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Rapid Communication

Roots and resilience: how architecture below ground supports life above

Rosangel Sozzan*

Department of Plant and Microbial Biology and NC Plant Sciences Initiative, North Carolina State University, USA

Email:ros_sozzan@ncsu.edu

INTRODUCTION

In the ever-evolving world of architecture, buildings have traditionally been seen as structures that rise above the ground, serving as visible landmarks of human ingenuity. However, there is an increasing trend in modern design to look below the surface for inspiration and practicality. The architecture beneath our feet plays a pivotal role in sustaining life above ground, providing critical support for everything from infrastructure to ecosystems. These subterranean spaces not only enhance the resilience of buildings and cities but also offer sustainable solutions to the growing challenges of urbanization, climate change, and resource management (Chaney.,et al 1197).

At the core of any resilient building lies a robust foundation. This essential component, often overlooked, serves as the unseen anchor that supports structures above ground. The foundation must withstand not only the weight of the building but also the natural forces of the earth, such as shifting soil, seismic activity, and water movement. In areas prone to flooding, earthquakes, or unstable ground conditions, deep foundations that extend below the surface are often the best solution (Cunningham.,et al 1996).

In seismic zones, buildings with foundations anchored deep below the surface are less likely to be damaged by ground movement. Piles or caissons—long, slender columns of concrete or steel—are driven into the earth to stabilize the structure. These deep foundations allow buildings to "float" above the unstable soil, offering a level of protection that could make the difference between survival and collapse (Gerhardt.,et al 2017).

Subterranean architecture is not limited to just foundations; underground spaces have become an integral part of urban infrastructure. As cities grow in size and population density, the demand for land above ground becomes increasingly strained. In response, urban planners and architects have turned to the underground for space to house essential utilities, transportation networks, and even residential and commercial facilities (Ghosh.,et al 2005).

One of the most striking examples of underground architecture is the development of subway systems in major cities. In cities like New York, London, and Tokyo, vast underground networks transport millions of people daily, alleviating surface-level congestion and reducing the environmental impact of transportation. These underground transit systems rely on careful engineering to ensure they remain safe and functional, even in the face of challenges like water infiltration or the risk of earthquakes (Pilon-Smits.,et al 2002).

Additionally, underground parking garages, storage facilities, and commercial spaces are becoming increasingly common in urban developments. By shifting these activities below ground, architects can free up valuable surface space for parks, plazas, and other green spaces that improve the quality of life for city dwellers. This approach not only maximizes land use but also reduces the carbon footprint of urban development (Salt.,et al 1998).

Sustainability has become a central focus in modern architecture, and underground spaces offer innovative solutions to many environmental challenges. The natural temperature regulation of the earth provides an excellent opportunity for energy-efficient building design. Geothermal heating and cooling systems, for example, rely on the stable temperature of the earth to regulate the internal climate of buildings, reducing the need for traditional energy-intensive HVAC systems (Salt.,et al 1999).

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In addition to geothermal energy, underground architecture can support sustainable water management systems. Underground reservoirs, for instance, can store rainwater for later use, reducing the strain on surface-level water sources. This is particularly crucial in areas that face drought conditions or experience irregular rainfall patterns. Similarly, underground stormwater management systems can help mitigate flooding by directing excess water away from the surface and into underground channels where it can be stored or filtered (Schnoor,.,et al 1995).

The concept of "green roofs" has also gained popularity in urban planning. These roofs, which are partially or fully covered with vegetation, help mitigate the heat island effect by providing insulation and reducing the absorption of heat by buildings. When paired with subterranean structures, these green roofs contribute to sustainable urban environments by supporting biodiversity and improving air quality.

Underground spaces are not only crucial for modern architecture but also play a vital role in preserving cultural heritage and ecosystems. Many ancient structures, such as the catacombs in Rome or the underground cities of Cappadocia in Turkey, offer insight into the ways in which humans have adapted to life below ground. These historical sites, which have withstood centuries of use and change, highlight the enduring importance of subterranean architecture (Trapp.,et al 2001).

Today, architects are increasingly mindful of the need to protect and preserve underground ecosystems. Caves, tunnels, and other underground habitats serve as refuges for a wide variety of plant and animal species. When developing new underground spaces, it is important to minimize disruption to these delicate ecosystems, ensuring that the balance between human development and environmental preservation is maintained (Watanabe.,et al 1997).

CONCLUSION

The architecture beneath our feet plays an indispensable role in supporting the world above. From foundational support to sustainable infrastructure, underground spaces are integral to building resilient, efficient, and environmentally conscious cities. As urbanization continues to increase and the challenges of climate change become more pressing, underground architecture offers a unique opportunity to meet these demands while preserving natural resources and historical sites. By looking below the surface, we can build a more resilient and sustainable future for generations to come.

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