



## The History of Civil Engineering Building Designs

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### ABSTRACT

Civil engineering is a cornerstone of modern societal infrastructure development. Its fundamental role in shaping the built environment is characterized by a shift in architectural thinking, new materials and technologies, and a renewed focus on sustainability and historical context in architectural design. This scholarly work provides a comprehensive and informative overview of the rich tapestry of civil engineering during this historical period, offering valuable insights into the intricate processes and remarkable achievements that have left an indelible mark on European architectural history. From the monumental achievements of ancient civilizations, such as the awe-inspiring pyramids of Egypt and the sophisticated aqueducts of Rome, to the intricate architectural wonders of the Medieval and Renaissance periods, our research underscores the profound impact of cultural, technological, and social influences on engineering practices. Our analysis demonstrates how civil engineering has consistently adapted to changing times, addressing societal needs and challenges.

Keywords: Civil Engineering, building designs, architectural history, evolution

### Introduction

Civil Engineering's growth on the designs of infrastructures is related to the altering paradigms of human wants, ambitions, and technology capable of bringing satisfaction to us humans. Early engineering wonders such as the pyramids, industrial aqueducts, and amphitheatres, dating back to ancient civilizations such as the Egyptians, Greeks, and Romans, displayed remarkable brilliance in construction and the techniques coming from the amazing minds behind these buildings. These ancient constructions fulfilled utilitarian objectives while also symbolizing perfection and organization, enduring emblems of power, creativity, and architectural talent, providing the foundation for the formation of civil engineers of today.

The improvement of architectural designs increased as times passed; civilizations grew and societies evolved to more futuristic and modern forms. The Medieval Period provided soaring cathedrals and walled castles, reinvigorated classical architectural features, stressing harmony and balance in its design representing the aesthetic and beauty of the Medieval Period. These architectural features not only pushed the boundaries of engineering but also created elements of art and spirituality, serving as expressions of faith and cultural identity. These feats from the history of civil engineering are a narrative of how human innovation, adaptability, powered the relentless pursuit of creating structures beyond our imagination that transcend generations.

Innovations in materials and construction techniques being used fueled the creation of railway bridges, expansive canals, and towering industrial structures that we see today. The emergence of iron and steel as key construction materials in the 19th century enabled engineers to push the limits of towering height and mind-blowing designs of our buildings and bridges today. Furthermore, these advances in structural analysis and design principles paved the path for safer, more efficient and sustainable structures, transforming how engineers planned and implemented structural projects. Each era in the history of civil engineering building designs represents not just technological advances, but also shifting socio-cultural, economic, and environmental settings that have shaped the innovations and technologies we are capable of building today.

### Methodology

Studying the history of engineering building design requires a holistic approach. Start by thoroughly reviewing the literature, including journals, textbooks, and conference proceedings. This process helps identify existing knowledge, gaps, and areas to explore. Analysis of real-world case studies provides valuable insights, while advanced technology, simulation, and modeling tools help validate and improve design concepts. Collaborating with experts, attending conferences, and participating in community discussions enhances the research process and fosters a dynamic exchange of ideas. The intersection of theoretical knowledge and practical applications of research contributes to the continued advancement of civil engineering and shapes how we conceptualize and create the structures that define our world.

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## Analysis

This research paper explores the history of civil engineering by closely examining how building designs have changed across four major historical periods: the Ancient Civilizations, the Medieval Era, the 18th and 19th Centuries, and the Contemporary Era. This research examines the architectural progress that has shaped our built environment, from the colossal structures of ancient civilizations to the inventive technical solutions of the industrial revolution and the state-of-the-art designs of today. This study sheds light on the critical role that civil engineering has played in shaping the nature and development of societies over time through an analysis of construction methods, socioeconomic factors, and the advancement of materials and technology. It also offers insights into the difficulties encountered, the solutions found, and the long-lasting effects of these engineering marvels.

### *Ancient Civilizations*

In exploring building designs, it is important to take into account the structures of the past. Exploring these structures provide a clear understanding of the origin of Civil Engineering. Ancient civilizations, specifically Ancient Egypt, Ancient Greece, and Ancient Rome, relied heavily on civil engineering to build gigantic structures that fulfilled symbolic and utilitarian functions. These societies' architectural accomplishments are a testament to their advanced engineering methods, inventiveness, and cultural relevance.

### *Ancient Egypt*

When one thinks about Egypt, structures that immediately come to mind are the Pyramids, and Temples. The question "How did they build it without the advancement of technology that we have today?" is often asked, and often a conundrum to some. Here, the Pyramids and Temples of Ancient Egypt are presented.

### *Pyramids*

Pyramid building is a well-known feat of the ancient Egyptians. One famous instance is the Giza Pyramids. Perhaps the most well-known and talked-about buildings in history, The great pyramids of Giza are the last of the Seven Wonders of the Ancient World (Calvert, n.d.). The pyramids were a significant religious symbol and showed the pharaoh's might (Baldwin, 2023). The pharaoh was honored with the construction of the Giza pyramids, which also functioned as his tomb upon death (Baldwin, 2023). The pharaohs were seen to be a combination of God and human, and it was thought that they would enter the afterlife upon dying (Baldwin, 2023). To build these enormous constructions, civil engineers used organized labor, sophisticated material understanding, and accurate surveying procedures. Thoughts abound over the precise techniques employed, there are still many unanswered mysteries regarding the building of these enormous monuments. There is also ongoing discussion over the labor force required to construct these pyramids (Khan Academy, n.d.). Some explanations have been provided by the discovery of a worker's settlement south of the plateau. There probably existed a year-round complement of some two thousand conscripted peasants who worked as seasonal crews to support a permanent group of highly competent craftsmen and builders. These crews were split up into 200 people, and then each group was further subdivided into 20-person teams (Khan Academy, n.d.).

### *Temples*

Priests served the gods in the hallowed spaces known as Egyptian temples (EES, 2022). A temple served as the residence for the deity or deities (EES, 2022) to whom it was dedicated. In the shrine of the temple, gods were thought to reside within their sculptures. Temples were made with the universe's maintenance and reflection in mind (EES, 2022). The world as it was perceived by the Egyptians is depicted in their décor. The ceilings were decorated in stars and constellations, the bottom portions of the walls and columns are carved with plant patterns, and the central section depicts the king performing rituals and worshipping the gods (EES, 2022). Temples were built for over 3,500 years in Ancient Egypt (Raneiri, 2021). Early temples were constructed entirely of stone, primarily sandstone but also limestone, granite, or basalt. Mudbrick was gradually replaced by stone throughout time (Raneiri, 2021). The pharaoh Nectanebo built the temple either by a mudbrick ramp, or by wooden scaffolding (Raneiri, 2021). The modern Egyptians build on shoddy foundations and utilize the same kind of wooden scaffolding (Raneiri 2021). It was constructed out of stone and then polished all the way around (Raneiri, 2021). Mostly for worship, they completed the temple's top in the shape of a pyramidion, covering it in gold and silver (Raneiri, 2021).

### *Ancient Greece*

Ancient Greece's approach to building design, especially in temples, theaters, and stadiums, showcased a unique fusion of architectural brilliance and engineering expertise. The Parthenon's precise columns and mathematical proportions exemplified structural mastery, while theaters displayed advanced acoustic engineering. Greek stadiums demonstrated an adept balance of functional design and aesthetic appeal, reflecting the enduring legacy of Greece's architectural ingenuity.

### ***Ancient Greek Architecture***

Greek cities and cultures, from the Greek mainland to Anatolia and Italy, are represented in Greek architecture, which has a rich history that dates back to 900 BCE. It includes colossal stone temples and residential buildings, the oldest of which date to approximately 600 BCE. According to Paga, J. (n.d.), a professor at William & Mary College specializing in Greek archaeology and history, "Ancient Greek architecture is a broad field of study that encompasses everything from monumental stone temples to domestic houses built of timber and mud brick."

Greek architecture, characterized by symmetry and harmony, was exemplified by the Greek temple. The temple had an oblong plan, with columns surrounding all sides (Hemingway, 2003). The vertical structure conformed to an order, with a pronaos and opisthodomos. Upper elements were made of mud brick and timber, while the platform was cut masonry (Hemingway, 2003). Columns were carved from local stone, with marble used in many temples. The interior consisted of a cella, inner shrine, and antechambers for treasury storage (Hemingway, 2003).

### ***Ancient Rome***

Ancient Rome's building design brilliance is epitomized by its aqueducts, roads, amphitheaters, and the Colosseum. Roman aqueducts showcased hydraulic expertise. Their road network reflected strategic planning and durability. Amphitheaters, including the Colosseum, displayed architectural innovation for large-scale events. Rome's holistic approach to building design left an indelible mark on the ancient world's urban landscape and technological advancements.

### ***Aqueducts and Roads***

The Romans used a combination of stone, brick, and a volcanic cement called pozzolana to hold their constructions together while building aqueducts and other structures (Lesso, 2023). The astonishing and inventive ingredient that gave Roman aqueducts their strength and the reason so many of them survive to this day are due to it (Lesso, 2023). The Romans utilized wooden structures like modern scaffolding when placing the stones, brick, and cement; these were later removed (Lesso, 2023). Roman roads were often built with a base layer of dry sand, a top layer of flat, wide stones called the summum dorsum, a layer of medium-to-large stones called the statumen, a layer of fine gravel mixed with cement called the rudus, and a layer of sand mixed with cement called the nucleus (Dresser, 2023).

### ***The Colosseum***

One of Rome's most famous amphitheaters is the Colosseum, which dates back to the first century CE. Classical Roman design is reflected in its circular shape and tiered seats, which are embellished with columns and archways (National Geographic, 2023). Originally employed for gladiatorial fights, it represents the splendor of Roman engineering and amusement (National Geographic, 2023). The majority of amphitheaters in ancient Rome were constructed as movable wooden constructions for gladiatorial matches and other entertainment (Evans, 2023). The Flavian Amphitheatre, or better known as the Colosseum, was primarily built using stones, muds, and cement work.

The achievements of civil engineering found in the architectural designs of ancient civilizations demonstrate a profound comprehension of materials, mathematics, and real-world applications. These buildings had practical uses, but they also had a big impact on the architectural and cultural legacies of the communities in which they were built. These historic buildings' resilience highlights the long-lasting influence of civil engineering on the advancement of human civilizations.

### ***Medieval and Renaissance Period***

The Medieval and Renaissance Period in civil engineering, as elucidated by Parry (2014), is marked by transformative developments that have enduringly shaped European architecture. In the introductory chapters, Parry provides a captivating exploration of the lives of influential 'artists' who served as engineers and architects during this era, shedding light on the materials and tools at their disposal. Subsequent chapters delve into various facets of civil engineering, covering water control, irrigation, drainage systems, and transportation networks. Parry skilfully details notable achievements of the period, including Dutch drainage works, the engineering marvel of the Canal du Midi, and iconic structures such as St. Paul's and Ponte Vecchio. His adept use of case studies serves to foster a deeper appreciation and stimulate further scholarly inquiry, maintaining a commendable balance between narrative and detailed analysis. However, it is crucial to note that the article does not extend its focus to encompass the broader context of medieval industry or manufacture (Parry, 2014, pp. 105-109). This scholarly work provides a comprehensive and informative overview of the rich tapestry of civil engineering during this historical period, offering valuable insights into the intricate processes and remarkable achievements that have left an indelible mark on European architectural history.

### ***Gothic***

The history of civil engineering building designs has witnessed significant contributions from the Gothic architectural style. The Gothic style, characterized by pointed arches, ribbed vaults, and flying buttresses, emerged during the medieval period and became prominent in the construction of cathedrals and other structures. Gothic architecture is renowned for its verticality and intricate detailing, exemplified in structures such as the Notre-Dame

Cathedral in Paris (Fletcher, Cruickshank, & Dan, 1996). This style marked a departure from the preceding Romanesque architecture, introducing innovations that allowed for the construction of taller and more elaborate buildings. The use of pointed arches distributed weight more effectively, enabling the creation of larger windows and expansive interiors. Gothic engineering principles not only influenced religious edifices but also found application in secular buildings, contributing to the evolution of civil engineering practices (Summerson, 1953). The incorporation of Gothic elements in building designs reflects the adaptability and enduring impact of historical architectural styles on civil engineering.

The Gothic architectural style has left an indelible mark on the history of civil engineering building designs, and its impact extends far beyond mere aesthetic considerations. Structures like the Notre-Dame Cathedral exemplify the mastery of Gothic design, characterized by pointed arches and flying buttresses (Scott, 2003). These architectural features not only contributed to the grandeur of religious edifices but also introduced innovative engineering principles that significantly influenced civil engineering practices. The pointed arch, for instance, allowed for a more efficient distribution of weight, enabling the construction of towering structures with expansive interiors. Flying buttresses provided external support, allowing for the creation of larger windows and open spaces. Gothic architecture's influence was not confined to religious buildings, as it found application in castles, civic structures, and even residential buildings, showcasing its adaptability and enduring legacy in civil engineering (Watkin, 2005). The enduring influence of Gothic principles on the structural and aesthetic aspects of buildings underscores their lasting impact on the evolution of civil engineering throughout history.

### ***Renaissance***

The Renaissance era marked a transformative period in the history of civil engineering building designs, witnessing a departure from Gothic architecture and the emergence of distinct Renaissance principles. The architectural shift is exemplified in structures like the Palazzo Medici Riccardi in Florence, showcasing the revival of classical elements (Heydenreich, 1996). During this period, architects such as Filippo Brunelleschi played a pivotal role in reintroducing classical principles, emphasizing proportion, symmetry, and mathematical precision (Ackerman, 1991). The dome of the Florence Cathedral, designed by Brunelleschi, stands as a testament to Renaissance engineering ingenuity and a departure from the pointed arches of the Gothic era (Heydenreich, 1996; Ackerman, 1991). Renaissance architects drew inspiration from classical antiquity, incorporating features such as columns, pilasters, and domes into their designs. This architectural transition reflects the Renaissance's commitment to humanism and a renewed focus on empirical knowledge, which profoundly influenced the evolution of civil engineering practices during this period.

The Renaissance era was a pivotal period in the evolution of civil engineering building designs, departing from the Gothic style and embracing distinctive Renaissance principles. Illustrated by structures like the Palazzo Medici Riccardi in Florence, the Renaissance showcased a revival of classical elements and a renewed emphasis on proportion, symmetry, and mathematical precision (Heydenreich, 1996). Architects such as Filippo Brunelleschi, a key figure of the era, reintroduced classical ideals, as evidenced in the dome of the Florence Cathedral, a departure from Gothic pointed arches and a testament to Renaissance engineering ingenuity (Millon, 1994). This architectural shift reflected the Renaissance's commitment to humanism and a renewed focus on empirical knowledge, significantly influencing civil engineering practices. Iconic structures like St. Peter's Basilica in Rome, designed by architects including Donato Bramante and Michelangelo, exemplify the grandeur and classical revival of Renaissance architecture, integrating colossal orders, harmonious proportions, and symmetrical designs (Hale, 1996). Engineering marvels such as the dome of St. Peter's Basilica demonstrated advancements in structural engineering, underscoring a holistic approach that combined art and science and leaving an enduring impact on civil engineering practices.

### ***18th and 19th Century***

The 18th and 19th centuries marked a significant shift in civil engineering building designs as engineers focused on functionality, aesthetics, and new materials. During this period, a unique style of architecture, known as Neoclassical, emerged, characterized by its symmetry, balance, and adherence to classical antiquity. This style was exemplified in the designs of Robert Adam and James Wyatt, who emphasized the importance of the Doric, Ionic, and Corinthian orders in their work. As engineering advancements were made and new materials were introduced, engineers like John Rennie and William Tierney Clark were able to create innovative structures that pushed the boundaries of civil engineering at the time. The 18th and 19th centuries also saw the rise of the Gothic Revival movement, which sought to revive the architectural styles of the medieval period. This movement led to the construction of numerous church buildings and the redesign of existing structures, often featuring pointed arches, ribbed vaults, and stained-glass windows. Overall, the 18th and 19th centuries were a time of significant change and innovation in civil engineering building designs as engineers and architects sought to create functional and visually stunning structures.

### ***Neoclassical***

The neoclassical period of civil engineering building designs spanned from the mid-17th century to the mid-19th century. It was marked by a return to order and rationality after the flamboyant Baroque and the decorative frivolity of the Rococo. Neoclassical architecture was composed of many elements based on the antique forms of Greek and Roman architecture, and it can be imitated to a greater or lesser extent. Building designers continued to borrow from Greek and Roman models, making neoclassicism the world's most famous building style. The period was characterized by large-scale structures supported and decorated by columns of Doric, Ionic, or Corinthian pillars surmounted by enlarged Renaissance-style domes. The neoclassical period also saw the establishment of an architectural academy as a continuation of the Renaissance informal architecture teaching. Many notable architects in neoclassical architecture introduced new schools of thought.

### *Postmodernism*

The postmodern period in civil engineering building designs, which emerged in the late 20th century, saw significant advancements in architectural design. One of the key developments during this period was the new building materials. Postmodernism introduced several new building materials, such as Glass Reinforced Polyester, Insulated Exterior Metal Panel Systems, and Dupont's Fabric Tensile Structures, which allowed architects to create innovative designs and formulations. Further, the postmodern era was marked by a shift in architectural design, moving away from the strictures of modernism and embracing new technologies. This led to high-tech architecture combining advanced technology with traditional construction methods. Historical references and eclectic styles were also among the many advancements during this period wherein architects rejected the rationalism of modern engineering and embraced historical building styles, forms, and elements to create a more human-scale and contextually responsive architecture. Postmodern engineering focuses on incorporating sustainable design principles and improving energy efficiency in buildings, reducing their environmental impact. As postmodern buildings reach the end of their design life-cycle, there is a growing interest in preserving and adapting these structures to meet contemporary needs and expectations. Overall, the postmodern period in civil engineering building designs was characterized by a shift in architectural thinking, new materials and technologies, and a renewed focus on sustainability and historical context in architectural design.

### *Contemporary Era*

In the recent era of civil engineering building designs, which stretches from the late 20th century to today, there has been a significant change due to increasing global challenges and advancements in technology. Architects and civil engineers have shifted their focus to creative solutions that not only meet practical needs but also consider environmental impact and efficiency. This period marks a departure from traditional design approaches, with a noticeable emphasis on sustainability, digitization, and parametric methods.

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## **Sustainable Designs**

Sustainable building design now encompasses a broad and interdisciplinary research effort, involving mechanical, electrical, electronic, communication, acoustic, architectural, and structural engineering. It requires collaboration among owners, contractors, suppliers, and building users. Common concerns are saving energy and water and making buildings more friendly to the environment. In the Contemporary Period, the development of civil engineering building designs has been significantly shaped by a dedication to sustainability. Engineers and architects are progressively incorporating environmentally friendly materials, energy-efficient systems, and green technologies into their projects. Sustainable designs aim to minimize the environmental footprint and enhance long-term resilience, incorporating features such as green roofs to mitigate urban heat islands and passive design principles that optimize natural lighting and ventilation. Innovations like net-zero energy buildings and the integration of renewable energy sources highlight a deliberate endeavor to align infrastructure development with ecological well-being, marking a crucial shift towards a more environmentally conscious approach.

Sustainable design in civil engineering encompasses a multifaceted approach that goes beyond environmental considerations, offering significant economic advantages. Implementation of sustainable design principles not only yields long-term cost savings and improved return on investment but also enhances construction efficiency. This is achieved through practices such as the use of eco-friendly materials, energy-efficient systems, and green technologies. The economic benefits extend to lower energy bills, reduced maintenance costs, and increased market value for sustainable buildings. Energy efficiency, a cornerstone of sustainable design, involves minimizing energy consumption through strategies like passive design, advanced insulation systems, and renewable energy integration. Moreover, sustainable design practices address the increasing importance of resilience and climate change adaptation in civil engineering. Infrastructure designed with climate-responsive principles can withstand extreme weather events and rising sea levels, contributing to long-term durability and reduced maintenance costs. Case studies, such as the LEED Platinum-certified Bank of America Tower and the California Academy of Sciences, serve as practical examples of successful sustainable design, providing valuable insights and benchmarks for future initiatives in the industry.

In summary, sustainable design in civil engineering offers economic benefits, energy efficiency, and resilience to climate change. The adoption of eco-friendly materials and energy-efficient systems not only results in long-term cost savings but also enhances construction efficiency. Integrating renewable energy sources contributes to a greener energy mix. Climate-responsive design principles ensure infrastructure durability in the face of changing climate patterns. Real-life examples, like the Bank of America Tower and the California Academy of Sciences, showcase the success of sustainable design, providing valuable benchmarks for the industry's ongoing pursuit of environmentally responsible solutions.

In recent times, civil engineering has witnessed a transformative evolution, notably with the introduction of innovative design paradigms like Parametric Design. Traditionally linked with architectural advancements, Parametric Design has emerged as a groundbreaking methodology, offering a distinctive approach to tackle form-finding challenges in Civil Engineering. This departure from conventional methods reflects a limited adoption of parametric techniques within the field. The exploration of Parametric Design's characteristics and methodology within the context of Civil Engineering aims to illuminate its potential implications and practical applications, showcasing its viability in addressing engineering challenges.

Civil engineering, serving as a cornerstone of modern societal infrastructure development, assumes a pivotal role in shaping the built environment. The intricate web of highways, bridges, buildings, and hydraulic structures that define our surroundings demands meticulous attention to precision, efficiency, and sustainability. In navigating these challenges, Computer-Aided Design (CAD) emerges as an indispensable tool for civil engineers. CAD technology empowers engineers with robust tools that facilitate the transformation of conceptual ideas into tangible projects. From conceptualization to detailed design and documentation, CAD provides a comprehensive platform for visualization and analysis. This ultimate guide delves into the profound

significance and benefits of CAD in civil engineering, unraveling how it not only shapes and enhances the field but also contributes to the creation of a more sustainable and efficient world. Through the utilization of CAD, civil engineers navigate complexities with heightened precision, streamline design processes, and contribute to the realization of infrastructure that stands at the intersection of innovation and sustainable development.

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## Conclusion

In conclusion, our exploration into the history of civil engineering building designs has unveiled a rich tapestry of human ingenuity and innovation spanning across millennia. From the monumental achievements of ancient civilizations, such as the awe-inspiring pyramids of Egypt and the sophisticated aqueducts of Rome, to the intricate architectural wonders of the Medieval and Renaissance periods, our research underscores the profound impact of cultural, technological, and societal influences on engineering practices. As we transitioned into the 18th and 19th centuries, the Industrial Revolution brought about unprecedented advancements in materials and construction techniques, reshaping urban landscapes and pushing the boundaries of structural engineering.

The journey through the contemporary period, marked by rapid technological evolution and globalization, reveals a dynamic landscape of skyscrapers, sustainable designs, and cutting-edge engineering feats. Our analysis demonstrates how civil engineering has consistently adapted to changing times, addressing societal needs and challenges. Notably, the integration of computer-aided design (CAD) and innovative materials has propelled the field into new frontiers. However, it is essential to acknowledge the ethical considerations and environmental impacts associated with modern construction practices, urging the industry to prioritize sustainable solutions for a resilient future.

In synthesizing this historical trajectory, it is evident that each era has left an indelible mark on the evolution of civil engineering. By appreciating the lessons from the past, we pave the way for a future where creativity, sustainability, and societal well-being remain at the forefront of architectural endeavors. The insights gained from this exploration contribute not only to our understanding of the past but also to the informed and responsible practice of civil engineering in the years to come.

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## References

- Ancient Egypt, an introduction (article)* | Khan Academy. (n.d.). Khan Academy. <https://www.khanacademy.org/humanities/ap-art-history/ancient-mediterranean-ap/ancient-egypt-ap/a/ancient-egypt-an-introduction>
2. Addis, B. [Hrsg.] (2021) *Physical Models: Their historical and current use in civil and building engineering design*. Berlin: Ernst & Sohn.
- Kostof, S. (1999). *A History of Architecture: Settings and Rituals*. Oxford University Press.
- Fazio, M. W., Moffett, M., & Wodehouse, L. (2003). *A World History of Architecture*. McGraw-Hill Education.
- Petroski, H. (1994). *The Evolution of Useful Things*. Vintage Books.
- Morley, J. (1994). The importance of being historical: Civil engineers and their history. *Journal of professional issues in engineering education and practice*, 120(4), 419-428.
- The Evolution of Real Estate* The evolution of real estate has had a significant impact on the way we. (2023, January 23). *Capital Connect*. <https://www.capitalconnect.me/post/the-evolution-of-real-estate-the-evolution-of-real-estate-has-had-a-significant-impact-on-the-way-we>
- 18th and 19th century humanities fiero*. 18th and 19th Century Humanities : GLoria F. Fiero : Free Download, Borrow, and Streaming : Internet Archive. 2022-10-16. (n.d.). <http://opportunities.alumdev.columbia.edu/18th-and-19th-century-humanities-fiero.php>
- Neoclassical architecture (1640-1850)*. (n.d.). <http://www.visual-arts-cork.com/history-of-art/neoclassical-architecture.htm>
- Wikipedia contributors. (2023, October 20). *New Classical architecture*. Wikipedia. [https://en.wikipedia.org/wiki/New\\_Classical\\_architecture](https://en.wikipedia.org/wiki/New_Classical_architecture)
- Engineering the Design - The History of the design and Construction* | Golden Gate. (n.d.). <https://www.goldengate.org/exhibits/engineering-the-design/>
- Fraser, J. L. (n.d.). *1.5 Neoclassicism and the late Neoclassical*. Pressbooks. <https://ecampusontario.pressbooks.pub/artcultures/chapter/1-5-neoclassicism-and-the-late-neoclassical/>
- Architecture paradigm shift: Neoclassic, Eclectic, art Nouveau*. (n.d.). Husam Talib. <https://husamtalib.com/paradigm-shift-in-architecture-neoclassicism-eclecticism-art-nouveau/>
- Kearney, K. (2019, January 28). *Post Modern Building Materials part one*. Peter Meijer Architect, PC. <https://pmapdx.com/blog-pmafindings/1930/postmodern-building-materials>
- Post-Modern engineering*. (2022, August 31). Consulting - Specifying Engineer. <https://www.csemag.com/articles/post-modern-engineering/>
- Kearney, K. (2019b, January 28). *Post Modern building materials part two*. Peter Meijer Architect, PC. <https://pmapdx.com/blog-pmafindings/2236/post-modern-building-materials-part-two>

- Brennecke, T. (2023, February 1). *Between modern and post-modern: Introducing high-tech architecture*. Parametric Architecture. <https://parametric-architecture.com/between-modern-and-post-modern-introducing-high-tech-architecture/>
- Armstrong, P. J., & Kapp, P. H. (2022). Preserving the past or past preserving: sustaining the legacy of postmodern museum architecture. *Built Heritage*, 6(1). <https://doi.org/10.1186/s43238-022-00055-z>
- Egyptian Exploration Society (2022). *Temples in Ancient Egypt*. EES. <https://www.ees.ac.uk/resource/temples-in-ancient-egypt.html>
- Ranieri, L. (2021, October 19). *Ancient Egyptian Temples – an in-depth look | Ancient Egypt Alive | Travel Tours | Online Learning | Online Courses | Networking Events*. <https://ancientegyptalive.com/2021/10/19/ancient-egyptian-temples-an-in-depth-look/>
- Wang, N., & Adeli, H. (2013, November 25). Sustainable Building Design. [https://www.researchgate.net/publication/261581479\\_Sustainable\\_building\\_design](https://www.researchgate.net/publication/261581479_Sustainable_building_design)
- Kibert, C. J. (2008). "Sustainable Construction: Green Building Design and Delivery." John Wiley & Sons.
- (2014). Reviews. *The International Journal for the History of Engineering & Technology*, 84, 105 - 109. <https://doi.org/10.1179/1758120613z.00000000039>.
- Fletcher, B., Cruickshank, D., & Dan, M. (1996). *Sir Banister Fletcher's A history of architecture*. Architectural Press.
- Summerson, J. (1953). *The Gothic revival: An essay in the history of taste*. Phaidon Press.
- Scott, G. (2003). *The Architecture of Humanism: A Study in the History of Taste*. Transaction Publishers.
- Watkin, D. (2005). *A History of Western Architecture*. Laurence King Publishing.
- Ackerman, J. S. (1991). *The Architecture of Michelangelo*. University of Chicago Press.
- Heydenreich, L. (1996). *Architecture in Italy, 1400-1600*. Yale University Press.
- Norberg-Schulz, C. (1988). *Renaissance Architecture*. Electa/Rizzoli.
- Hale, J. R. (1996). *Renaissance Europe, 1480-1520*. Wiley.
- Millon, H. A. (1994). *Italian Renaissance Architecture*. Thames and Hudson.
- Authors: Colette Hemingway. (1 C.E., January 1). *Architecture in Ancient Greece*. The Met's Heilbrunn Timeline of Art History. [https://www.metmuseum.org/toah/hd/grarc/hd\\_grarc.htm#:~:text=The%20upper%20elements%20of%20the,have%20been%20made%20of%20wood](https://www.metmuseum.org/toah/hd/grarc/hd_grarc.htm#:~:text=The%20upper%20elements%20of%20the,have%20been%20made%20of%20wood).
- Lesso, R. (2023, October 2). *How did Romans build aqueducts?* TheCollector. <https://www.thecollector.com/how-did-romans-build-aqueducts/>
- Dresser, S. (2023). *Ancient Roman Roads | Facts, Construction & History*. Study.com. Retrieved December 9, 2023, from <https://study.com/academy/lesson/building-ancient-roman-roads-history-facts-quiz.html#:~:text=Roman%20roads%20were%20usually%20constructed,stones%20called%20the%20sumum%20dorsum>.
- Evans, F. (2023, March 28). *How the Colosseum Was Built—and Why It Was an Architectural Marvel*. HISTORY. <https://www.history.com/news/how-roman-colosseum-built>
- National Geographic Society (2023, October 19). *The Colosseum*. Anthropology, Archaeology, Social Studies, World History <https://education.nationalgeographic.org/resource/colosseum/>
- Gonzales, G. (n.d.). The Impact of Sustainable Design in Civil Engineering. *gonzalez-strength*. <https://www.gonzalez-strength.com/blog/civil-engineering/sustainable-design-in-civil-engineering/>
- Maggie. (2023, December 7). *The importance of CAD in Civil Engineering: Ultimate guide*. *cad-importance-in-civil-engineering*. <https://blog.zwsoft.com/cad-importance-in-civil-engineering/>