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Editorial: Global excellence in sustainable design and construction: Europe 2023

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Editorial on the Research Topic
Global excellence in sustainable design and construction: Europe 2023

Nowadays, sustainability and sustainable development are major concerns of humanity aiming to protect the Earth and ensure that all people live in peace and prosperity (United Nations, 2015b). As well known, a sustainable development shall balance environmental, economic and social aspects. However, unprecedented urban growth has occurred in the last and current centuries, and more intense migration are causing many cities to be converted to megacities (Wong, 2015). In this context, the construction sector is becoming more impactful on the planetary ecosystems (UNEP, 2022). Cities and buildings play a fundamental role in facilitating the transition towards greener and more sustainable energy practices. At the urban level, international policies are geared towards achieving carbon neutrality by advocating for widespread accessibility and affordability of clean energy sources, consequently actively contributing to the reduction of greenhouse gas emissions to reach carbon neutrality. Furthermore, these policies are instrumental in fostering biodiversity and promoting the deployment of effective climate mitigation and adaptation measures. Besides, building-focused initiatives concentrate on the optimization of energy efficiency, prioritizing extensive deep renovation projects, and spearheading robust decarbonization efforts within the built environment (EPBD, 2018; European Commission, 2019; European Union, 2023).

Central themes are the reuse of construction materials and the embodied energy used in building production processes. A considerable amount of resources is required to construct, operate, and maintain the built environment, including buildings (UNEP, 2022). Most of these resources are later converted into waste, for example, construction and demolition waste (European Commission, 2023). Thus, Circular Economy is a fundamental instrument that allows to convert what is considered "waste" by some into valuable resources for other applications (European Commission, 2020).

Among the previous resources, energy is a very relevant one, given its relevant share compared to other economic sectors and whenever generated by fossil fuels (EPBD, 2018). Thus, the adoption of Renewable Energy Sources (RES) is crucial to the decarbonization of buildings in particular and of the construction industry in general (The European Parliament And The Council Of The European Union, 2018; Material Economics, 2019).

Existing buildings have a unique position in this debate thanks to their positive contribution to climate adaptation linked to the use of natural sources and local, raw,

and durable materials that necessitate low energy for production, transportation, and recycling (United Nations, 2015a). In this context, the present Research Topic collects different relevant contributions, highlighting some key issues related to sustainable design and construction, namely:

- Learning from the architecture of the past to rediscover the importance of bioclimatic strategies in modern construction.
- Role of innovative technologies in preservation.
- Resilience and adaptability in the face of severe weather conditions.
- Focus of the construction sector towards sustainable solutions and the adoption of eco-friendly materials to reduce environmental impact.
- Exploration of biological growth for building solutions.
- Importance of the research on Life Cycle Energy Analysis (LCEA) and how this methodology is shaping the understanding of the energy impact of construction materials throughout a building's entire life cycle.

Going into more detail, the contributions of each research are explained in the following.

Picuno addresses the importance of farm buildings for the sustainable development of rural areas thanks to their unique architectural and technical challenges. Historically, they have been closely intertwined with the surrounding agricultural landscape and human activities, significantly shaping the rural and cultural environment. The growing emphasis on sustainable development has prompted a renewed interest in their heritage and natural value and adaptation to the climate. This study investigates the distinctive features of farm buildings, examining their environmental conditions and showcasing various global instances of their survey, reuse, and enhancement, with a focus on Southern Italy. Additionally, it emphasizes the importance of integrating cutting-edge technologies to preserve and promote this rural building heritage. The research also highlights the collaboration among various sectors for effectively supporting rural improvement through education and knowledge-sharing among students, practitioners, and stakeholders.

Booth and Jankovic examine the impact of severe weather conditions on the preservation of historic structures. Their study explores the potential of innovations of bio-augmented self-repair materials to improve building resilience and reduce maintenance activities. By encapsulating bacteria within multiple layers of limewash, they demonstrate how atmospheric carbon can be absorbed, thereby minimizing carbon-emitting maintenance processes. The materials used for bacterial encapsulation and nutrient delivery, such as hydrogels, alginates, and biofilm-based biopolymers, have been presented, emphasizing the possibility of developing a self-renewing sacrificial limewash in future research. Additionally, the study discusses the potential application of microbe-enhanced carbon-capturing limewash, particularly in improving the performance of sustainable materials like hemp-lime bio-composites.

Brandić Lipińska et al. examine the potential and challenges of using mycelium-based bio-composites for both earth and space applications. Their research highlights these composites' fire-resistant and insulating properties, underlining their adaptability to different environments and minimizing energy expenditure. A roadmap of available technologies is designed, suggesting recommendations for further development. Subsequently, they explore how controlled biological growth can facilitate fabrication, assembly, and maintenance processes, resulting in resilient structures suitable for sustainable building solutions in long-duration space missions and extraterrestrial habitats.

Schenk and Amiri focus on LCEA as an essential tool for assessing the energy impact of construction materials. Their study compares the performance of embodied, operational, and demolition energies for 100 timber, concrete, and steel buildings. The findings demonstrate that, on average, the embodied energy of timber buildings is 28%–47% lower than concrete and steel buildings, respectively. The mean and median values of embodied emissions are 2.92 and 2.97 GJ/m^2 for timber, 4.08 and 3.95 GJ/m^2 for concrete, and 5.55 and 5.53 GJ/m^2 for steel buildings. Otherwise, operational energy consumption is influenced by energy supply systems and building design elements. Surprisingly, demolition energy has a minimal contribution to the overall life cycle energy.

Together, these pioneering studies pave the way for more sustainable and environmentally conscious approaches to construction practices, underscoring the critical need for continued research and development in this field.

Author contributions

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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