

An Investigation Of Roof Garden Design Criteria: Zorlu Center, Kanyon And Hilton Hotel Cases

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Abstract

With the effects inflicted by irregular development and growth of built environment that started to form towards the end of the 20th century, green areas started to lose their original function and started to decrease. Higher cost of land in urban areas have led to a re-evaluation of the usable space on building roofs. Accordingly, the number of design applications the roof sections of terraces and living roof gardens has dramatically increased. This study aimed to investigate the components of a successful roof garden design. Accordingly, the roof garden design criteria were examined under three main titles of climatic, structural, and vegetal. The prestigious Zorlu Center, Kanyon, and Hilton Hotel projects, which are located close to each other in Istanbul, were chosen as the study areas. The areas were investigated by means of on-site discovery, observation, photography and video recording methods. As a result of the study, there were no serious issues regarding the use of climatic and vegetal elements, but there were some inadequacies in the design of structural elements, and furthermore, the structural element designs of the Hilton hotel were more inadequate compared to the other two projects.

Keywords: Roof gardens, living roof, design, design approaches, vegetated roof

1. INTRODUCTION

Green roofs involve the placement of vegetation over built structures. They range from simple installations consisting of ground covering plants to more elaborate arrangements that include trees, shrubs, and various plant species. Some green roofs are even used for urban agriculture, with fruits, vegetables, and herbs grown for local consumption (URBINAT, 2023). According to Gary Robinette of the American Society Landscape Architecture (ASLA), a rooftop garden is defined as a landscape development separated from the ground level by a man-made structure, an artificial environment in which a building is

placed between landscape elements and the earth itself (University of Ideho, 2023). Active and passive green areas and residential green areas designed in city centers and in the immediate surroundings of cities are not sufficient to meet the recreational needs of the user (Adıgüzel, Doğan, 2020). The use of roof gardens dates back to the Hanging Gardens of Babylon, circa 500 BC. These gardens have not only provided recreational opportunities for centuries, but also increased the ecological comfort of life in their environments (Osmundson, 1999). Active use and vegetation of roofs were used by many civilizations in Mesopotamia to provide thermal insulation by means of cooling the arid environment (Tunbiş, 1987). Along the

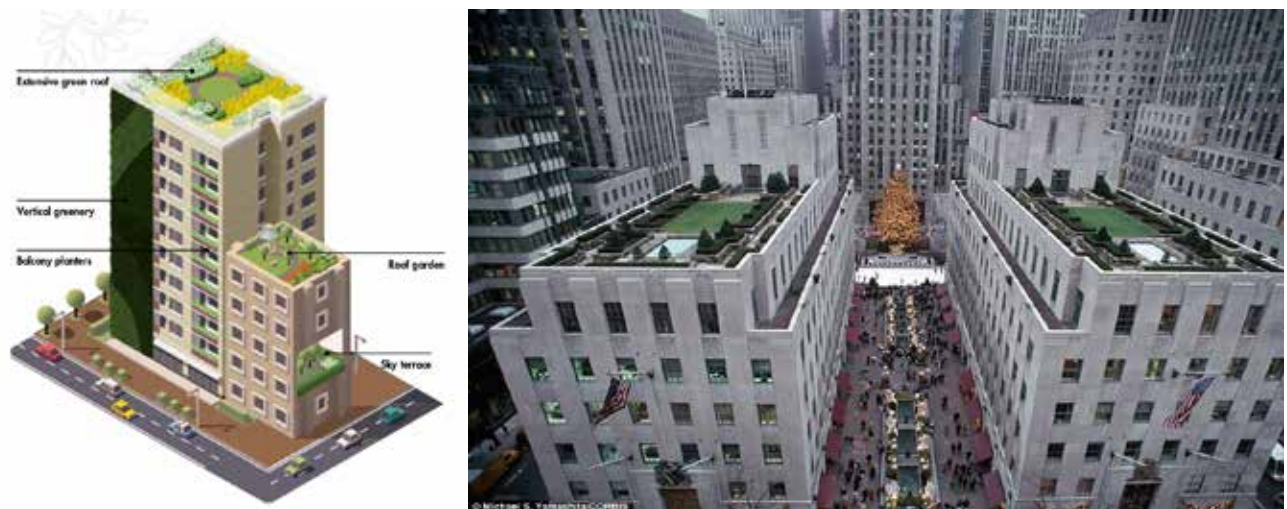


Figure 1. Different types of green space use around the building (New York Parks, 2023), right: Rockefeller Center Channel and Rooftop Gardens Photo: Elaine Kingman (URL-1)

journey of the roof garden to the present day, the roof gardens have become more comfortable and continued to maintain their intended function with the development of technology and diversifying human needs. Due to rapid population growth in cities, the need for living spaces has increased as a result of intensification of built environment to the detriment of green areas along with the emerging need for additional green areas such as green walls, floor gardens, roof gardens to existing uses (Figure 1) (Ekşi,Uzun, 2016; Kabanyegeye, 2023; Kasim et al., Kruize et al., 2019). It was then envisaged that the need for green areas compatible with nature could be partially met with planned roof designs and terrace gardens. Roof garden designs and terrace gardens are considered of great importance because they would pave the way for the formation of a healthy and high-quality living environment located in the city (Ekşi, 2006). In addition to the use of roof gardens around buildings; there may be alternative uses, including intensive green roofs, vertical greenery, balcony planters, and sky terrace (Figure 1).

Considering these differences, the design principles for the arrangement of roof gardens fall into three groups, namely structural manufacturing of roof gardens, planting, and maintenance and repair. The most important parameter regarding landscape structures in the structural manufacturing of roof gardens is to ensure the continuous

resilience of the roof structure. First of all, the building must be resistant to the additional load that would be placed on top of it and must have a rigid posture to overcome those loads. Therefore, the calculations in the design of the building elements under the roof gardens are should be made in consideration of the expected extra load and the structural elements that may be located in the roof garden, such as railings, windbreaks, pergolas, borders and steps, should be planned according to those parameters in buildings planned as roof gardens. While some green roofs are accessible only for maintenance, other green roof gardens are specifically designed for daily use with exposure to high visitor and user traffic. Types of access can include elevators, stairs, a doored stairwell, or a hatch. Roof gardens include structural elements such as walls, trees, pergolas and staircase lighting elements. `Durability and lightness should be prioritized in addition to aesthetics in the design and material selection of these structural elements (Ekşi and Uzun, 2016) (Figure 2).

Vegetation is considered another parameter in the design of roof gardens. There are two types of vegetal designs in the design of roof gardens: Intensive planting and extensive planting. Depending on the design nature of the roof garden, mixed planting can be applied, where extensive and intensive planting types are used in combination (Dunnett, Kingsbury, 2008; Gündüz, 2021). Intensive planting consists



Figure 2. Green Roof City Hall. Source: TonyTheTiger, Chicago City Hall Green Roof. 2008, DigitalImage. Available from Wikipedia (URL- 2)

of grass and trees; it is dense in terms of soil, plant species, and systems. Whereas, extensive planting uses only dwarf shrubs, weeds, and grassland cover. Extensive plantings are generally placed so densely that they would completely cover the area with vegetation. The plant species of choice are generally drought- and excess water-resistant, have high regeneration ability, require low maintenance, and are shorter (Snodgrass, Snodgrass, 2006).

Architectural elements such as *structural elements*, parapets, roof coverings, landscaping, furnishing, and mechanical and electrical systems in roof gardens should be designed by considering the relationship between plants, water, sunlight, and natural construction. The relationship of the structural elements between the building and the roof garden should be rigid and the integration of the carrier system should be ensured during the design process of a roof garden. Adequate irrigation systems should be introduced by creating the necessary infrastructure system and ensuring drainage systems at an optimum level. As regards the urban furniture intended for roof gardens, functional furnishings should be preferred by making choices specific to the area where they are located. Lighting, transportation, and irrigation infrastructures in the roof garden should be designed by taking the necessary precautions (Werthmann, 2007).

Important considerations with regard to the *climatic factors* in roof designs include roof's exposure to rain, blocking the wind by using tall plants in the roof garden, allowing sufficient daylight for the plants to grow, use of

low-maintenance plants, wind resistance, use of evergreen plants, use of flowering plants (visual-color-smell), and landscape of the vicinity. Climatic data specific for the project area is important when designing roof gardens. (Pudjiastuti, Fatmawati, 2022). Since roof gardens are above the ground level, precautions must be taken to create a physical barrier at the level of the roof parapet. Long-lasting vegetal furnishings suitable for sun, wind, and shade should be selected and easy maintenance should be provided (Hopkins, Goodwin, 2011; Yazgan, Barış and Erdoğan, 2003). These furnishings provide shade and shelter from the sun's rays on hot days for garden visitors. Trees should be placed in a way that casts shadow on sitting areas. Deciduous trees are preferred because they provide shade during hot times of the year and allow solar radiation to penetrate their leafless branches during cold months. Heat-tolerant conifers may be a priority, especially for hot and sunny areas. Artificial amenities, including bench umbrellas, gazebos, trellises and pergolas planted with vines can also be used as a source of shade. As regards structural elements; fire extinguishing vehicles, adequate water supply and fire hoses, availability of water, electricity and drainage system, points where the drainage system can be checked and cleaned regularly, presence of different user groups, presence of disabled people, children's playgrounds, observation and sightseeing areas, walking areas, reading areas, availability of shading elements, terrace roof slope, availability of wind-protective parapet walls, availability of seating areas in the shade, presence of aesthetic elements

such as sculptures, ornamental pools and flower beds, adequate lighting of the roads, and availability of recycling bins should be taken into consideration.

It is important to use low-maintenance, evergreen, and flowering plants in botanical designs. Because natural soils are heavy, especially when wet, rooftop gardeners often tend to use lightweight growing media composed of high-quality compost and recycled materials. These materials are selected for water permeability, water and air retention, resistance to decay, heat, sparks, and frost and shrinkage properties, and ability to provide suitable nutrition and rooting environment for the plants. Plants suitable for large green roofs prefer poor soils. In general, the growing medium should be as deep as possible and have as large a volume as possible within the constraints of structural capacity to provide stability to the plants under windy conditions and to prevent the system from becoming too dry. Extra insulation may be required inside and/or outside planting containers to protect plants from winter freeze/thaw cycles. As a general rule, wind speed doubles for every ten floors of the building. Windy conditions increase moisture loss from the growing medium and leaves, and therefore typically drought-tolerant plants would survive best. Many plants, especially native species, are viable and attractive options for rooftop gardeners (City of Chicago Department of Environment, 2023).

This study aimed to investigate the Zorlu Center, Kanyon and Hilton Hotel projects upon review of the climatic, structural, and vegetal design criteria, which were considered effective in a successful roof garden design.

2. METHOD

2.1. Research Areas







The award-winner Zorlu Center, Kanyon, and Hilton Hotel projects located in the city of Istanbul, which are similar in terms of planning and design parameters and close to each other in terms of location, were selected for the purposes of the study. Zincirlikuyu district, where Zorlu Center is located, serves a number of users due to the heavy pedestrian and vehicle traffic and its strategic location on transportation axes. In addition to residences and offices, Zorlu Center also includes a hotel, shopping

mall, and performing arts center. It has an acreage of approximately 120,000 m² including the roof garden. Out of the total acreage, approximately 72,000 m² is allotted for green roofs, where approximately 45,000 m² is reserved for greeneries on the ground. Due to its location, Kanyon is located on a busy axis. There is a high pedestrian and vehicle circulation in the surroundings. The building was designed to accommodate residences, offices, and shopping center, and features floor gardens in some of the residences, and terrace gardens on the roof of the building. There are private and public open and closed areas in the Kanyon. There is a ventilation and protection system that provides climate control intended for wind, rain, etc. in the roof garden at Kanyon. The planting types, seating areas, resting and shading areas, and water use in green the areas were designed with building load and other calculations in mind. It includes sitting, resting, waiting, walking, and recreation areas for users. Hilton Hotel features one of the oldest roof gardens. It is located in the annex building of the Hilton Hotel. The roof garden in the annex building is linked to the main garden of the hotel building. While designing the hotel's annex building, the roof garden design was also taken into consideration, and these gardens were planned prior to the actual construction of the building and determined according to the load-bearing capacity of the building. Large trees and bushes were used in the Hilton Hotel roof garden.

2.2. Research Method

A literature review was conducted on academic studies provided by Google's Internet database to investigate roof garden design criteria. Subsequently, a checklist containing the parameters of climatic, structural and, vegetal elements was developed on the bases of the article "Examination of Roof Garden Design Criteria in the Example of Marmara Forum Shopping Mall" by Gündüz and Caymaz (2021). On-site discovery, observation activities were performed, and relevant photographs and video recordings were made at the research areas before the assessment of the checklist. The roof gardens of Zorlu Center, Kanyon and Hilton Hotel were compared to the check list. Affirmative issues were marked with a tick mark (✓), where negative aspects were expressed with a cross mark (x).

Table 1. Features of Research Areas (Canpolat, 2023; Jerde, 2006; Koroğlu, 2023; URL-3, 4.5)

	Zorlu Center	Kanyon	Hilton Hotel
Year of Construction	2013	2006	1955
Location	Istanbul	Istanbul	Istanbul
Coordinates	41°04'00"K 29°01'01"D	41°04'42"K 29°00'40"D	41°02'39"K 28°59'23"D
Project Area	105,000 m ²	40,000 m ²	5,000 m ²
Roof Garden Area	12,000 m ²	1,200 m ²	2,100 m ²
Plan			
Views			

3. RESEARCH RESULTS

As a result of the study, there was no serious problem with the design of climatic and vegetative elements in all three areas in question. As regards structural element designs; children's playgrounds, observation and sightseeing areas, and the presence of shading elements were insufficient in all the three examples. There were no recycling bins in Zorlu Center and Hilton Hotel. The number of negative issues with regard to the structural element design was higher in Hilton Hotel compared to other two examples.

4. DISCUSSION

There was no serious issue with climatic elements in all three areas in question. Given the heights and uses of roof gardens, the presence of shade elements would be important, especially in hot seasons. Shading structures are

lightweight, colorful, functional, and elegant sun shading solutions that aim to cover a larger or smaller outdoor spaces, protect it from the weather and make it pleasant and livable. The feature of shade structures is that they can create shaded areas by reducing the temperature in the area of coverage without blocking air circulation. Fixed roof structures are costly, but shade structures, especially sail options, are cost-effective. This type of structure provides maximum protection against UV rays and will help reduce the heat around the area (Broyles, 2023). Given the exposure to climatic factors, especially around the roof, shading areas, which are inadequate in all the three areas in question, need to be improved and supplemented.

Rooftop playgrounds provide parental privacy and are also safe. Children are further away from the dangers of the street (Reed, 2023). Parks and playgrounds create a heightened sense of community, which is associated with

Table 2. Research Results




Climatic, Structural, and Vegetal Elements		Zorlu Center	Kanyon	Hilton Hotel
CLIMATIC ELEMENTS	Rain exposure of the roof	✓	✓	✓
	Blocking the wind with the use of tall plants in the roof garden	✓	✓	✓
	Plants receive enough sunlight to grow	✓	✓	✓
	Wind resistance	✓	✓	✓
	Covering the bad view by special planting	✓	✓	✓
	Considering access to natural light	✓	✓	✓
				
STRUCTURAL ELEMENTS	Availability of fire extinguishers, adequate water supply and fire hoses	✓	✓	✓
	Availability of water, electricity, and drainage system	✓	✓	✓
	Access points where the drainage system can be checked and cleaned regularly	✓	✓	✓
	Presence of different user groups	✓	✓	X
	Presence of disabled people	✓	✓	X
	Children's playgrounds	X	X	X
	Presence of landscape in the surroundings	✓	✓	✓
	Observation and Sightseeing Area	X	X	X
	Walking areas	✓	✓	✓
	Reading areas	✓	✓	X
	Availability of shading elements	X	X	X
	Terrace roof slope	✓	✓	✓
	Availability of a wind-protective parapet wall	✓	✓	✓
	Availability of seating areas under the shade	✓	✓	X
	Availability of aesthetic elements such as statues, decorative pools, and flower beds	✓	✓	X
	Adequate lighting of roads	✓	✓	X
Availability of recycling bins	X	✓	X	
				
VEGETAL ELEMENTS	Low-maintenance plant use	✓	✓	✓
	Use of evergreen plants	✓	✓	✓
	Use of flowering plants (visual-color-fragrance)	✓	✓	X
				



Figure 3. Yinian Rooftop Garden, China (Landezine, 2023)

increased personal connection and accountability and reduces adverse behaviors (including crime and vandalism). Outdoor play opportunities contribute to children's mental health and emotional well-being. Just being in nature with fresh air and Vitamin D can help relieve adverse emotions of stress and depression. In combination with friends, fun, and physical activity, the experience of building happiness and confidence increases even more (Inspiredplay, 2023). It is necessary to include children's playgrounds in the gardens so that the users can spend time with their children. There was a need to introduce children's playgrounds in all the three areas in question.

As with all open space designs, the needs and wishes of different user groups, especially the elderly and disabled, must be taken into account. Considering the current designs of the examples, introducing additions such as ramp slopes and use of special furniture, intended for the disabled

individuals, would increase the safety of use (Tunbiş, 1987). Yinian Rooftop Garden (Figure 3) is fully accessible for disabled individuals and allows visitors to benefit from a full range of activities including flexible recreation, vegetable/community gardens, lounges and creative arts facilities. Yinian Rooftop Garden is considered a new initiative for Chongqing's strategy towards urban land use and aging population. In the sample areas, handrails, ramps, elevated plantings and use of colors suitable for elderly ergonomics can be predicted, as in the Yinian example.

The aesthetic elements such as sculptures, ornamental pools and flowers will help increase the environmental quality for users. While the sculptures create a focal point, the sound of water and flowers will positively affect visual and acoustic comfort. Especially in the case of Hilton, additions are needed with regard to foregoing (Ekşi, 2006). The lack of recycling bins in Zorlu Center and Hilton Hotel

is an adverse aspect in terms of sustainability. It would be appropriate to include recycling bins at certain points in the areas in question.

In terms of parameters related to plant elements, the use of flowering plants was insufficient only in the case of Hilton Hotel. Considering the importance of flowering plants in terms of visual and olfactory comfort, further use of colorful plants can be recommended for the Hilton Hotel case (Hasdemir, 1990).

Just as the durability of the building is associated with the ground on which it was built, the success and compatibility of the roof garden is also related to the roof structure underneath. The landscape architect must adopt a simple perception to understand the roof structure that will support the roof garden and must cooperate closely and warmly with the building's architect, structural engineer and roofing contractor in the work before the building is built. In no other landscape project are the collaborative working relationships in design, execution, detailing, drainage, and long-term maintenance so interconnected, and no professional disciplines are so strongly influenced by the other (Osmundson, 1999).

5. CONCLUSION

In this study, the effective parameters in the design of a successful roof garden were investigated under the titles of climatic, structural, and vegetal design. Upon an analysis on the selected examples, the climatic and vegetal elements were sufficient in all three samples; Zorlu Center, Kanyon and Hilton Hotel required further improvement in terms of children's playgrounds, observation and sightseeing areas, and the shading elements. In conclusion, there was a higher need of improvement in the climatic, structural and vegetal parameters for the Hilton Hotel case compared to the Zorlu Center and Kanyon projects.

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