, 1971. Available at: <https://www.movie-locations.com/movies/c/Clockwork-Orange.php> (Accessed 23rd April 2023)
- Nuruddin, M.F, Mohamed, B.S, Sani, H, and Shaaban, I.G., 2018, "Methods of curing Geopolymer concrete: A review", *International Journal of Advanced and Applied Sciences (IASSE)*, Vol. 5, No. 1, pp. 31-36. Available at: <https://doi.org/10.21833/ijaas.2018.01.005>
- Paschalis, S. A., Lampropoulos, A. P., and Rizzuto, J. P (2023) Development of sustainable ultra-high performance fibre reinforced concrete (UHPFRC). Cement-based materials and structural concrete conference SynerCrete'23, 15-16 June 2023, Milos Island, Greece.
- Patankar SV, Jamkar SS, and Ghugal YM (2013). Effect of water-to-geopolymer binder ratio on the production of fly ash based geopolymer concrete. *International Journal of Advanced Technology Civil Engineering*, 2(1): 79-83.
- Rizzuto, J. P., Kamal, M., Elsayad, H., Bashandy, A., Etman, Z., Aboel Roos, M.N., and Shaaban, I. G., "Effect of self-curing admixture on concrete properties in hot climate conditions", *Construction and Building Materials*, Vol. 261, November 2020, 119933, Available at: doi.org/10.1016/j.conbuildmat.2020.119933
- I.G. Shaaban, O.A. Seoud, Experimental behavior of full-scale exterior beam-column space joints retrofitted by ferrocement layers under cyclic loading, *Case studies in construction materials* 8 (2018) 61-78.
- Shaaban I., Rizzuto, J.P., El-Nemr, A., Bohan, L., Ahmed, H. and, Tindyebwa, H. (2020) Mechanical Properties and Air Permeability of Concrete containing Waste Tyre Extracts. *ASCE Journal of Materials in Civil Engineering*.

- Shaaban, S., Hammad, N., Elnemr, A., & Shaaban, I. G. (2023), "Efficiency of Bacteria-Based Self-Healing Mechanism in Concrete", *Materials Science Forum* (Vol. 1089, pp. 135–143). Trans Tech Publications Ltd. Available at: <https://doi.org/10.4028/p-tc6w54>
- Smith, A. (1993) *The History of Concrete in Architecture 1890-1980*. Architectural Packages. AP2. Crawthorn: British Cement Association.
- Smith, J (2022) *Nasty, brutish & tall; The Utilisation & representation of Brutalist Architecture in British Cinema post-1970*. PhD Thesis. University of Manchester.
- Stories from Hilton (2023) Hotel Marcel New Haven, Tapestry Collection by Hilton becomes first certified Passive House hotel in the US. Date: 27 September 2023. Available at: [Hotel Marcel Becomes First Certified Passive House Hotel in US | Hilton News](#) (Accessed: 16th December 2023)
- Stouhi, D. (2021) 'Marcel Breuer's Iconic Brutalist building being transformed into an eco-friendly Boutique hotel'. [Archdaily] Date: 21st October 2021. Available at: [Marcel Breuer's Iconic Brutalist Building is being Transformed into an Eco-friendly Boutique Hotel | ArchDaily](#) (Accessed 16th December 2023)
- Sussex Modern (2023) De la Warr Pavilion Available at: <https://sussexmodern.org.uk/places/de-la-warr-pavilion/> (Accessed 25th July 2023)
- M. Panahi, S.A. Zareei, A. Izadic, Flexural Strengthening of Reinforced Concrete Beams through Externally Bonded FRP Sheets and Near Surface Mounted FRP Bars, *Case Studies in Construction Materials* (2021) e00601.
- Understanding Concrete. (2019). Historic concrete structures and how the material came to be so widely used. Royal Institution of Chartered Surveyors (RICS). Available at: <http://www.isurv.com> (Accessed July 2023)
- Victoria and Albert Museum (2023) Engineering the penguin pool at London Zoo. Available at: <https://www.vam.ac.uk/articles/engineering-the-penguin-pool-at-london-zoo> (Accessed 25th July 2023)