

Enhancing Sustainability in Multistory Buildings Through Green Roofs

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Abstract. Modern architecture and construction have adopted creative approaches to solve environmental problems in a time when sustainable practices are not just a choice but also a need. One of these innovative approaches is the incorporation of green roofs onto multistory structures. Green roofs, sometimes called living roofs or eco-roofs, provide a compelling chance to transform urban architecture and address pressing environmental issues simultaneously. This report examines the profound relevance of using green roofs in multistory building design and construction. This study seeks to explain why green roof installation should be a top concern in modern building projects by thoroughly examining these structures' environmental, economic, and social effects. It is impossible to overestimate the contribution of green roofs to decreasing energy use, improving biodiversity, and alleviating ecological problems like the urban heat island effect as urbanization continues to change our towns and skylines. In addition to outlining the many advantages of green roofs, this essay will answer criticisms and offer strong arguments—along with case studies—to demonstrate how crucial they are to the resilience and sustainability of contemporary design.

Keywords: Hospitality Management, Sustainable development, Eco System.

1. Introduction

Green roofs, also known as vegetated or living roofs, are a prime example of a cutting-edge method of designing sustainable buildings. They entail growing plants on a building's roof introducing a multi-layered system that goes well beyond conventional roofing. Typically, a green roof has many levels. The waterproofing membrane at its foundation is essential for preventing water seepage into the building. This layer is vital to preserving the structure's integrity and guarding against possible moisture-related harm. A root barrier sits directly above the membrane and keeps the roots of the plants contained so they do not damage the underlying structure by seeping in.

The drainage system in the layer below makes sure that extra water is effectively drained away to avoid waterlogging, which might otherwise damage the plants and may jeopardize the structural integrity of the structure. The growth media, which serves as the base for the foliage, is placed on top of this. Because it holds onto water and nutrients, this substrate helps maintain plant and vegetation growth. The vegetation itself makes up the uppermost layer. It is made up of a range of plants, from tiny shrubs to sedums and grasses, that have been carefully chosen to flourish in the particular circumstances of the rooftop environment [4]. There are several varieties of green roofs, often divided into two categories: intensive and extensive. Deeper soil depths and more intricate designs enable more plants to be grown on intensive green roofs and the possibility of gardens or leisure areas. However, large green roofs are heavier and have shorter soil depths, which makes them suitable for low-maintenance plants like grasses or sedums. These are better suited for buildings with limited load-bearing capacity or for upgrading already-existing structures.

2. Impacts of Green Roofs

2.1. Environmental Benefits

Green roofs have a wide range of positive effects on the environment, which makes them an essential component of sustainable building design. One significant contributor is their capacity to lessen the impact of the urban heat island. Green roofs improve the microclimate overall by lowering

surface temperatures in urban areas, which acts as a buffer against the excess heat produced by the built environment. Furthermore, green roofs are naturally insulating, so less energy is needed to heat and cool buildings. This reduces energy expenses and the need for mechanical heating and cooling systems, reducing greenhouse gas emissions linked to energy use. Because of its ability to filter out pollutants and carbon dioxide while also producing oxygen through photosynthesis, its flora is essential to air cleansing. Urban air quality is greatly improved by this technique, giving residents of cities a healthier and more breathable environment [3]. Additionally, green roofs support biodiversity, ecological balance in urban landscapes, and peaceful cohabitation of the built environment and nature by serving as habitats for various plants and animals.

2.2. Economic Benefits

Solid financial benefits exist to integrate green roofs into multistory structures from both the short- and long-term perspectives. Even while the initial implementation expenses can appear high, they are vastly outweighed in the long run by the financial advantages. One of the leading economic benefits of green roofs is their ability to prolong the life of a building's roof. The vegetation acts as a screen to protect the top from weathering, UV rays, and temperature variations. This lowers the need for premature replacement and more regular maintenance. As a result, over time, this results in significant cost savings.

Moreover, green roofs significantly improve a building's energy efficiency. They control interior temperatures by acting as natural insulators, which lessens the need for excessive heating and cooling. This ultimately results in less energy being used and cheaper power bills. For example, installing a green roof of the Bank of America Tower at One Bryant Park in New York City is claimed to have saved \$30,000 in energy costs annually [6]. Furthermore, green roofs have outstanding benefits for stormwater management. When it rains a lot, they efficiently collect and hold onto rainwater, which eases the pressure on drainage systems and municipal infrastructure. Stormwater management expenses for the building and the larger community may be reduced due to this feature.

Studies and case studies regularly highlight the potential long-term financial advantages of incorporating green roofs when considering the holistic economic impact. Even with the upfront expenses, they are a wise investment in sustainable construction practices because of their capacity to minimize maintenance, save energy costs, and improve stormwater management.

2.3. Social Benefits

Beyond the environmental and financial benefits, green roofs also provide significant social benefits. These rooftop gardens enhance the living conditions of those who live in multistory buildings by giving urban dwellers common areas for leisure, farming, and other activities. Building occupants can find a tranquil haven amidst busy metropolitan landscapes because of the green spaces and peaceful atmosphere these roofs produce. These facilities provide opportunities for socializing, exercise, and recreational pursuits, which helps residents and employees feel better mentally and cope with stress. For instance, the Phipps Conservatory's rooftop garden in Pittsburgh connects people with nature and provides a tranquil haven from the city, serving as an educational and recreational area [7].

Furthermore, efforts in urban agriculture may benefit from installing green roofs. Some rooftop areas allow inhabitants to produce their food, creating a relationship between them and the food they eat. Building occupant engagement and a feeling of community are fostered in addition to sustainability and local food production. Green roofs improve multistory buildings' general livability and social fabric by establishing these green common areas. They provide spaces for unwinding and socializing, encouraging a more wholesome, united society in metropolitan areas.

3. Case Studies of Successful Green Roof Projects

One excellent example of a green roof that has been implemented successfully is the rooftop of Chicago City Hall. Budgetary issues were highlighted by the project's \$2.5 million initial outlay [5]. However, these worries were eclipsed by the following savings and advantages. Consider the green roof on City Hall, which increased the roof's lifespan, saved around \$24,000, and reduced yearly energy expenses by almost \$89,000. These monetary gains resulted from lower energy use for heating and cooling, highlighting the long-term cost-effectiveness of such programs. City Hall's green roof had a significant positive environmental impact and financial advantages. It significantly improved the metropolitan area's surface temperatures and air quality, reducing the urban heat island effect. In addition to enhancing the building's environmental performance, this sustainable addition served as a template for future municipal sustainability initiatives. The installation at Philadelphia City Hall is another noteworthy case study demonstrating green roofs' practicality. Despite the \$23 million initial investment, there were many worries about the high upfront expenses. But the savings and rewards that followed demonstrated how wise the investment was. The effect of the green roof on stormwater management was very significant. Because of the rooftop's efficient rainfall absorption and management capabilities, stormwater management for the building and the surrounding neighborhood was significantly less expensive. In addition to managing stormwater, the green roof decreased energy use, increased lifespan, and significantly lessened the building's environmental impact. The yearly savings and benefits in these locations demonstrated the many benefits of green roofs in urban settings and made the original expenditure worthwhile.

When taken as a whole, these case studies highlight the considerable advantages and affordability of green roofs for multistory structures. By displaying exemplary cases, they proficiently elucidate the advantages of green roofs in terms of the environment, economy, and society. This physical proof of the viability and benefits of incorporating green roofs into contemporary architectural designs is shown.

4. Addressing Stakeholder Concerns

For the incorporation of green roofs into multistory building designs to be effective, stakeholder concerns must be addressed. Many worries always come up, including financial limitations, possible effects on the building's architecture and structure, and concerns about long-term upkeep. Recognizing these worries and offering information demonstrating the viability and advantages of adding green roofs while reducing possible risks is critical. The initial expense of building green roofs is one of the main concerns among stakeholders. Even though the upfront costs may appear high, it is essential to emphasize that they outweigh the long-term financial gains. Cost-benefit studies frequently show that green roofs significantly impact cost reductions throughout their lifespan. For example, the \$2.5 million installation at Chicago City Hall saved \$89,000 in energy expenses annually and an additional \$24,000 in roof lifespan savings. Furthermore, a compelling financial argument must be made for installing green roofs due to the possibility of lower energy usage, maintenance expenses, and the roof's longer lifespan. The economic feasibility of green roof installations has been substantiated by case studies, such as the Bank of America Tower at One Bryant Park, which showed yearly energy savings of \$30,000 after installing a green roof.

It is expected to have concerns about how incorporating green roofs may affect the structure. Concerns over changes to the building's design or structural soundness may arise from stakeholders. Numerous worries have been alleviated by the progress made in engineering and design methodologies. As an illustration, the 2.5-acre living roof of the California Academy of Sciences in San Francisco was effectively incorporated without sacrificing the structure's structural soundness or visual attractiveness. Another significant concern is the weight of green roofs. However, lightweight materials and modular construction developments accommodate facilities with limited load-bearing capacity. This makes installation simpler without sacrificing stability or safety.

The ongoing upkeep and attention that green roofs demand is another source of worry. Such worries can be reduced by informing interested parties about how easy upkeep is—usually routine watering, weeding, and inspection. Furthermore, the protective layer of the plant frequently lengthens the roof's lifespan by lowering the need for early replacement and regular maintenance, which saves money over time. Case studies demonstrating effectiveness, such as the Philadelphia City Hall installation, should be highlighted to address these issues further. The yearly savings and advantages in stormwater management, decreased energy use, and extended roof lifespan resulted in significant cost reductions, even after the initial \$23 million expenditure [8].

It is important to remember that many areas provide grants, incentives, or tax breaks for installing green roofs, which helps offset early expenses. Educating stakeholders about these government initiatives might promote a more positive viewpoint on the financial benefits of integrating green roofs [1]. Through thorough data, successful case studies, and examples, stakeholders' concerns about cost, structural integrity, long-term maintenance, and potential regulatory benefits can be addressed. This helps to effectively alleviate doubts and provide a comprehensive understanding of the advantages and viability of green roofs in multistory buildings.

5. Conclusion and Future Implications

Conclusively, incorporating green roofs into multistory buildings presents a practical and sustainable approach to tackling environmental, economic, and social issues. It is clear from thorough case studies and analysis that green roofs provide a variety of advantages, such as lowering energy costs, promoting biodiversity, minimizing the impact of the urban heat island effect, and giving building inhabitants access to community areas. Notwithstanding first apprehensions about finances, structural influence, and upkeep, prosperous case studies demonstrate the enduring financial benefits and favorable ecological consequences. The information emphasizes green roofs' importance in developing resilient, energy-efficient, and socially beneficial urban environments. Installing green roofs highlights a commitment to a greener and more sustainable future for metropolitan areas and aligns with global sustainability goals. It also establishes a precedent for future building projects.

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