ROOF GARDENING IN CITIES:
SUGGESTIONS FOR ANKARA

A THESIS
SUBMITTED TO THE DEPARTMENT OF
INTERIOR ARCHITECTURE AND ENVIRONMENTAL DESIGN
AND THE INSTITUTE OF FINE ARTS OF BİLKENT ÜNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF FINE ARTS

by
Pınar Köylü

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I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Fine Arts.

Prof. Dr. Sümer Gülez (Principal Advisor)

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Fine Arts.

Dr. Cemal İnceruh

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Fine Arts.

Assoc. Prof. Dr. Cengiz Yener

Approved by the Institute of Fine Arts

Prof. Dr. Bülent Özgüç, Director of the Institute of Fine Arts

ABSTRACT

ROOF GARDENING IN CITIES: SUGGESTIONS FOR ANKARA

Pınar Köylü

M. F. A. in Interior Architecture and Environmental Design

Supervisor: Prof. Dr. Sümer Gülez

June, 1997

This study examines a way of creating green spaces in cities, that is roof gardening. Contributions of roof gardens to urban settlements and technical aspects of roof gardens are emphasized, and some examples are illustrated. People's tendency towards roof gardening are examined by conducting survey research with citizens of Ankara. Thus, suggestions for roof gardening in Ankara are made by considering the results of the research.

Key words: Roof gardens, green spaces, cities, urban green system, Ankara.

ÖZET

KENTLERDE ÇATI BAHÇECİLİĞİ: ANKARA İÇİN ÖNERİLER

Pınar Köylü

İç Mimarlık ve Çevre Tasarımı Bölümü

Yüksek Lisans Tezi

Tez Yöneticisi: Prof. Dr. Sümer Gülez

Haziran, 1997

Bu çalışmada, kentlerde yeşil mekan yaratmanın bir yolu olan çatı bahçeciliği incelenmektedir. Çatı bahçelerinin kentsel yerleşimlere katkısı ve teknik yönleri üzerinde durulmakta ve bazı örnekler tanıtılmaktadır. İnsanların çatı bahçeciliğine eğilimlerini öğrenmek için, Ankara'da yaşayan halkın anket yapılarak fikri alınmıştır. Böylece, anket sonuçları da gözönünde bulundurularak, Ankara kenti için çatı bahçeciliğine yönelik öneriler getirilmektedir.

Anahtar sözcükler: çatı bahçeleri, yeşil alanlar, kentler, kentsel yeşil alan sistemi, Ankara.

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1. INTRODUCTION

Our cities are becoming more and more crowded day-by-day due to migration from rural areas to urban settlements. The growth of the population in cities necessitates the construction of more buildings. Therefore, green spaces, usually called "the lungs of cities", are decreasing in most of the urban areas. As a result, air pollution, noise, visual deterioration etc. are on the increase in urban settlements. Air pollution, noise pollution and visual deterioration of the built environment affect human beings not only physically, causing various health problems, but also psychologically.

Local and global ecosystems are affected by the planning and design of sites. We need the most healthy, fulfilling and satisfying environs for people. Not only social factors, but also ecological factors need to be considered in order to realize functional efficiency, effective use of space and personal effectiveness. As stated by Simonds (1983):

> ...We humans need in our cities *sources of inspiration, stimulation, refreshment, beauty and delight.* We need and must have, in short, *a salubrious, pollution-free urban environment* conducive to the living of the whole, full life. Such a city will not ignore nature. Rather, it will be integrated with nature. And it will invite nature back into its confines in the form of clean air, sunshine, water, foliage, breeze, wooded hills, rediscovered water edges, and interconnected garden parks.... (285)

As more buildings are built in cities, we become separated from nature, which sustains our bodies and our minds. The adverse effects of urbanization could be reduced to some extent and contact with nature could be provided by creating green spaces. By this way, people can feel themselves close to nature and observe seasonal changes through variations of foliage, blossoms and color of plants, live in microclimatic environments, and socialize at those spaces which offer recreational facilities.

Roof gardens are attracting greater public interest as cities become more congested. This interest has been accelerated due to an increasing awareness of the quality of life. In the past many buildings were basic structures used only for mundane activities. Today, on the contrary, they can be thought as attractive and stimulating environments, and a part of nature, which can also provide space for passive and/or active recreation. Roof gardens, being constructed on the tops of buildings, contribute to the ecology, aesthetics and recreational areas in cities. That is, they improve the air quality and the microclimate, reduce noise to some extent, improve and soften the harsh edges of buildings, enhance the appearance of flat roofs viewed from higher levels and provide extra space for recreation.

1. 1. Aim of the Thesis

Open spaces, such as streets, plazas, squares, parks, small gardens, small enclosures contribute to the quality of a city. Since our cities are piled with buildings here and there, the amount of green space per person is below the standards (see part 4.2). Standards could be achieved to some extent by creating more green spaces. Since the amount of green spaces within the city center, where there are a lot of buildings, is not enough, green spaces could be provided on roofs, which are often wastelands.

Roof garden design is quite a new concept in our country. Roof gardening is not widespread, except for the few roof gardens in big cities. Since roof gardening is not very much popular in our country, we need to introduce this concept as a contribution to the urban green system. Therefore, this study aims to offer a way of creating more green spaces in the heart of cities via roof gardens by considering some examples in the world, contributions of roof gardens to cities in terms of ecology, aesthetics and recreational areas, construction techniques of roof gardens, and the system of urban green spaces and opinions of citizens.

1. 2. Structure of the Thesis

This study consists of five chapters. After making an introduction to the study and stating the aim of the thesis in the first chapter, the concept of roof gardens is introduced in the second chapter which aims to present the importance of roof gardens as part of green areas in cities and the usage of roof gardens which are located on various buildings. These are achieved by presenting the history of roof gardens, types of roof gardens, explaining contributions of roof gardens to the ecology, aesthetics and recreational areas of cities, and illustrating some examples.

The third chapter of the thesis deals with the construction of roof gardens; by considering the properties of the insulation layer, waterproofing membrane, drainage system, filter layer, irrigation systems, medium of vegetation, and plantation. Roof loading, maintenance requirements, life cycle of roof gardens and issues such as boundaries, water features, lighting and paving are also covered in this chapter. This chapter aims to present construction techniques of roof gardens that could be a leading guide for further research.

The system of urban green spaces is discussed and the existing roof gardens in Ankara are illustrated in the fourth chapter. This chapter also covers the explanation and results of the research which was conducted in Ankara with 250 subjects. The aim of this chapter is to present people's tendency towards roof gardening, so that some suggestions will be derived from the results of the research.

In the last chapter the thesis is concluded by considering the suggestions made in the previous chapter, and topics for further research are suggested.

2. THE CONCEPT OF ROOF GARDENS

A roof garden is defined as "an area of largely ornamental planting whose substrate is isolated from the natural strata." (Scrivens, 1982e, p. 73). Roof gardens, as stated by Southard (1971), may be located at any level from a few meters below ground to several nieters above, which are all separated from natural ground by a man-made structure.

A perfect roof garden can provide some of the functions that a ground level garden does. Limits to the plants, trees and pools, fountains etc. will decrease if a roof garden is considered initially as part of the structural system (Halprin, 1963).

The concept of roof gardens, which dates its origins to the great ziggurat of the Sumerian city of Ur, is quite a new concept in our country. However, it has received great attentions particularly in the USA, UK, Canada, Switzerland and Japan. In these countries, roof garden design is considered as an integrated part of building structure.

2. 1. Brief History of Roof Gardens

The great ziggurat of the Sumerian city of Ur, which was built about 500 BC, was the first structure carrying plants specifically. It was approximately 20 m. high on a 3 m. high terrace above the city, where the terraces were planted with trees (Jellicoe, 1987). However, according to Osmundson (1979), ziggurat plantings were not true roof gardens as they had solid cores of rubble or soil.

Structures in Babylon were of brick made and usually low and horizontal with flat roofs, inviting roof gardens. Hanging Gardens of Babylon, one of the few stone structures in the Kingdom of Mesopotamia, were built between 604 and 562 BC above two rows of seven vaulted chambers. The structure was waterproofed with bitumen, baked brick and lead, and covered with soil for trees. Water was lifted from the Euphrates to the roof (Jellicoe, 1987). Different levels or terraces were created on the roof by raising or lowering the elevations of barrel vaults. As the Hanging Gardens are independent of the ground, they should be considered as true roof gardens (Osmundson, 1979) (Figure 1). Greek and Roman civilizations also built flat roofs on their houses and grew plants in planters on those flat roofs (Rodrigue, 1996).

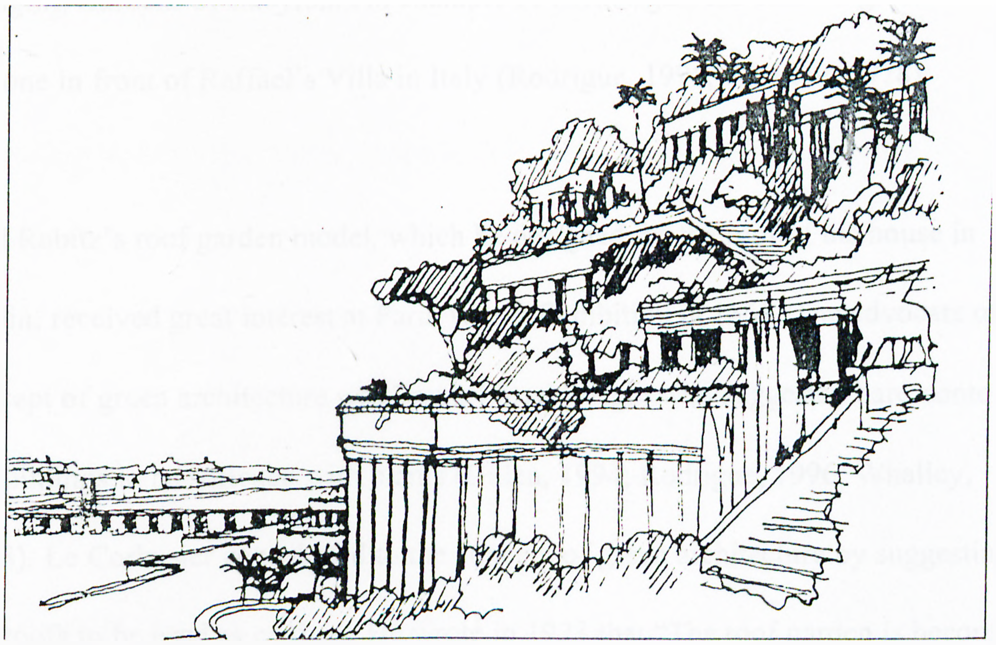


Figure 1. Hanging Gardens of Babylon (Laurie, 1986, p. 17)

Roof gardens have already existed in Russia more than 350 years ago. An upper garden, which overlooked the Moskva River, was built on the domed vaults of a corner building at the Kremlin Palace in Moscow. Unfortunately, it was destroyed in 1773 in order to make way for the foundations of a new Kremlin Palace. Many roof gardens were designed and built in Russia, including the Hanging Garden of the Little Hermitage Palace in St. Petersburg which was built on the stone vaults of the palace (Van Vliet, 1992).

Terraced gardens were very popular during Renaissance. Garden on the roof of Graf Matter's château in Verona, hanging gardens with 10 terraces of 30 m. height at Borromeo Park in Lago Maggiora, Villa Careggi of Casimo Medici, Cardinal von Lamberg's roof garden terraces at his Passau residence, hanging garden of Cardinal Andrea delle Walle, built in 1530 in Rome, were important terraces after the

Hanging Gardens of Babylon. An example of terrace gardens built on grottoes was the one in front of Raffael's Villa in Italy (Rodrigue, 1996; Whalley, 1978).

Carl Rabitz's roof garden model, which he designed for the roof of his house in Berlin, received great interest at Paris World Exhibition in 1867. The advocate of the concept of green architecture was Frank Lloyd Wright who suggested hard contours of buildings to be softened with plants (Gülen, 1994; Rodrigue, 1996; Whalley, 1978). Le Corbusier contributed to the concept of green architecture by suggesting flat roofs to be used as gardens. He wrote in 1923 that "The roof garden is becoming the favorite place to be in the house and means, furthermore for the city, the winning back of the whole of its developed area." (qtd. in Van Vliet, 1992, p. 15).

In North Africa, water cisterns are still covered with domed shell roofs, which are waterproofed with bitumen and covered with soil and gravel; thus, supporting the coarse grasses to provide thermal insulation. This system of construction had been used during the time of Roman occupation. Earth sods are also used in Scandinavia and North America to provide thermal insulation (Scrivens, 1994).

The ancient idea of roof gardens has been adopted to today's cities. There are many examples of roof gardens in some of the countries around the world.

2. 2. Types of Roof Gardens

According to Scrivens (1982e), special characteristics of a roof garden can be developed by two main ways: either by being extrovert or by being introvert. Extrovert roof gardens offer wide views across the surrounding townscape. Introvert roof gardens, on the contrary, offer a sense of enclosure. These two philosophies may be combined in view of the blustery nature of many urban environments.

Aslanboğa (1988) and Rodrigue (1996) classify roof gardens in two groups according to their plantings and maintenance requirements. Intensive roof gardens are gardens where the soil is often deep, and isolation, filtration, drainage and irrigation systems are excellent. This type of roof gardens require high maintenance since a variety of plants: grass, groundcovers, shrubs and trees, and non-living materials are used. Intensive roof gardens may house recreational facilities.

Roof gardens which require minimum maintenance are called extensive roof gardens. Low shrubs, moss, annual and perennial herbs, grass and succulent plants can survive at extensive roof gardens where the soil is considerably shallow. Plants are of species that resist frost, drought and overwatering. Unlike intensive roof gardens, extensive roof gardens cannot house recreational facilities.

2. 3. Contributions of Roof Gardens to Cities

Roof gardens contribute to cities in terms of ecology, aesthetics and spaces provided for recreational facilities. They improve the microclimate within cities, enhance and soften the harsh edges of buildings, and provide more space for recreational activities that take place in cities.

2. 3. 1. Contribution of Roof Gardens to the Ecology of Cities

Green spaces in cities improve the ecological quality of cities by creating microclimatic regions, reducing air pollution, absorbing dust particles, creating habitats for various species and reducing noise to some extent. Microclimate can be modified by the use of plants. Light colored surfaces, light soils and vegetation reflect most of the incoming radiation (Carpenter and Walker, 1990). As discussed by Çepel (1991), temperature in cities is 1-3°C more than that of open spaces around cities and the temperature difference between an asphalt surface and a lawn area is approximately 20°C. In summer, the temperature may increase to 60°C on dark colored roofs and asphalt roads, whereas the maximum temperature on plant leaves is 25°C.

Trees improve the air quality of cities by creating air circulation between their canopies and asphalt surfaces. Warm air rises from the asphalt surface to the canopy of a tree and air cooled by transpiration and shadowness around the canopy of a tree sets down. Thus, air circulation occurs between the asphalt surface and the canopy of the tree (Çepel, 1991).

As rainwater is drained from the asphalt and concrete paving to the sewage system of cities, the evaporation rate in cities is 30-60% less than the evaporation rate in rural areas. Although the relative humidity of cities can be increased by the use of sprinklers and spray nozzles, it is cheaper to achieve higher relative humidity by planting trees (Çepel, 1991). This is due to plants' ability of adding considerable amounts of moisture to the air through transpiration.

Roof gardens reduce the temperature in cities in summer, as the plants covering rooftops reflect and refract the infrared radiation falling onto the surface of the roofs; and air circulation is provided by the use of plants at different levels. The relative humidity increases due to the addition of more green spaces to cities. Consequently, microclimatic regions can be created in certain areas of cities.

As stated by Carpenter and Walker (1990), plants are well-known sources of oxygen, and act as 'natural filters' in the Earth's atmosphere. Because of the high consumption of fossil fuels in cities, dust particles are 9 times more than in rural areas, sulfur dioxide is 4-9 times more, carbon monoxide is 24 times more, carbon dioxide is 9 times more. The dust particles in a city center are 5 times more than that found in a park in the same city. These rates can be reduced by vegetation within cities since plants have the capability of filtering air. Plants' ability of absorbing dust

dust particles even without leaves is 60% (Çepel, 1991). Increasing the quantity of green spaces in cities via roof gardens reduces the amount of dust particles in city centers. Roof gardens contribute to the air quality of cities also, by giving oxygen to the atmosphere.

Biological diversity in urban areas affect the psychology of human beings. Good scenes, improved by biological diversity reduces daily stress from which most of the citizens suffer (Çepel, 1991). Creating roof gardens in urban areas offer habitats for flora and fauna. Various species of trees, shrubs, herbs, groundcovers, and birds, insects, microorganisms can be provided in cities.

Noise is also reduced to some extent by the use of trees in urban areas (Carpenter and Walker, 1990; Çepel, 1991). Roof gardens reduce noise pollution as plants can reflect and absorb the sound waves considerably.

2. 3. 2. Contributions of Roof Gardens to the Aesthetics of Cities

By appropriate plantation, a continuous and unifying pattern can be created throughout an urban landscape. The sterile, harsh qualities of urban structures are alleviated by the various textures and softening effect of green leaves.

Carpenter and Walker (1990) describe the aesthetic values of plants:

> Shadows of plants make beautiful patterns on paving and walls, which change each hour with the Earth's rotation. Summer patterns contrast sharply with the bright sunlight, whereas the bare branches of winter will create intricate, more subtle patterns.
>
> A unique animation is expressed by plants as they respond to wind. The slender, hanging branches of a weeping willow sway gracefully as the wind moves through them. The leaves of the quaking aspen shimmer or flutter even in a light breeze.
>
> In winter, when a wet snow falls in a neat little mounds on the branches of plants with dark bark, contrasting texture and new, unusual forms create a memorable beauty that occurs infrequently and disappears quickly.... (174-5)

The appearances of roofs can be improved by giving interesting forms to structural shapes, using various types of colored and textured living and non-living materials (Southard, 1971). Hence, roof gardens viewed from higher levels enhance the visual quality of urban spaces by creating naturalistic spaces in cities via plants instead of concrete or clay roofing tiles on the surfaces of the roofs (Aslanboğa, 1988).

2. 3. 3. Contributions of Roof Gardens to the Recreational Areas of Cities

Roofs within cities can be considered as the sand of a desert. There are plenty of buildings in our cities, whereas the number of green spaces are considerably few. Roof gardens constructed on the roofs of commercial places, shopping malls, restaurants, schools, hospitals, hotels etc. offer recreational spaces for people.

Land in downtown and other urban areas costs high and this has brought about a reappraisal of the usable space on the roofs of buildings. Hence, roofs, which are generally considered as wastelands, can be appraised as recreational areas of cities as our cities become more congested.

According to Osmundson (1988) and Aslanboğa (1988), roof areas are required as an economic necessity which provide outdoor areas for social interchange since it is costly to obtain flat space at ground level. By the construction of roof gardens, two functions can be given to certain places. For instance, an underground parking area can also be used as a recreational space or the roof of a shopping mall can serve as a city park. Thus, the percentage of green spaces in cities increase, and green spaces and recreational areas can be created at different levels without paying extra money for the land.

Roof gardens may serve different purposes due to their localities. Roof gardens may be used privately or used by groups or the public. Tiny paved balconies and extensive roof gardens with paving, water, grass, low planting and trees which are attached to penthouse flats form private roof gardens. These are mostly used for sitting, eating outdoors, growing plants and toddlers play. It is mostly desired to create privacy and wind screening at private roof gardens (Southard, 1971).

Some roof gardens may serve some groups, such as the members of a company, school, some organizations etc. Since these roof gardens are used by some groups, sufficient space for sitting should be provided. Eating can be offered at these gardens which are mostly located on roofs of low blocks possibly with higher blocks adjoining them. Where there is enough space, ball or tennis courts can also be provided (Southard, 1971).

Some of the recreational facilities taking place on the ground can also take place at roof gardens. However, there should not be excessive loading. Public roof gardens can be used for active and passive recreation of the citizens. Organized games requiring hard surfaces, such as tennis, roller skating, children's play, can take place at public roof gardens. Fences for ball games should be 1-3 m. higher at roof gardens than at ground levels. Places to sit, eat, chat, read etc. are required for passive recreation (Southard, 1971).

Roof gardens not only contribute to the ecology, aesthetics and recreational areas in cities, they also provide technical advantages to the buildings by reducing physical and mechanical effects which damage the roof surface because of the temperature extremes and by preventing UV-radiation which affect the isolation layer of the roof. According to Aslanboğa (1988) and Scrivens (1994) a roof garden protects the roof membrane against climatic extremes, so that the life of the roof membrane increases.

2. 4. Some Examples of Roof Gardens

Roof gardening is a widespread concept in the world particularly in the USA, UK, Canada, Switzerland and Japan. In these countries, roof garden design is considered an integrated part of building structure. In contrast, it is quite a new concept in Türkiye.

2. 4. 1. Some examples of Roof Gardens in the World

2. 4. 1. 1. Arundel Great Court

Arundel Great Court, in Westminster, in the UK, is a courtyard which is actually the roof of a car park and plant units. The courtyard, surrounded by buildings, is designed as a roof garden (Figure 2). Being enclosed, the courtyard is protected from the noise of the surrounding streets and seems to be isolated from public use (Scrivens, 1980c; Gülen, 1994).

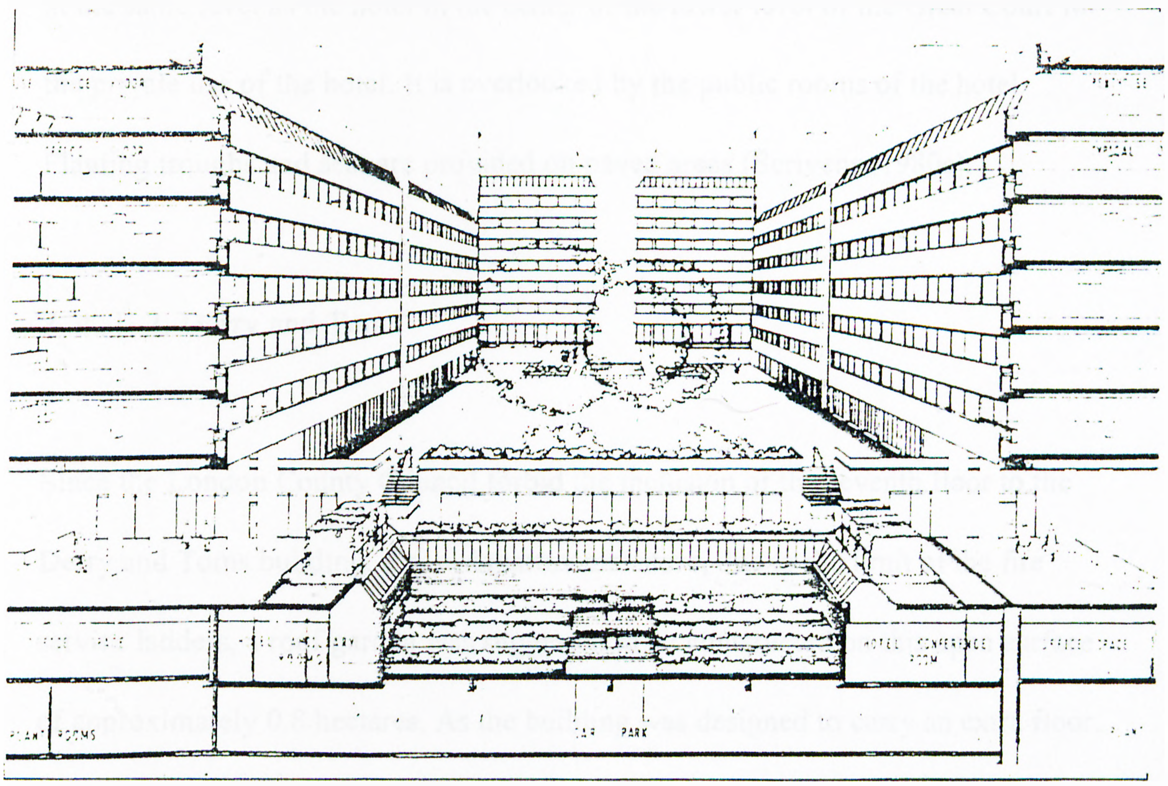


Figure 2. Sectional perspective of the Arundel Great Court showing how the court is a roof garden (Scrivens, 1980c, p. 733).

Broad lawns within the upper courtyard are broken by a clump of plane trees that are located centrally. Narrow lawns separate the office buildings from the paths, thus, giving privacy to the office space at the court level. A wide planting level marks the change in level from the upper court to the lower court. A circulation route for people not wishing to descend the steps to the lower level is provided by a cross path (Scrivens, 1980c).

The lower level, being smaller and more intricate than the upper level, has a predominantly hard surface of paving. There is a brick paved sunken garden which is at the same level as the hotel in the center of the lower level of the Great Court for the private use of the hotel. It is overlooked by the public rooms of the hotel. Planting troughs and seat are provided on paved areas (Scrivens, 1980c).

2. 4. 1. 2. Derry and Toms

Since the London County Council forbid the inclusion of the seventh floor to the Derry and Toms building, a new departmental store, due to the limit of the fire service ladders, a roof garden was suggested to be constructed on this open surface of approximately 0.8 hectares. As the building was designed to carry an extra floor, the load bearing capacity of the building was sufficient for a roof garden to be designed at that level (Scrivens, 1980g).

The roof garden consisted of 3 main gardens originally; the Spanish Garden, Tudor Courts, and the English Woodland Garden (Figure 3). There were over 500 varieties of trees and shrubs, whereas the number is decreased today. Although the site is extensively exposed, plants such as palms, figs and vines grow on top of a six-story structure possibly due to the warmth passing up from the building. Blossoming also occurs earlier on the roof garden due to the bottom heat from the building. Roses, however, do not do well, supposedly because they prefer a cool root system. Propagation of some plants take place in a greenhouse on the roof (Scrivens, 1980g).

A 2.5 m. high wall, surrounding the perimeter of the garden not only acts as windbreak and a safety barrier, but also gives a feeling of enclosure. Since the roof garden has an isolated character and an open water, it has been attractive to birds and to several other species; such as flamingoes and fish (Scrivens, 1980g).

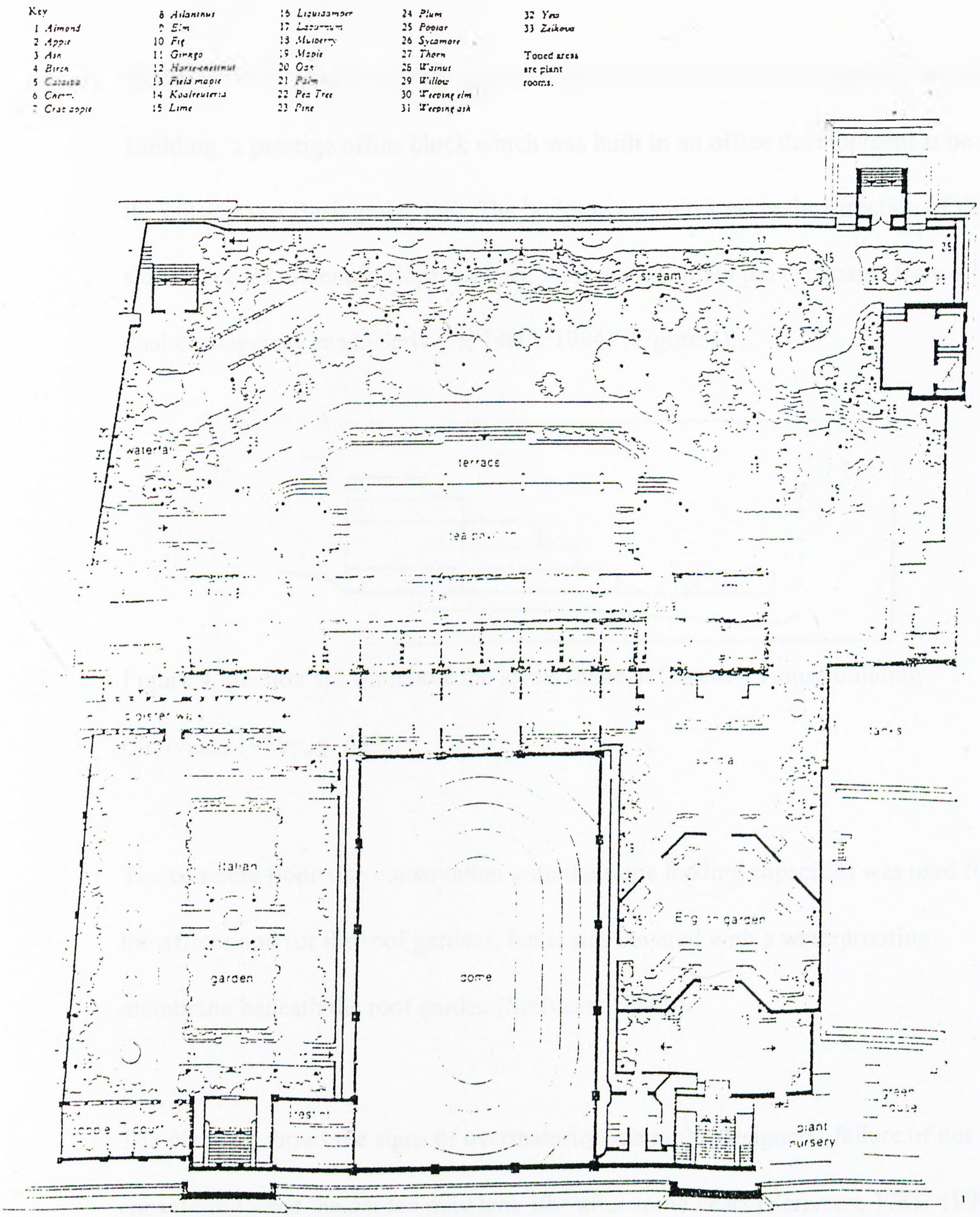


Figure 3. Original plan of the roof garden on Derry and Toms department store when it was constructed in 1938 (Scrivens, 1980g).

2. 4. 1. 3. Gateway House

Extensive roof gardens were designed over the five levels of the Gateway House Building, a prestige office block which was built in an office development zone on the outskirts of Basingtoke, UK. The building was terraced in the direction of the slope in order to benefit from the open view and to shield the occupants from a busy dual carriageway road (Scrivens, 1980b;1994) (Figure 4).

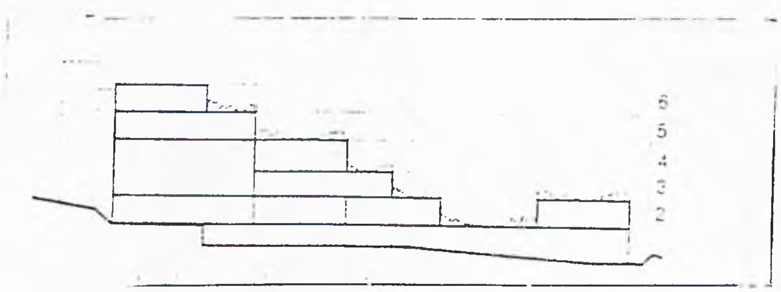


Figure 4. Section showing how the levels relate at Gateway House building (Scrivens, 1980b, p. 632).

The concrete floor slab construction with the same loading capacities was used for the offices and for the roof gardens, but it was covered with a waterproofing membrane beneath the roof garden (Scrivens, 1980b).

The planting shows the signs of overmaturity due to the designers' failure of not considering what the garden may look like after some years (Scrivens, 1985; 1994). Despite the shallowness of the substrate, a wide range of plants are potentially successful because of the good irrigation. However, plantings on the upper levels of the building, especially at fifth and sixth levels, are not as successful as the planting on the lower levels, due to the high degree of exposure (Scrivens, 1980b). The smaller, high level theme gardens (Japanese garden and herb garden), which require careful attention have been unsuccessful due to lack of maintenance (Scrivens, 1985; 1994) (Figure 5).

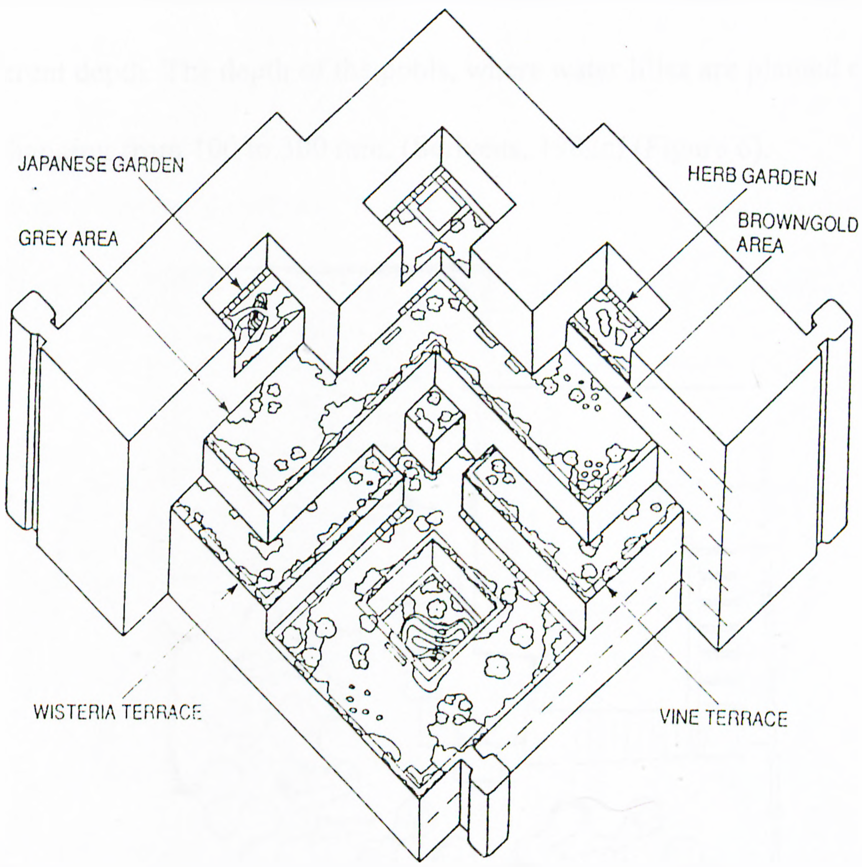


Figure 5. Terraces at Gateway House (Scrivens, 1985, p. 42).

2. 4. 1. 4. Harvey's Store

The lower four stories are used as a department store, the fifth as the restaurant of the department store and the roof of the restaurant was used as a public roof garden at Harvey's Store on the west side of Guilford High Street, UK. A coffee bar, service equipment, boiler room and tank room existed on the roof. Because of the vandalism with groups of children throwing objects from the roof, the roof was then closed to public access (Scrivens, 1982c).

The roof is covered with mastic asphalt, and most of it is flooded to form two pools of different depth. The depth of the pools, where water lilies are planted on shallow pans, changing from 100 to 300 mm. (Scrivens, 1982c) (Figure 6).

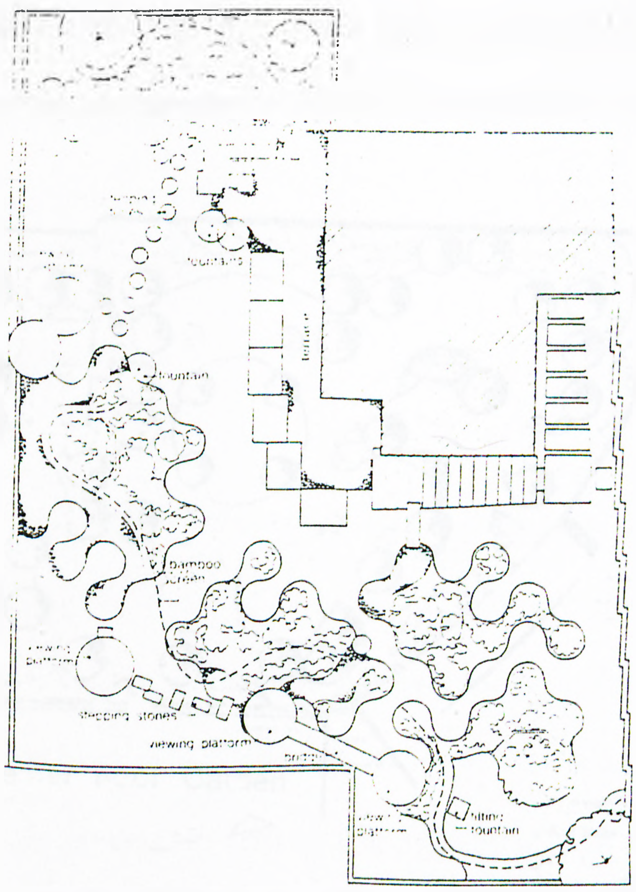


Figure 6. Plan of the roof garden at Harvey's Store (Scrivens, 1982c, p. 86)

An open steel barrier of 1.2 m. high surrounds the perimeter of the roof garden. A partition of diagonal slats is erected on the east side of the roof against the exposure of plants. A curved screen of bamboo canes of 1.6 m. high, protects the roof garden from the southerly and westerly winds (Scrivens, 1982c).

2. 4. 1. 5. Kaiser Center Roof Garden, Oakland, California and Vancouver, British Columbia

The Kaiser Center roof garden in Oakland, California, USA, which is visible from 24 levels of the adjacent office tower, had been influenced by the basic concept of use by the public and by the company's employees (Osmundson, 1979) (Figure 7).

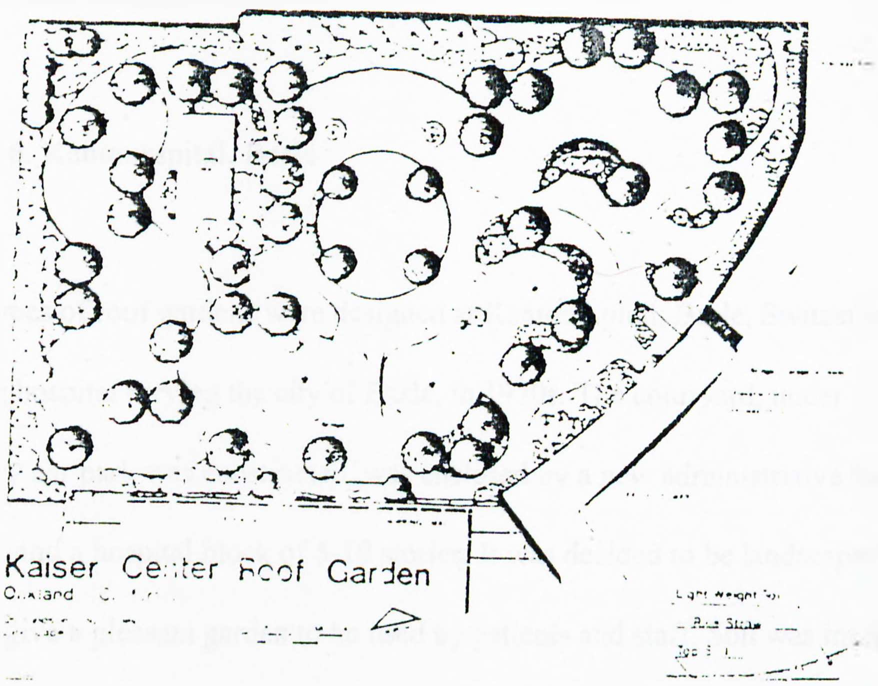


Figure 7. Plan of the Kaiser Center roof garden at Oakland, California (Osmundson, 1979, p. 496).

The building where the roof garden is constructed has a heavy garage structure beneath. Lightweight concrete and proper soil mix has been used to solve the weight restrictions. Trees are placed at column locations with 75 cm. of soil depth, while the depth of soil is 15 cm. for lawns and groundcovers. The 75 cm. soil where the trees are planted sloped away to the 15 cm. Plants with fibrous root systems has been used at this roof garden (Osmundson, 1979).

The Kaiser Center roof garden in Vancouver, British Columbia, Canada, had more formidable list of constraints than the one in Oakland because the building was not supported by columns. Although, this roof was not designed to permit a garden, a naturalistic roof garden with some flat open areas for parties was constructed by careful design (Osmundson, 1979).

2. 4. 1. 6. Kantonsspital, Basle

Three types of roof gardens were designed at Kantonsspital, Basle, Switzerland, a teaching hospital serving the city of Basle, in 1970s. The courtyard, under which a five-story car park was constructed, was enclosed by a new administrative block, a cafeteria and a hospital block of 5-10 stories. It was decided to be landscaped in order to give a pleasant garden to be used by patients and staff. Soil was imported to the courtyard, covering nearly two hectares, in order to create an artificial surface (Scrivens, 1982b).

The terrace outside the cafeteria and administrative block was softened by the use of raised planters of 1 m. high, which had to have a lower weight than the main courtyard. Since the cafeteria was lower than the administrative block and the hospital block, the roof of the cafeteria was also planted. The development is of great interest as it contains three roof gardens built to three levels of complexity on the same site (Scrivens, 1982b) (Figure 8).

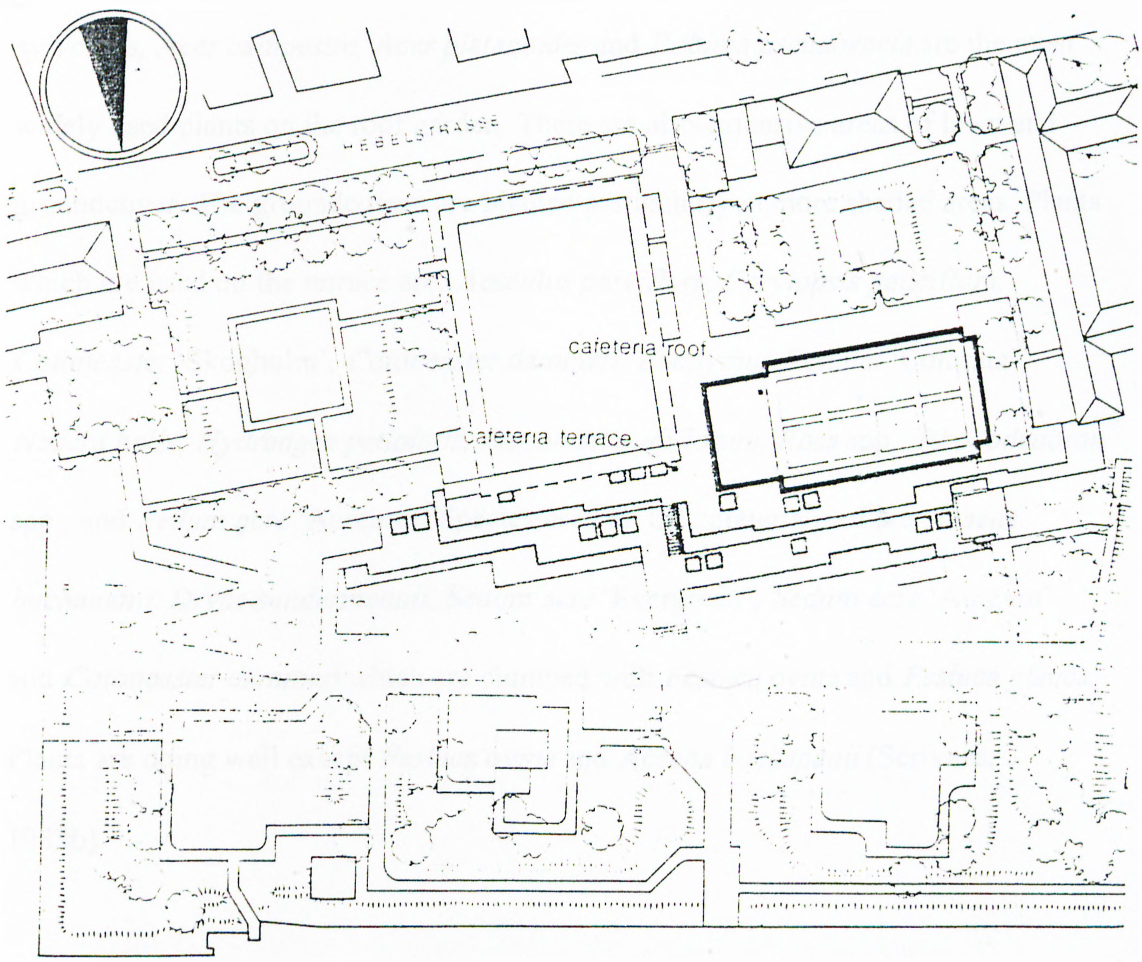


Figure 8. Plan showing the three roof gardens at Kantonsspital, Basle (Scrivens, 1982b, p. 65).

The stream starting in a cascade between a mass of heavy stones, which runs through the roof and flows into a series of interlocking fan-shaped concrete pools and another series of natural pools, make the roof garden more pleasant (Scrivens, 1982b).

Azalea spp., *Acer palmatum*, *Calluna* spp., *Juniperus horizontalis*, *Cotoneaster horizontalis*, *Cotoneaster dammeri*, *Cotoneaster salicifolius*, *Erica* spp., *Hedera helix*, *Lavandula spica*, *Mahonia japonica*, *Pachysandra terminalis*, *Spiraea japonica*, *Pinus sylvestris*, *Acer campestre*, *Acer platanoides* and *Robinia pseudocacia* are the most widely used plants on the roof garden. There are also extensive areas of lawn and groundcover. The groundcovers are planted particularly in more shaded areas. Plants which are used on the terrace are: *Aesculus parviflora*, *Corylopsis pauciflora*, *Cotoneaster* 'Skogholm', *Cotoneaster dammeri*, *Euonymus fortunei* 'Colorata', *Hedera helix*, *Hydrangea petiolaris*, *Jasminum nudiflorum*, *Rosa* spp., *Rhododendron* spp., and *Sedum acre* 'Aureum'. Species used on the cafeteria roof are *Acaena buchananii*, *Dryas sundermannii*, *Sedum acre* 'Evergreen', *Sedum acre* 'Aureum' and *Cotoneaster dammeri* which are clumped with *Festuca ovina* and *Festuca glauca*. Plants are doing well except *Festuca ovina* and *Acaena buchananii* (Scrivens, 1982b).

2. 4. 1. 7. Kingston Hospital

A staff lounge and a snack bar on Kingston upon Thames Hospital, UK, which were set slightly off center provided a large area to be designed on the roof (Scrivens, 1982d) (Figure 9).

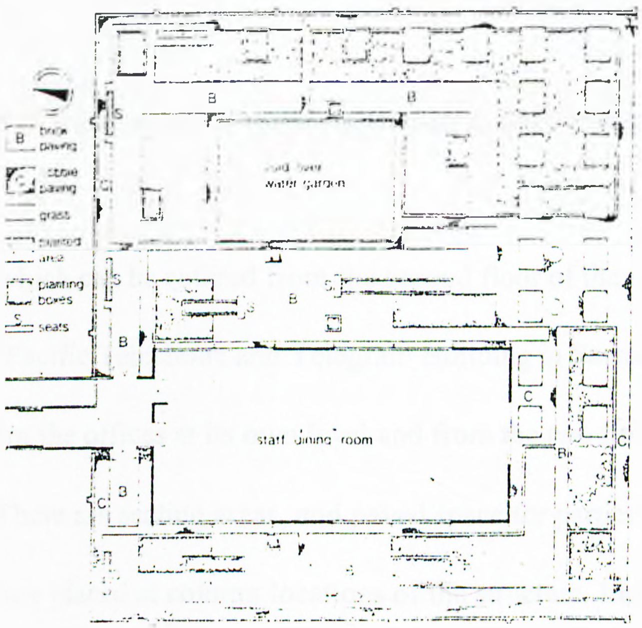


Figure 9. Plan of the roof garden at Kingston Hospital (Scrivens, 1982d, p. 89)

The depth of the topsoil is 100 mm. on the roof garden, but in the planters this increases to 400-800 mm. A number of species are quite successful in 100 mm. soil even though there is lack of substrate drainage. Plants do better where the soil depth has been increased to 400 mm. *Acer palmatum, Chaenomeles japonica, Corylus avellana* 'Contorta', *Cotoneaster dammeri* 'Skogholm', *Cupressus sempervirens*

'Gracilis', *Cotoneaster salicifolius, Euonymus fortunei* 'Silver Queen', *Erica carnea* 'Aurea', *Erica cinerca* 'Pallida', *Fagus sylvatica* 'Pendula', *Hebe quinqifolia* 'Pagei' and *Vinca major* 'Variegata' have done well at deeper beds. Species that are successful at 100 mm. depth are *Ajuga reptans* 'Atropurpurea', *Ajuga reptans* 'Rainbow', *Arundinaria spp., Eucalyptus gunnii, Festuca glauca, Hypericum calycinum, Lonicera nirida* 'Baggesen's Gold', *Salix* spp., *Sedum acre* 'Aureum' (Scrivens, 1982d).

2. 4. 1. 8. Pacific Telephone and Telegraph Building, Sacramento, California

The roof garden which can be entered from the second floor of the rectangular doughnut shaped Pacific Telephone and Telegram Building in Sacramento, USA, can be viewed from the offices at its own level and from the two floors above (Figures 10-11). There are seating areas, and paved space for parties and for other gatherings. Trees are placed at column locations of the structure. Lightweight concrete and proper soil mixture were used and irrigation and electrical services are buried in the soil (Osmundson, 1979).

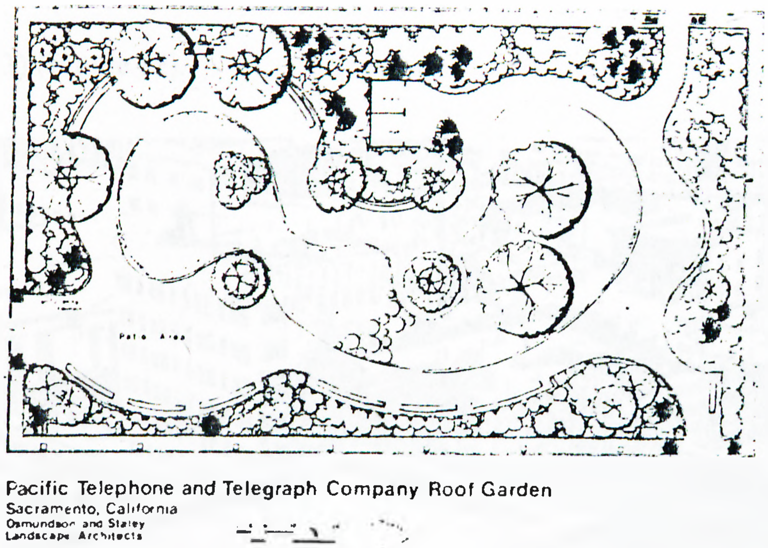


Figure 10. Plan of the Pacific Telephone and Telegraph Company Roof Garden (Osmundson, 1979, p. 497).

Figure 11. Section of the Pacific Telephone and Telegraph Company Roof Garden (Osmundson, 1979, p. 497)

2. 4. 1. 9. Roof Garden on a New Garage at the Pre-earthquake Fairmont Hotel in San Francisco

The roof garden of a new garage at the pre-earthquake Fairmont Hotel in San Francisco, USA, is a place for viewing across the city. On the roof garden, there are palm trees planted in sunken pits specially designed and suspended between beams of the underground garage. There are also low-growing flowers and leafy plants which were arranged in complex patterns with colored gravels and fountains (Halprin, 1983) (Figure 12).

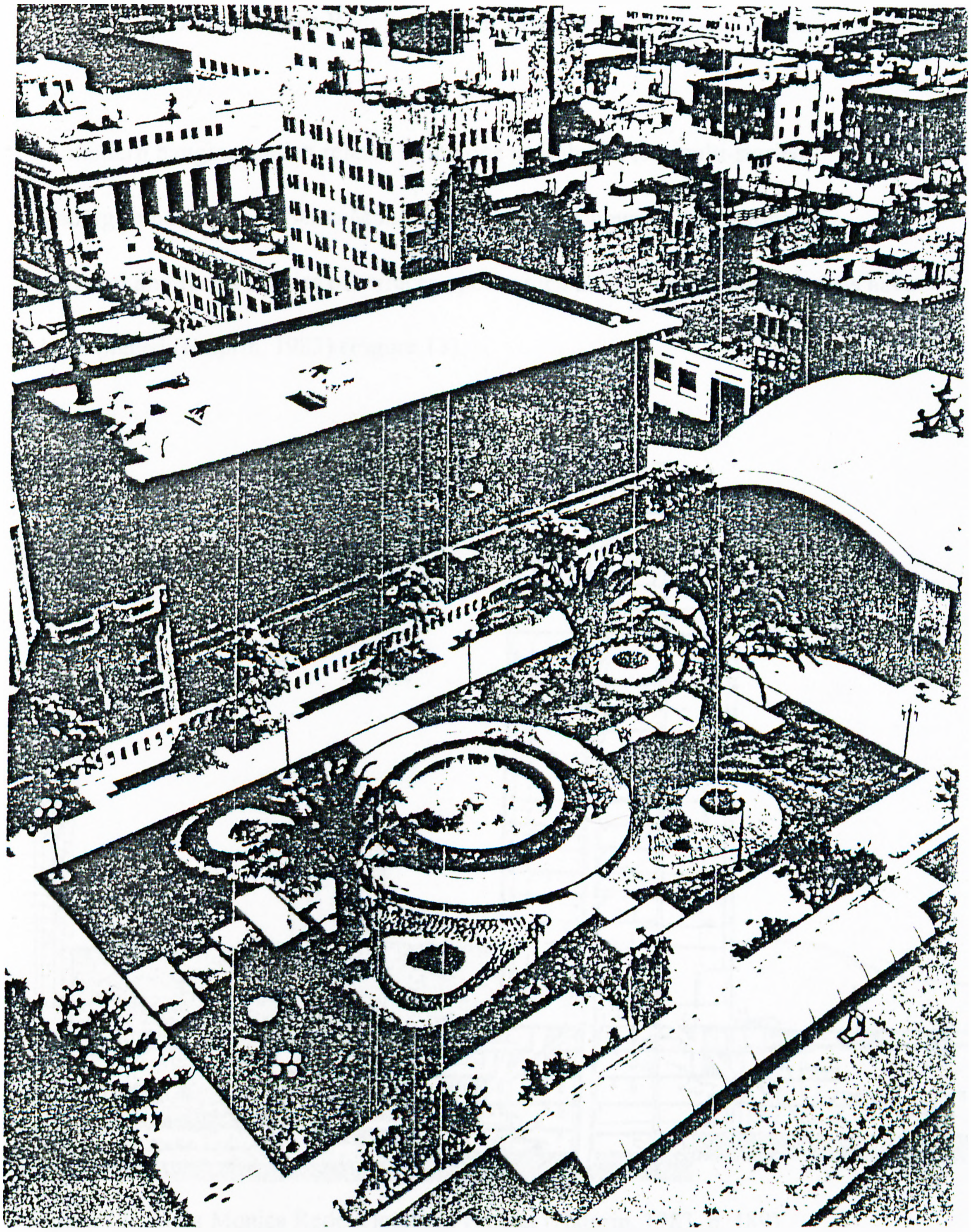


Figure 12. Roof Garden on a New Garage at the Pre-earthquake Fairmont Hotel in San Francisco (Halprin, 1983, p.186).

2. 4. 1. 10. Santa Monica Redevelopment Project

A modern hanging garden related to the one in Babylon is a multi-storied underground garage in Santa Monica, USA. It steps upwards in the form of a ziggurat and forms a series of terraces upon which houses and outdoor gardens have been placed (Halprin, 1983) (Figure 13).

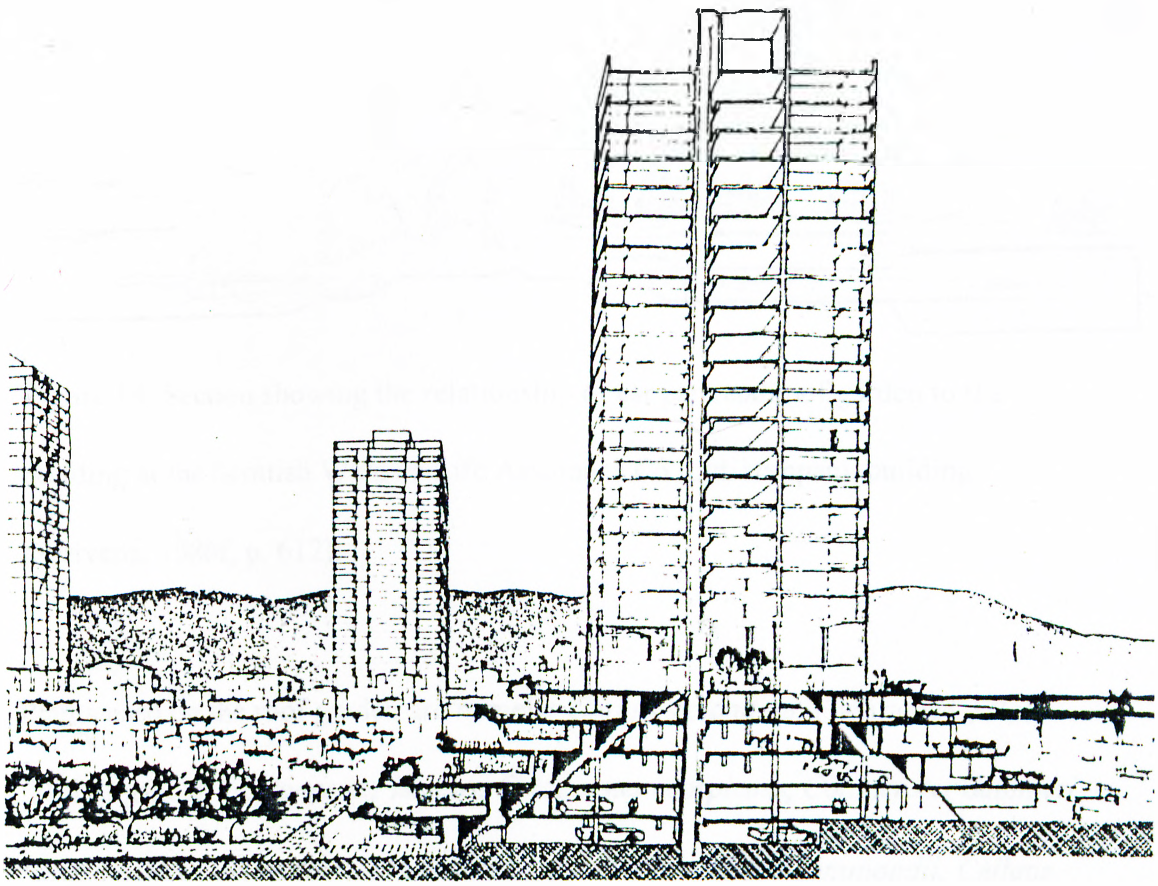


Figure 13. Santa Monica Redevelopment Project (Halprin, 1983, p. 189).

2. 4. 1. 11. Scottish Widows

Both the location of the site and the large amount of land available for landscape made it apparent that a considerable landscape input was required at the Scottish Widows Life Assurance Co.Ltd. building in the UK. As the site was overlooked from Arthur's Seat, a popular public place close to the site, it was decided to cover the car park by a roof garden (Figure 14). The car park was designed as a figure of eight with changes in level, thus, producing an irregular roof line and large voids in the side to provide natural lighting and ventilation (Scrivens, 1980f).

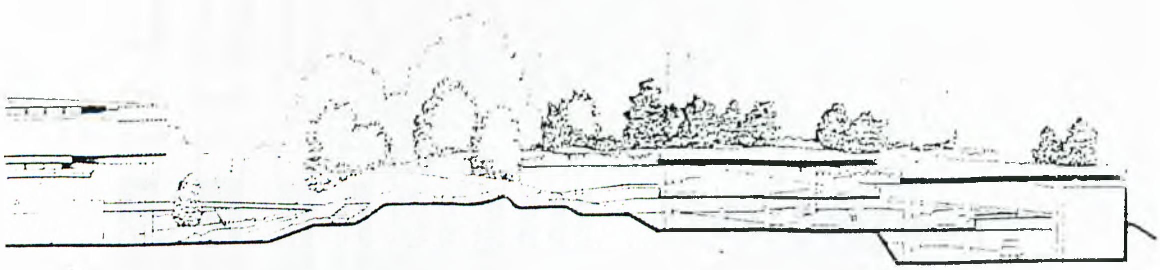


Figure 14. Section showing the relationship of car park and roof garden to the building at the Scottish Widows Life Assurance Co. Ltd. company building (Scrivens, 1980f, p. 612).

Plants used on the roof garden are namely: *Cornus stolonifera* 'Flaviramea', *Rosa* 'Frühlingsgold', *Cotoneaster lacteus, Cotoneaster conspicuus, Cotoneaster dammeri, Parthenocissus quiquefoila, Hedera helix, Erica* spp., *Calluna hammondii, Calluna alba pilosa, Calluna hibernica, Genista lydia, Geranium macrorrhizum* (Scrivens, 1980f).

2. 4. 1. 12. Standard Oil Company, San Francisco, California

This roof garden on the roof of a six-storied portion of a tower of 20 floors at San Francisco, USA, was designed to be used by the employees of the company. It can be entered from the interior corridor of the building. Lightweight concrete and soil mix is used to lessen the weight loading of the roof garden where trees are planted in planters (Osmundson, 1979) (Figure 15).

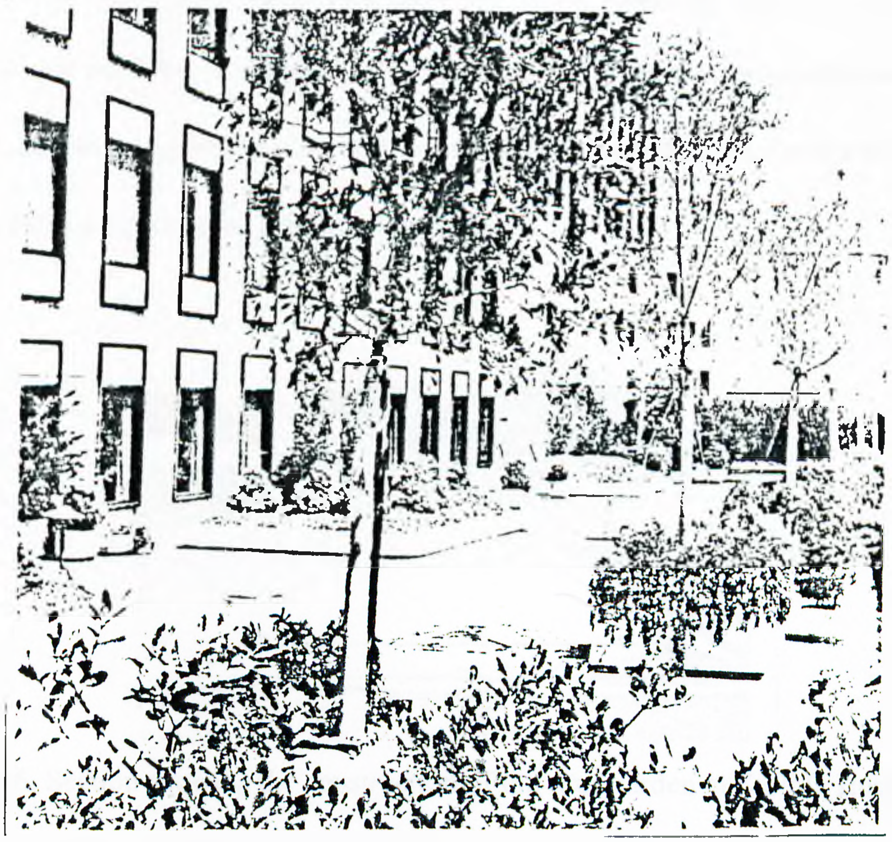


Figure 15. Roof Garden of the Standard Oil Company (Osmundson, 1979, p. 498).

2. 4. 1. 13. Suffolk Hospital

The upper story of the West Suffolk General Hospital, in the UK, which gathers the functions of numerous hospitals in the Bury St. Edmunds area, overlooks the roof of the more recent development, Geriatric Day Hospital, located on a lower site (Scrivens, 1980d).

As clerestory windows were used throughout the hospital, the roof of the geriatric day hospital reflected glare into the nearest parts of the main building and caused discomfort to the long stay patients. Although actions were taken against glare by the use of non-reflective paints and tinted glass, little improvement could be achieved. A thin plant layer was proposed to be produced over the whole surface of the roof so that it would need low maintenance when it got mature. By the construction of a roof garden, an annoying problem has been overcome by a relatively low cost and a great deal of pleasure (Scrivens, 1980d) (Figure 16).

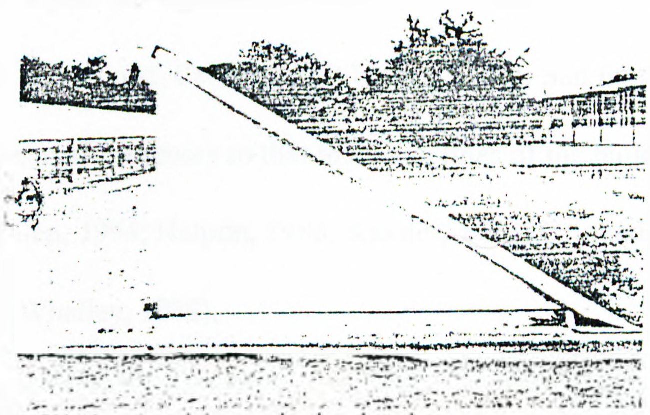


Figure 16. Section showing the construction of the roof garden at Suffolk Hospital (Scrivens, 1980d, p. 781).

2. 4. 1. 14. Other Examples of Roof Gardens

There are also some other roof gardens, most of which are used by the employees of that particular building. Examples include the roof garden of the Boston Federal Reserve Bank Building, Massachusetts; Lincoln Plaza, Sacramento, California; the John Hancock Building, San Francisco, California; Uetlihof, an insurance company, Zurich, Switzerland; Irish Life Assurance Building, Dublin, UK; Willis, Faber and Dumas Ltd. building in the UK, National Computing Center Building, Manchester, UK; Ministry of Education Building, Rio de Janeiro, Brazil. Examples of roof gardens designed for public use include Grosse Schanze Park, Berne, Switzerland; Oakland Museum, Oakland, California; Yamashita Park Plaza in Yamashita Park,Yokohama, Japan. Roof gardens of Bonaventure Hotel, Montreal, Canada; Peninsula Hotel, Hollywood, Califronia; St.Francis Hotel, San Francisco, California are planted for aesthetic purposes so that the harsh lines of the buildings are softened (Crume 1983; Gülen, 1994; Halprin, 1983; Kassler, 1984; Osmundson, 1979; Scrivens, 1980e; Whalley, 1978).

2. 4. 2. Some Examples of Roof Gardens in Türkiye

In Türkiye, there are few examples of roof gardens at some hotel buildings in some of the big cities. In this section, some roof gardens which have been visited in İstanbul are illustrated. These include the roof gardens at Conrad Hotel, Ceylan

Intercontinental Hotel, Polat Renaissance Hotel, and Princess Hotel. Existing roof gardens in Ankara will be illustrated in part 4.3.

2. 4. 2. 1. Conrad Hotel

The terraces at the Conrad Hotel, which can be accessed from some of the rooms and viewed from the terrace on the executive floor, are designed as roof gardens and planted with low shrubs and groundcovers (Figure 17). The roof of the underground garage of the hotel is also planted (Figure 18). The high walls enclosing one side of the patio, where there is an open swimming pool, are terraced and planted with loose plants (Figure 19).

Plants used include *Ampelopsis quencifolia, Buxus sempervirens, Cornus alba, Cupressus arizonica, Euonymus japonica, Hedera helix, Mahonia aquifolium, Pinus mugo, Pyracantha coccinea, Rosa* spp., *Thuja orientalis, Juniperus horizontalis.*

Figure 17. Terraces of the Conrad Hotel viewed from the executive floor (November, 1996).

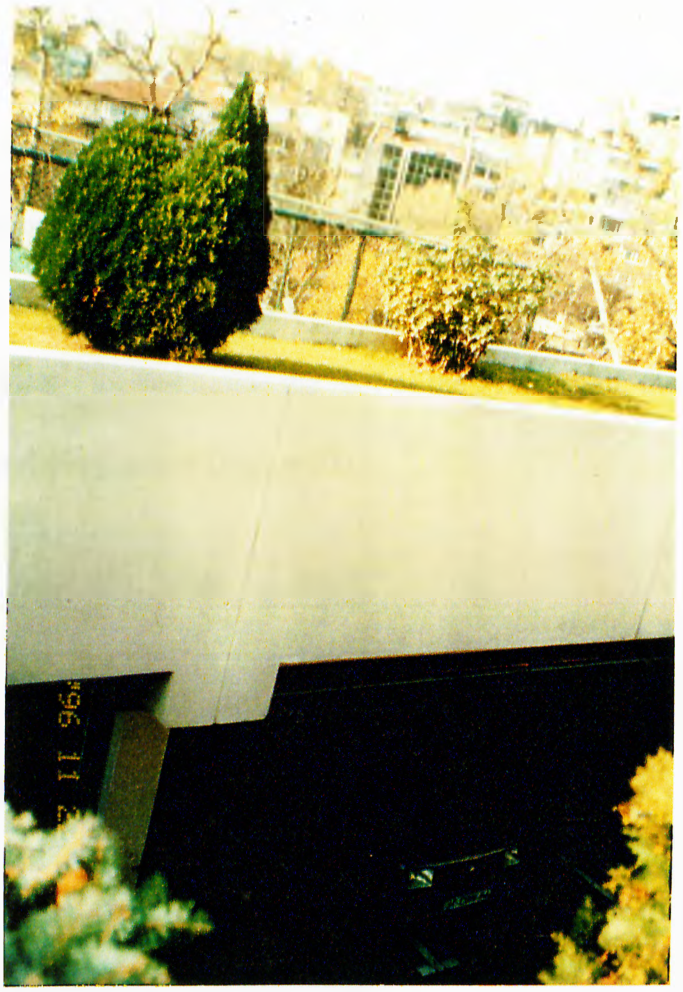


Figure 18. Roof of the underground garage at the Conrad Hotel (November, 1996).

Figure 19. View of the roof garden at the Conrad Hotel (November, 1996).

2. 4. 2. 2. Ceylan Intercontinental Hotel

The roof of the gymnasium of the Ceylan Intercontinental Hotel, which is planted for aesthetic purposes, is covered with grass and annual flowers (Figure 20). Around the swimming pool, which is located beside the roof of the gymnasium, there are some flowers and low shrubs in planters (Figure 21).

Figure 20. Roof of the gymnasium at Ceylan Intercontinental Hotel (November, 1996).

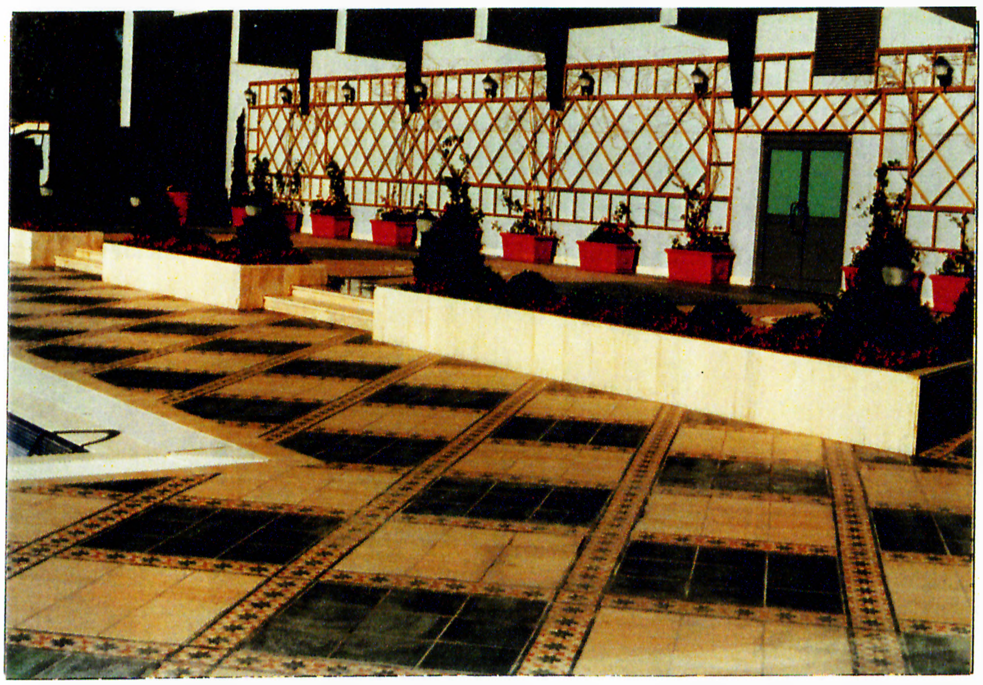


Figure 21. Planters around the swimming pool at Ceylan Intercontinental Hotel (November, 1996).

2. 4. 2. 3. Polat Renaissance Hotel

The extensive roof gardens at the Polat Renaissance Hotel, which can be viewed from the rooms of the hotel are accessed only for maintenance. Low shrubs and grass have been used at these extensive roof gardens (Figures 22-23).

Figure 22. Aerial view of the extensive roof gardens at the Polat Renaissance Hotel.

Figure 23. Low shrubs at the roof garden, Polat Renaissance Hotel (November, 1996)

2. 4. 2. 4. Princess Hotel

On the third floor of the Princess Hotel is located a roof garden where there is a wide range of plants used. The roof garden is accessed from the cafeteria of the hotel and can be viewed from the rooms and surrounding buildings. Plants used include *Agave americana, Berberis thunbergii, Euonymus japonica, Mahonia aquifolium, Pyracantha coccinea, Yucca filementosa* (Figures 24-25).

Figure 24. View of the roof garden at the Princess Hotel (November, 1996).

Figure 25. Plants used at the roof garden of the Princess Hotel (November, 1996).

3. CONSTRUCTION OF ROOF GARDENS

The most important thing in roofscapes is the preservation of the unity of the building structure and the roof. Thus, a good drainage system, water resistivity, optimum weight loading and irrigation, light medium of vegetation with a long life cycle should be provided; and precautions should be taken against damages. Roof garden construction needs proper placement of the successive layers (Figure 26). Plants are to be of species that are adaptable to restrictions. Water and electrical installations should be well designed, while suitable materials are to be chosen. Good maintenance should be provided for roof gardens so that they would look their best (Gülen, 1994; Osmundson, 1988).

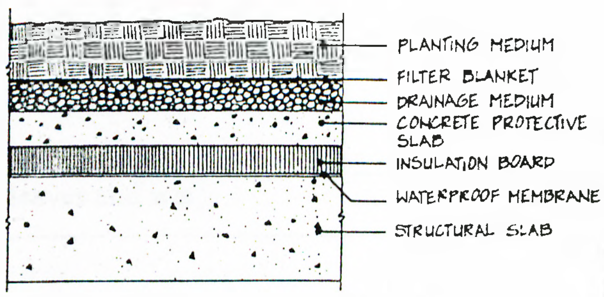


Figure 26. Cross section through roof (Osmundson, 1988, p. 610-2).

3. 1. Roof Loading

Although weight is thought to be the major problem faced during roof garden construction, adequate structural design of the building would make roof garden design easier and less costly (Osmundson, 1979).

Aslanboğa (1988) and Southard (1971) classify roof loading in two groups: Live and dead loads. Pedestrian access and maintenance machines increase live loads; whereas dead loads are increased by paving, soil, and trees (Table 1).

Table 1. Loads of some materials (Aslanboğa, 1988, p. 17).

Medium of vegetation	Load (kg/m^2)
Topsoil	16 - 20
Sand	20 - 22
Gravel	16 - 18
Peat	7 - 9
Polystrol plates	0.3 - 0.4
Formaldehyde foam	5 - 6
Plant Materials (on leaves and wet)	**Load (kg/m^2)**
Grass	5
Low shrubs, groundcovers	10
Shrubs up to 150 cm.	20
Shrubs up to 300 cm.	30
Trees up to 6 m.	40
Trees up to 10 m.	60
Trees up to 15 m.	150

People cause a live load of 200 kg/m^2 load, whereas live load caused by vehicles and machines is 350 kg/m^2 (Aslanboğa, 1988).

3. 2. Waterproofing Membrane

Both vertical and horizontal sections of roof gardens should be waterproofed by a protective membrane which controlls water. The waterproofing membrane should be sealed well before any additional materials are put on top. A single leak within the waterproof membrane may require the removal of the entire garden (Osmundson, 1988).

Waterproofing membrane should be protected against damages caused by construction and planting work, planters, root penetration and soil chemicals. In order to minimize the damages caused by root actions, a protective screed layer should be laid over the waterproofing membrane both on the horizontal plane and on the vertical plane (Aslanboğa, 1988; Scrivens, 1994; Southard, 1971). Instead of paving slabs or screed, insulation slabs can also be used over the membrane in order to protect root penetration (Figure 26).

3. 3. Insulation Layer

It is needed to provide insulation in order to preserve heat within the building. These factors should be considered when insulating a roof (Günalp, 1989):

- Roof slab should be light and should improve heat insulation.
- Heat insulation layer should not absorb water or its water absorbing capacity should be minimum. Its chemical structure should not alter after a long period of time.

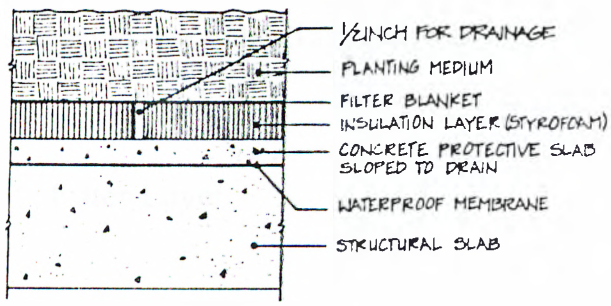
Lightweight heat insulation layer should bear the load of the vegetation. Polystrol-foam, glassfibre, perlite-concrete can be used for heat isolation at roof gardens (Aslanboğa, 1988).

3. 4. Drainage

Rainwater and excess water need to be discharged from roof gardens because high moisture content may damage roots of the plants.

A good drainage layer should be formed at the bottom parts of the soil. Water penetrating immediately downwards the planting medium is accumulated in the drainage layer and is drained from the rainwater pipes. The radius and the number of the pipes are determined due to the maximum rainfall of that region (Aslanboğa, 1988; Gülen, 1994; Osmundson, 1988; Scrivens, 1982e) (see Appendix A: Figure 1).

Drainage layer should resist atmospheric conditions, have long-life, and be stabile. It should have pores in order to drain excess water. It should be water resistant and should not decompose chemically. Drainage materials can be of artificial or natural lightweight and porous material (Figure 27). If there are not any loading restrictions, gravel can serve this purpose. However, it is not suggested to use cornered materials as they are likely to damage the waterproofing membrane (Aslanboğa, 1988).



Lightweight Drainage Techniques In small areas where a lightweight drainage medium is needed, slope the protective slab to the roof drain, and cover with 4 ft × 4 ft × 2 in (1.22 m × 1.22 m × 50 mm) Styrofoam sheets. Sheets must be square with 2-in (50 mm) spaces between for adequate drainage. Cover with filter blanket.

Figure 27. Lightweight drainage techniques (Osmundson, 1988, p. 610-3).

According to Aslanboğa (1988) and Van Vliet (1992), slope of the drainage layer should fit the slope of the roof (Figure 28). Depth of the drainage layer and its installation depend on the plants used, the structure of the layers, the amount of rainfall and irrigation water (see Appendix A: Figures 2-13).

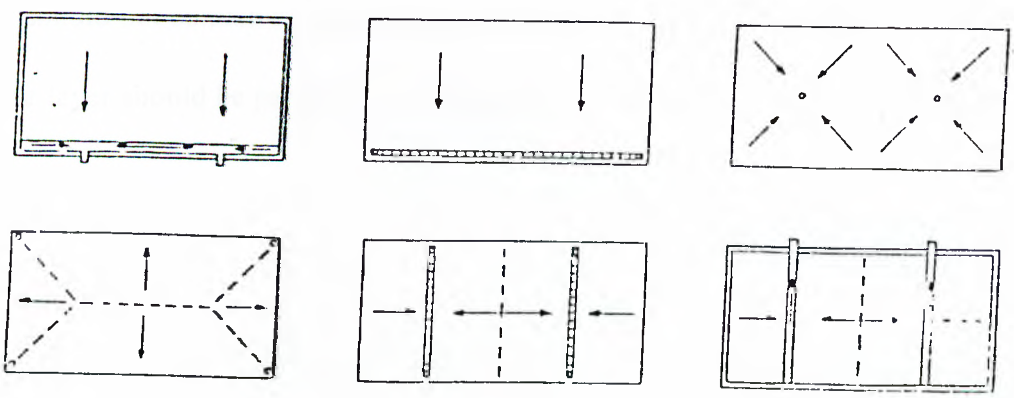


Figure 28. Possible ways of sloping the drainage layer (Aslanboğa, 1988, p. 9).

Drainage points can be detailed in some ways. Indiscreet manhole covers, small lids, drainage points hidden below the substrate can be used on roof gardens. Small lids may be affected by lime scales since they have narrow gaps. Hiding drainage points below the substrate have some aesthetic advantages. However, they should be easily inspected in case of blockage (Scrivens, 1982e, 1994).

3. 5. Filter Layer

Filter layer is used to separate the growing medium from the drainage layer. Water penetrating the soil passes through the filter blanket into the drainage layer.

During dry weather, moisture rising from the expanded clay granules is distributed to the garden through this layer. A rot-resistant filter layer of woven or nonwoven polypropylene fabric (filter blanket) prevents the soil medium from entering and clogging the drainage medium (Osmundson, 1988). Filter layer should resist loads, and should not contain any materials that decompose chemically and harm plants. Filter layer should be parallel to the drainage layer on which it is overlaid (Figure 26).

3. 6. Irrigation Systems

Continuous supplies of water is required for all actively growing plants in order to develop their full potential. As urban landscapes are subject to high degree of exposure and have limited soil depths, water should be provided by means of irrigation. During summer, water is lost from the soil more than it is added in the form of precipitation. Therefore, a comprehensive irrigation system is needed for the survival of plants (Osmundson, 1988; Scrivens, 1994).

Water is lost from an area by drainage to waste, evaporation from the substrate or transpiration by the plants. Water is lost especially from the upper 300 mm. of the soil profile. However, water loss from below this layer depends entirely on the activity of plants. Transpiration increases in conditions of high light levels, high temperature, low humidity and rapid air movement. If transpiration exceeds the rate of water uptake, the plant will certainly wilt (Scrivens, 1994).

Aslanboğa (1988), Scrivens (1994) and Southard (1971) suggest three ways of irrigation for roof gardens: Percolation of the accumulated water to the layers, spray irrigation (sprinkler) and drip irrigation.

Water may enter soil from below or above. When a dry layer exists above a wet one, water enters from the moistured part below by surface tension which lifts it upwards. The standing water in the drainage layer passing round the surface of the drainage layer and into the soil separator moves into the substrate and is lifted up by surface tension. Saturated vapor between the particles of the drainage layer assists this process. Although this system provides plants with water for at least six weeks in a dry summer, the number of species that appear to be truly successful is limited. Also, extra weight should be considered and yet be carried by the structure. The rate of infiltration governs the entry from above. Each successive layer of substrate becomes saturated before water moves further downward. Water cannot move downwards if there is no free water available. Thus, moistening the soil lightly results in only a limited depth of penetration (Scrivens, 1982e; 1994).

Water circles or segments by pop-up sprinklers (Figure 29). Precautions should be taken against spreading of water because of wind (Southard, 1971; Aslanboğa, 1988). While designing an sprinkle irrigation system, nozzle location should be considered well against obstruction by vegetation and the damages of mowing machines (Scrivens, 1982e)

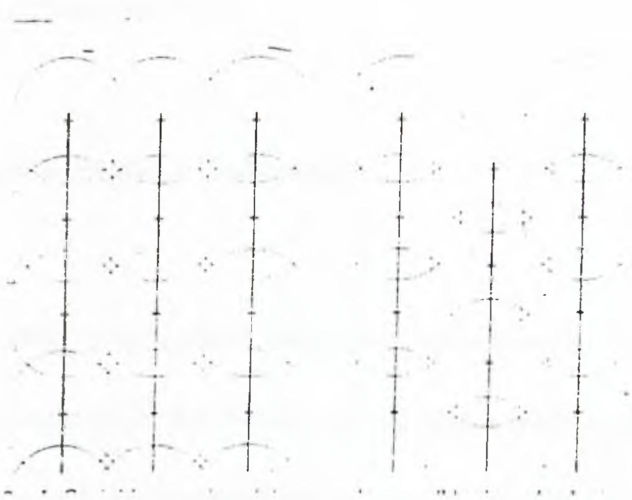


Figure 29. Sprinkler spacing (a) square layout, (b) triangular layout (Scrivens, 1980a, p. 585).

Drip irrigation by which water is reserved in the medium of vegetation (substrate) can also be used at roof gardens (Southard, 1971). Although shadow and sunny areas receive equal amount of water, and pipes which are laid on the surface of the substrate or onto the drainage layer can be damaged by people or maintenance equipment, it is thought to be the best irrigation system for roof gardens (Aslanboğa, 1988).

In most urban situations, however, there will be need for some degree of hand-watering by using large bore, heavy duty industrial hoses. Supply points should be placed suitably to reduce the length of the hose which is required and there should be a drain placed beneath each tap (Scrivens, 1994).

Nutrients should be applied during irrigation at certain times since they are leached out while water passes through the soil profile. Liquid fertilizers can be applied through irrigation (Southard, 1971).

3. 7. Medium of Vegetation (Substrate)

Medium of vegetation is the medium where plant roots develop. Rainwater and irrigation water is reserved in this medium, while excess water is drained. It holds water and nutrients, and provides anchorage. The substrate should have enough pore spaces in which air is present. Medium of vegetation should not contain any materials that are likely to harm plants. The pH value of the substrate may be between 5.5-6.5 (Aslanboğa, 1988; Osmundson, 1988; Scrivens, 1994; Southard, 1971).

Improved topsoil have been used on roof gardens traditionally. As ordinary garden soil is not suitable and soil weight is a problem at roof gardens, the soil mixture should be lightened by artificial soil conditioners (Carpenter and Walker, 1990). Topsoil can be improved by use of expanded polystyrene, Leca, perlite and bark, and peat (Figure 30). Peat is the most commonly used topsoil improving material. These materials tend to produce more open texture with improved drainage properties. Thus, the roof garden needs more watering if these materials are used. Although lightweight materials reduce loading when they are dry, the saving in weight is not as great as expected when they are wet (Southard, 1971). Lightweight materials, such as styrofoam plates and concrete planters, can be used in order to raise the plant beds (Gülen, 1994) (Figures 31-33).

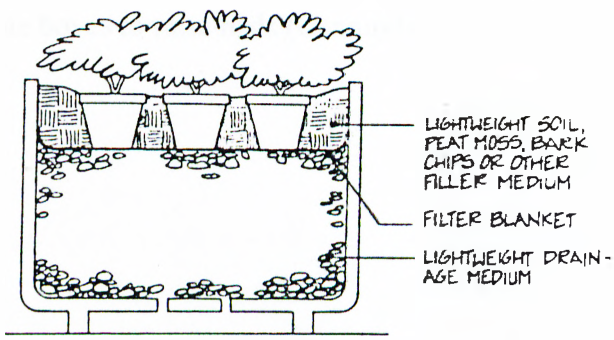


Figure 30. Plant containers with lightweight topsoil materials (Osmundson, 1988, p. 610-9).

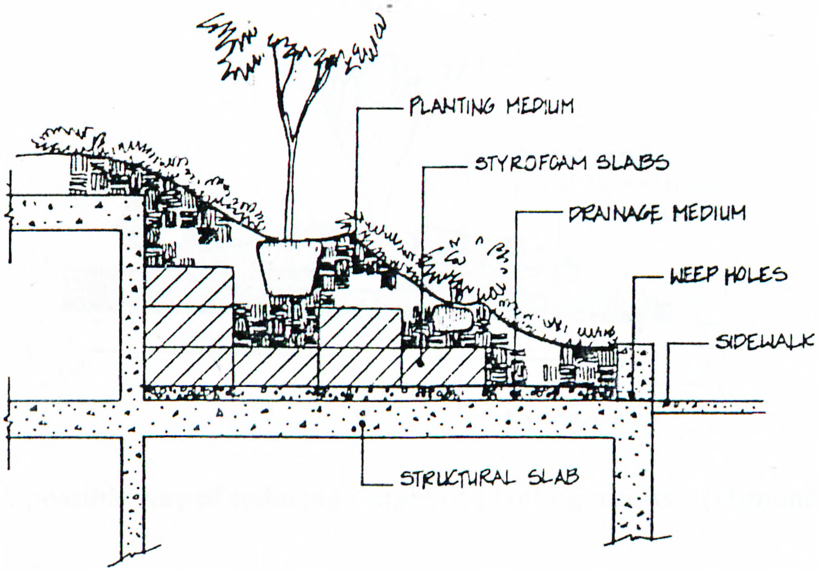


Figure 31. Lightweight method for changing grades (Osmundson, 1988, p. 610-9).

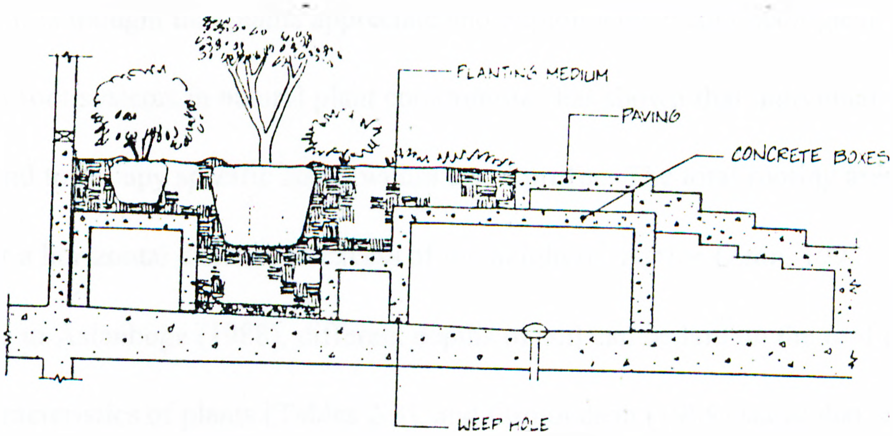


Figure 32. Concrete boxes to raise beds (Osmundson, 1988, p. 610-7).

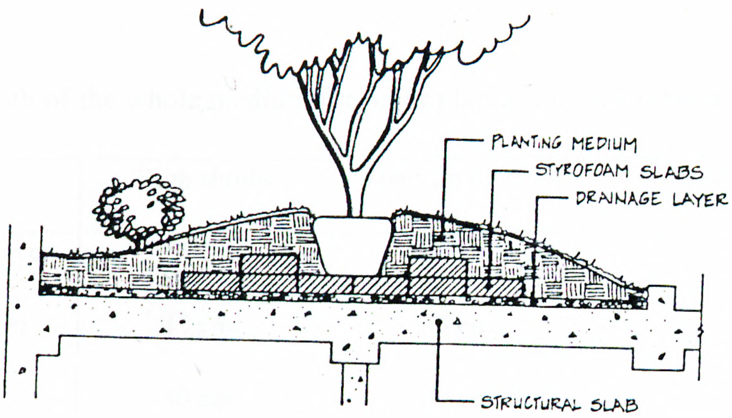


Figure 33. A possible way of reducing weight of planting medium (Osmundson, 1988, p. 610-7).

Although it is thought that plants appreciate and exploit a deep soil, ecological studies on root systems in natural plant communities has shown that individual species tend to occupy specific zones within a soil profile. The total rooting area may extend for a horizontal distance in excess of the height of the tree (Zion, 1995). According to Aslanboğa (1988), different depths of soil can be laid on the roof due to the characteristics of plants (Tables 2-3), and Osmundson (1988) states that, a roof structure can be designed to provide a recessed planting area over a column for a large tree (Figure 34)

Table 2. Depth of the whole medium for surface plantation (Aslanboğa, 1988, p. 12).

Layers	Grass/groundcovers	Perennials/low shrubs	Shrubs growing up to 3 m
Vegetation layer	8 cm.	15 cm.	25 cm.
Drainage layer	5-7 cm.	7-10 cm.	10-15 cm.
Total	15 cm.	25 cm.	40 cm.

Table 3. Depth of the whole medium for point plantation (Aslanboğa, 1988, p. 12).

Layers	High shrubs	Trees up to 10 m.	Trees up to 15 m.
Vegetation layer	35 cm.	65 cm.	100 cm.
Drainage layer	15 cm.	35 cm.	50 cm.
Total	50 cm.	100 cm.	150 cm.

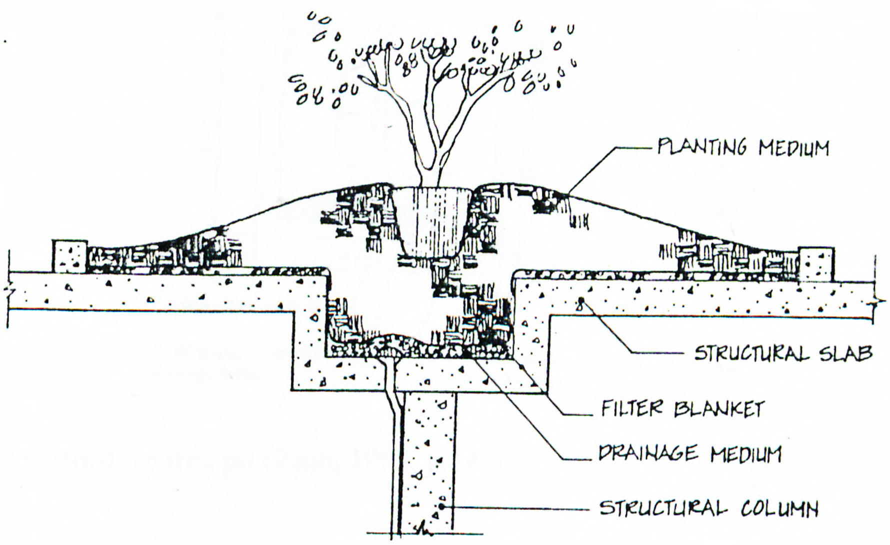


Figure 34. Recessed area for large plants (Osmundson, 1988, p. 610-7).

Stability within the soil has to be provided against blowing of plants because of wind (Figure 35). It is suggested to plant trees in heavy tubs to provide anchorage if lightweight soil is to be used (Southard, 1971).

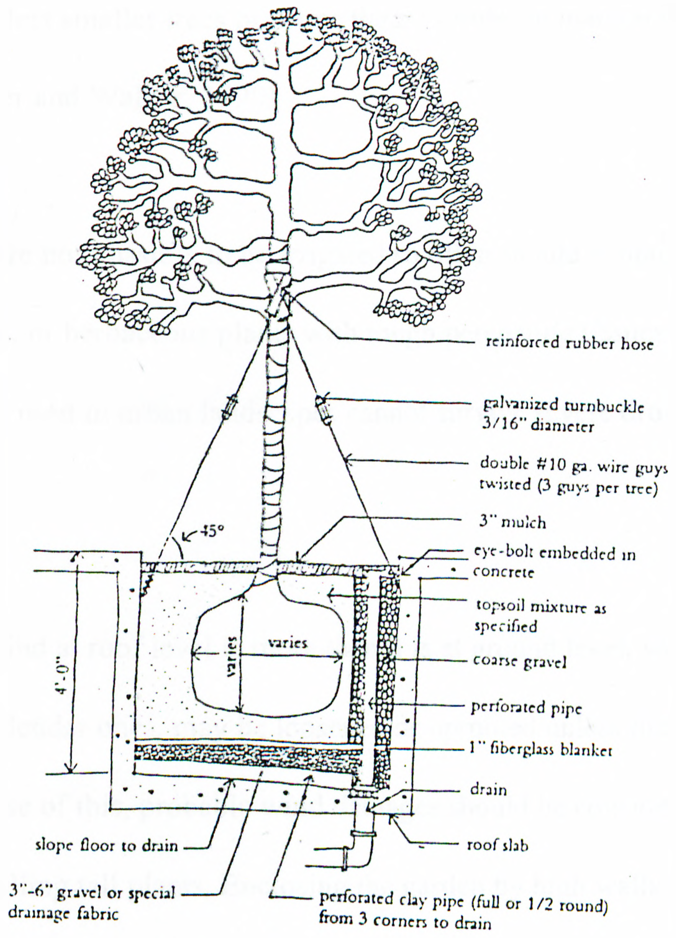


Figure 35. Rooftop tree pit (Zion, 1995, p.144).

3. 8. Plantation

Maintenance standards, depth of soil, exposure to wind and droughts, overshadowing or sheltering from rain by buildings, atmospheric pollution, susceptibility to disease should be taken into account when choosing plants for roof gardens. Plants on roof gardens should resist extreme temperatures, be able to grow at shallow soils, and be located according to their light and shade requirements. Species that necessitate minimum maintenance are preferred (Aslanboğa, 1988; Southard, 1971; Zion, 1995). The mature size and shape of plants should be considered. Where space is limited, it is suggested to select smaller trees or prune them in order to maintain the root-to-top balance (Carpenter and Walker, 1990).

Landscapes that are not possible to be irrigated so often should contain plants that grow in arid areas, or herbaceous plants with tough perenating tissues. However, most of the plants used in urban landscapes cannot survive severe drought (Scrivens, 1982e).

As the speed of wind at roof level is more than it is at ground level, some plants, especially tall or slender ones, may be loosened or uprooted unless they are protected from wind. Because of this, probable wind damages should be considered when selecting and installing tall plants. Enclosing the garden by high walls, and sometimes supporting by internal partitions will reduce the effects of wind. Plants having a height of more than 3 m. should be supported (Aslanboğa, 1988; Osmundson, 1988; Scrivens, 1982e; 1994; Southard, 1971).

Because of the structural problems, trees can be planted in raised containers over the supporting columns of the structure (Carpenter and Walker, 1990) (Figure 34). These containers must have their own drainage outlets, drainage layers and separating filters.

Kseromorfs, succulents, bulbs best suit roof gardens. *Sedum, Mesembrianthemum, Lambranthus, Alyssum, Dianthus, Sempervivum* are mostly used at roof gardens

(Aslanboğa, 1988). *Betula* varieties, *Crateagus* varieties, *Koelreuteria paniculata, Malus floribunda, Pinus sylvestris, Robinia pseudacacia, Sophora japonica, Sorbus aria, Sorbus aucuparia, Tilia* varieties are suitable trees for roof gardens. Specially suitable shrubs include *Calluna vulgaris, Cotoneaster* varieties, *Cytissus* varieties (short lived), *Erica* varieties, *Euonymus* varieties, *Hedera* varieties, *Juniperus* varieties, *Rhus typhina, Sambucus nigra* and *Ulex* varieties. *Cotula squalida, Cotoneaster* (low growing vars), *Hypericum calycinum, Mentha rotundifolia, Thymus serphyllum* (on poor shallow soil) and *Vinca minor* are among the suitable groundcover plants (Southard, 1971; Zion, 1995).

3. 9. Maintenance and Life Cycle

Maintenance should be provided on roof gardens if they are to look their best. Roof gardens may have high maintenance requirements due to their gardenesque design, plant selection etc. The roof will naturally require low maintenance if more natural plantings are used in their designs (Scrivens, 1982e).

There should be convenient stores for the small tools, that are used for garden maintenance. Soil, and some trees and shrubs should be replaced when needed. Grass cuttings, tree and shrub prunings, fallen leaves should be removed, hard areas should be swept, pools should be cleaned, weeds should be sorted (Osmundson, 1988; Southard, 1971). Precautions should be taken against wind. Location of irrigation taps should be easy to reach. Irrigation and drainage systems should be controlled regularly (Aslanboğa, 1988).

Life cycle of roof gardens should be at least for 10 years, as most shrub plantings require a major overhaul after 10 years (Scrivens, 1982e).

3. 10. Other Considerations

Other considerations, that are to be taken into account, while constructing a roof garden include barriers, water features, lighting and paving.

3. 10. 1. Barriers

Since most roof gardens are on high stories of buildings, they should be surrounded by barriers in order to provide psychological relaxation and prevent probable accidents. A single-strained wire-fence or a more substantial steel barrier can be used against falling down. Low barriers are also necessary against debris rolling off the edge of the roof. There should be higher enclosure at roof gardens where active games are played or children congregate without supervision (Gülen, 1994; Osmundson, 1988; Scrivens, 1982e; 1994; Southard, 1971) (Figure 36).

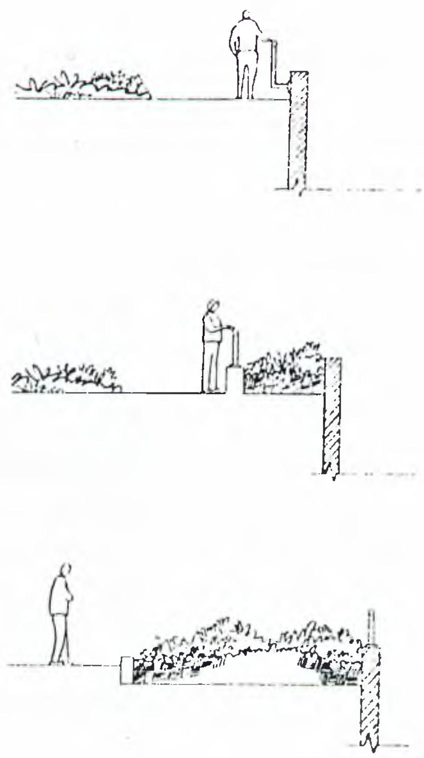


Figure 36. Techniques for creating safety barriers (Osmundson, 1988, p. 610-14).

3. 10. 2. Water Features

According to Carpenter and Walker (1990), Gülen (1994) and Osmundson (1988), pleasant spaces can be created on roofs by water features. Water in a splashing fountain or a reflection pool and lighting will make a roof garden more pleasant. It will be easier to take precautions against loads of water features if it is known that there will be water features on the roof garden. Otherwise, limited amounts of water can be used at roof gardens. If heavy water features are to be used, these should be located over the columns of the building. Sides of the pools should be sealed well against fractures (Gülen, 1994; Osmundson, 1988).

Pools with gray or black colored bottom and sides give a feeling of depth. Shallow pools can be constructed by using fiberglass of 6 mm. thick if the static of the building does not allow heavy loads (Gülen, 1994; Osmundson, 1988) (Figure 37).

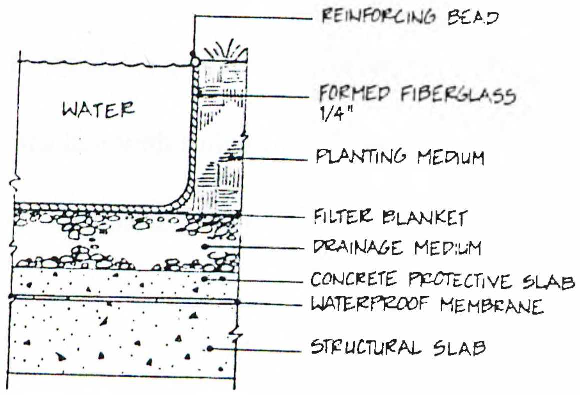


Figure 37. Fiberglass pool wall (Osmundson, 1988, p. 610-13).

3. 10. 3. Lighting

Sufficient electrical supply should be provided for lighting. In order not to be damaged by digging, all electrical supply conduits should be enclosed in metal (Osmundson, 1988). According to Southard (1971), roof gardens can be illuminated from the internal lighting behind adjacent glass facades since enough light can be spilled. General, flood, spot or decorative lighting can be used for the illumination of roof gardens.

3. 10. 4. Paving

Strong visual impressions can be created also by color and texture of paving materials. Brick pavers, hollow tiles with open joints, patterned or textured screeds, expanded clay, paving slabs, quarry tiles, loose rounded gravel, textured wood decking and tarmacadam with rolled-in dressings can be used at roof gardens (Osmundson, 1988; Southard, 1971).

4. TENDENCY TOWARDS ROOF GARDENING IN ANKARA: A CASE STUDY

4. 1. Classification of Urban Green Spaces

Urban open-green spaces can be briefly defined as areas which form voids within cities and provide space for recreational facilities (Öztan, 1991). According to Kilciler (1993), distribution of green spaces within the city, the amount of greenery in terms of m^2 per person, and the functionality of green spaces form the urban green space system of a city.

Richter classifies urban open-green spaces in 3 groups (qtd. in Odabaş, 1990, p. 19):

- Common Open Spaces: Active spaces, such as sports areas, playlots, strolling areas, camping sites, parks; non-active spaces, including botanical gardens, cemeteries, walkway greenery, viewing terraces; authoritative spaces including gardens of schools, hospitals, dormitories, mosques, churches, nurseries form common open spaces within a city.

- Green Objects: Trees and shrubs are the green objects within cities.

- Special Open Spaces: House gardens, courtyards, golf courts, roof gardens, terraces and balconies are the special open spaces of cities.

Simonds (1983), however, classifies open spaces in 5 groups:

-Waterfront: Beach, lake shore or river edges are the waterfronts of a city.

- Blueways: Rivers and streams passing through a city form the blueways of that city.

- Greenways: Freeways, parkways, transportation corridors, transmission easements, slopes, walkways, jogging paths and bicycle trails are considered as greenways of cities.

- Urban Parks and Recreation Areas: These can be classified in subgroups, such as community park, neighborhood park, city park and civic and cultural centers, including business office and industrial parks, institutional campuses, hospitals, libraries, museums, universities contribute to the open spaces of cities.

- Other Open Space Contributors: Urban forests, reservoirs, private golf, swim and tennis clubs, rooftops, vacant lots, land-banked property, military installations, locks and dams, in-city gardens and nurseries also form open spaces within cities.

4. 2. Evaluation of Urban Green Spaces in Ankara

As stated by Öztan (1991), the city of Ankara has stretched out from 250 hectares to an area of approximately 800 hectares from 1920s to 1990, and its population has increased 100 times. 9 years after being established as the capital of Türkiye, the city of Ankara was planned by a German city planner, H. Jansen, who preserved the topographic and morphologic characteristics of the city in his plan. However, due to rapid population increase, Jansen's plan has changed since 1957. Gençlik Parkı, Hippodrome, 19 Mayıs Sports Complex, Park of the Citadel of Ankara and Atatürk Orman Çiftliği are the extensions of the urban green space system which was suggested by Jansen.

The amount of green spaces in terms of m^2 per person and distribution of them within Ankara do not form a commensurate urban green space system. As stated by Kilciler (1993), the amount of green spaces was 5.65 m^2/person in Ankara in 1990, being far below the standards. For cities whose population is more than 500.000, the amount of passive green space per person is suggested be 8 m^2, and the amount of active green space per person is suggested to be 12 m^2, which make a total of 20 m^2/person. Moreover, urban green spaces in Ankara are not distributed homogeneously. East-west axis of the city has large green spaces, including university campuses, Atatürk Orman Çiftliği, military installations, Atatürk Kültür Merkezi. However, we cannot identify green spaces that much large on the north-south axis of the city, because the green spaces on the north-south axis of the city, except for a few parks, are smaller in scale than those on the east-west axis.

4. 3. Existing Roof Gardens in Ankara

There are few existing roof gardens in Ankara, which include the roof gardens on the Interbank building, Park Apart Hotel, underground garage of Karum Shopping Mall and roof of Beğendik Shopping Mall (courtyard of Kocatepe Mosque).

4. 3. 1. Interbank Building

The terraces on the first and the second floors of the Interbank building, which are designed as hanging gardens, can be accessed from the executive offices of the bank, and can be viewed from the offices at higher levels and from the adjacent buildings. Various species of trees, shrubs and groundcovers are used at these hanging gardens. *Ampelopsis quencifolia, Berberis thunbergii* 'Atropurpurea', *Cedrus libani, Lonicera tatarica, Mahonia aquifolium, Rosa* spp., *Thuja orientalis* are the plants of the roof garden on Interbank building (Figures 38-40).

Unfortunately, some parts of the ceilings of the offices are damaged due to lack of good waterproofing.

Figure 38. Roof garden on the first floor of the Interbank building (July, 1996).

Figure 39. Roof garden on the second floor of the Interbank building (July, 1996).

Figure 40. Plants, softening the contours of the Interbank Building (July, 1996).

4. 3. 2. Park Apart Hotel

The terrace of the Park Apart Hotel, which is used for dining during summer, is designed as an intensive roof garden. *Buxus sempervirens, Cotoneaster horizontalis, Euonymus japonica, Lonicera tatarica, Pyracantha coccinea* are grown up in the planters surrounding the swimming pool (Figure 41). There is also an extensive roof garden on the locker rooms from where the terrace is entered (Figure 42). Various species of groundcovers are planted on this extensive roof garden. Both the extensive and the intensive roof gardens of the hotel can be viewed from the rooms of the hotel and the adjacent buildings.

Figure 41. Planters of the intensive roof garden at Park Apart Hotel (July, 1996).

Figure 42. Extensive roof garden at Park Apart Hotel (July, 1996).

4. 3. 3. Karum Shopping Mall

Roof of the underground garage of Karum Shopping Mall is a wide lawn (Figure 43). It is an open space near the shopping mall, which is a popular place used mostly by teenagers. Rooms of the Sheraton Hotel and other buildings have a view to the lawn. This area balances the ratio of solids and voids on that street to some extent.

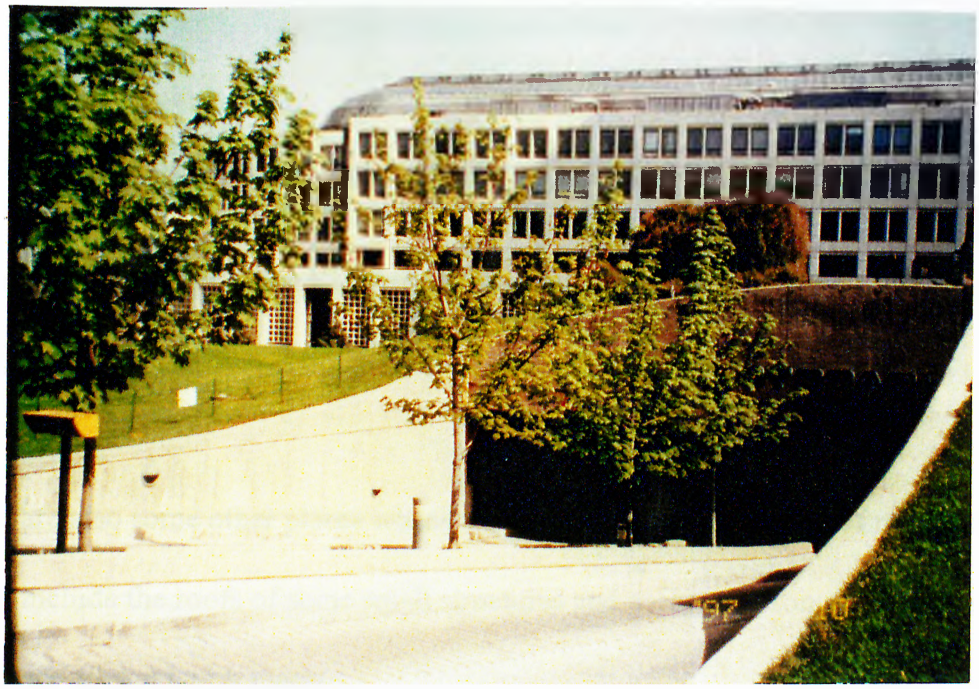


Figure 43. Roof garden on the underground garage of Karum (May, 1997).

4. 3. 4. Beğendik Shopping Mall (Courtyard of Kocatepe Mosque)

The courtyard of Kocatepe Mosque is a roof garden actually, on the Beğendik Shopping Mall. Plants are grown at some parts of the courtyard and in planters within the courtyard. *Berberis thunbergii* 'Atropurpurea', *Hibiscus syriacus, Pinus nigra* are among plants planted on the roof garden (Figure 44).

Figure 44. Courtyard of the Kocatepe Mosque on Beğendik Shopping Mall (July, 1996).

There are also some other places where we can see modest examples of roof gardens. These include the roofs of some small structures and garages of some residences which are covered with plants.

4. 4. An Empirical Study on People's Opinions About Green Spaces in Ankara and Their Tendency Towards Roof Gardening

This empirical study aims to evaluate people's opinions about green spaces and their tendency towards wanting or not wanting roof gardens. People's opinions will be taken into consideration while making suggestions for roof gardening in Ankara, as public participation is thought to be an important aspect of designing and planning human environment.

4. 4. 1. Method of the Study

In this study, data was collected by making survey research in Ankara. The research consisted of 250 subjects from 5 municipalities within the borders of Greater Ankara Municipality. Subjects were selected from the municipalities of Altındağ, Çankaya, Keçiören, Mamak and Yenimahalle. While selecting a representative sample group, proportional sampling was used to form a single composite sample in the same proportion as the total population. Thus, a total of 250 people were interviewed (Table 4).

Table 4. Distribution of subjects according to municipalities.

Municipalities	Population	%	Number of subjects
Altındağ	422.668	17	43
Çankaya	714.330	30	74
Keçiören	536.168	22	55
Mamak	410.359	17	42
Yenimahalle	351.436	14	36
Total	2.434.961	100	250

A questionnaire consisting of 17 close-ended questions were asked so that the respondents were to choose the answer which suited them the best (see Appendix B). The interviewer filled up the questionnaires and it took approximately 5-10 minutes to interview with each respondent. A pilot test had been conducted before the research in order to check the reliability of the questionnaire.

Questions were ordered sequentially by introducing a theme in a question and then asking some other questions related to that theme. Respondents were asked questions about their present situations and the characteristics of the places where they live and work in the first five questions. Questions number 6 and 7 were related to the sufficiency of green spaces in Ankara. These questions were asked to determine citizens' opinions about sufficiency of green spaces in Ankara. Green space visits, the reason and the frequency of green space visits, the walking distance to the nearest green space from residences and working places were asked in questions 8, 9, 10, 11 and 12. Subjects were asked to specify their preferences of green spaces in question 13. Questions from 6 to 13, give us information about respondents' attitudes towards green spaces in Ankara. Questions related to roof gardening are introduced in question 14 by asking whether or not the respondents have ever heard the term "roof garden". Those who indicated that they had not heard that term were told what a roof garden was. Hence, they could answer the following questions by knowing what is meant by that term. Questions 15 and 16 were asked to determine people's tendency towards roof gardening. Question number 17 checks respondents' willingness to support roof gardening financially.

4. 4. 2. Characteristics of the Sample Group and Their Residences and Working Places

The percentages of male and female subjects who participated to the research are 60% and 40% respectively. People between 36 and 45 participated the most according to age groups (Table 5).

Table 5. Distribution of respondents according to age groups.

Age Groups	Number of respondents	%
16 - 25	42	17
26 - 35	53	21
36 - 45	65	26
46 - 55	50	20
56 - 65	31	12
66 +	9	4
Total	250	100

70% of the participants are those who are working, and the percentage of housewives, students, non-working and retired people is 30%. Half of the respondents are from the income group of 25-60 million TL (Table 6).

Table 6. Distribution of respondents according to income groups.

Income Groups	Number of respondents	%
Less than 25 million TL.	64	26
25 - 60 million TL.	127	50
61 - 100 million TL.	40	16
More than 100 million TL.	19	8
Total	250	100

A high percentage of people work and live in/close to the city center. The places where they work and live are surrounded by buildings. Considerably few people work and live at low story buildings. The number of respondents working and living close to green spaces is almost equal to those working and living away from green spaces. Most of the respondents cannot view green spaces from their working places and residences. Although more than half of the respondents responded that they had gardens at their residences, many of them stated that the gardens were considerably small. Therefore, we can say that a high percentage of people live and/or work at places that are congested with buildings and do not have much greenery. The places where most of the people live are a little noisy and not noisy. Most of the people, however, work at places that are a little noisy and considerably noisy. Figure 45 shows the distribution of the characteristics of respondents' working places and figure 46 shows the distribution of the characteristics of respondents' residences.

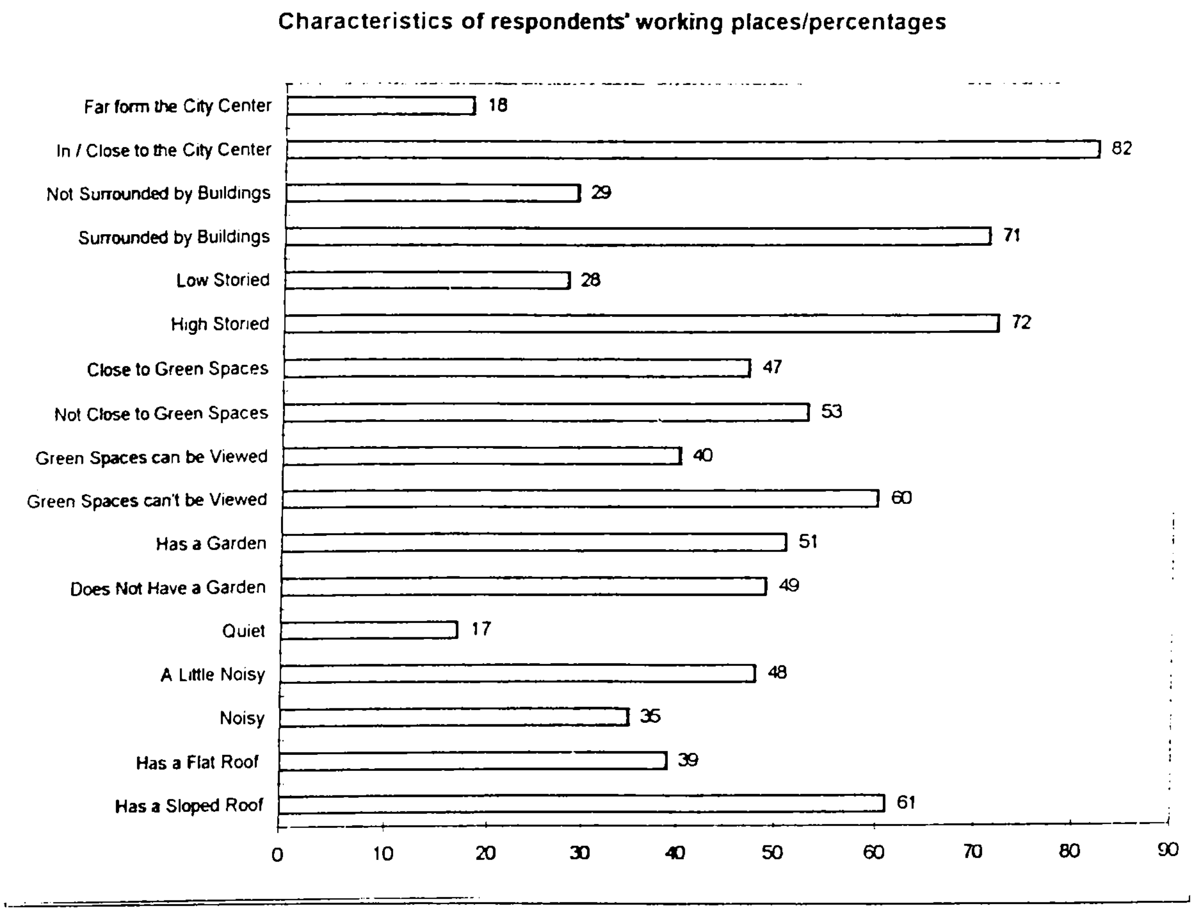


Figure 45. Distribution of the characteristics of respondents' working places.

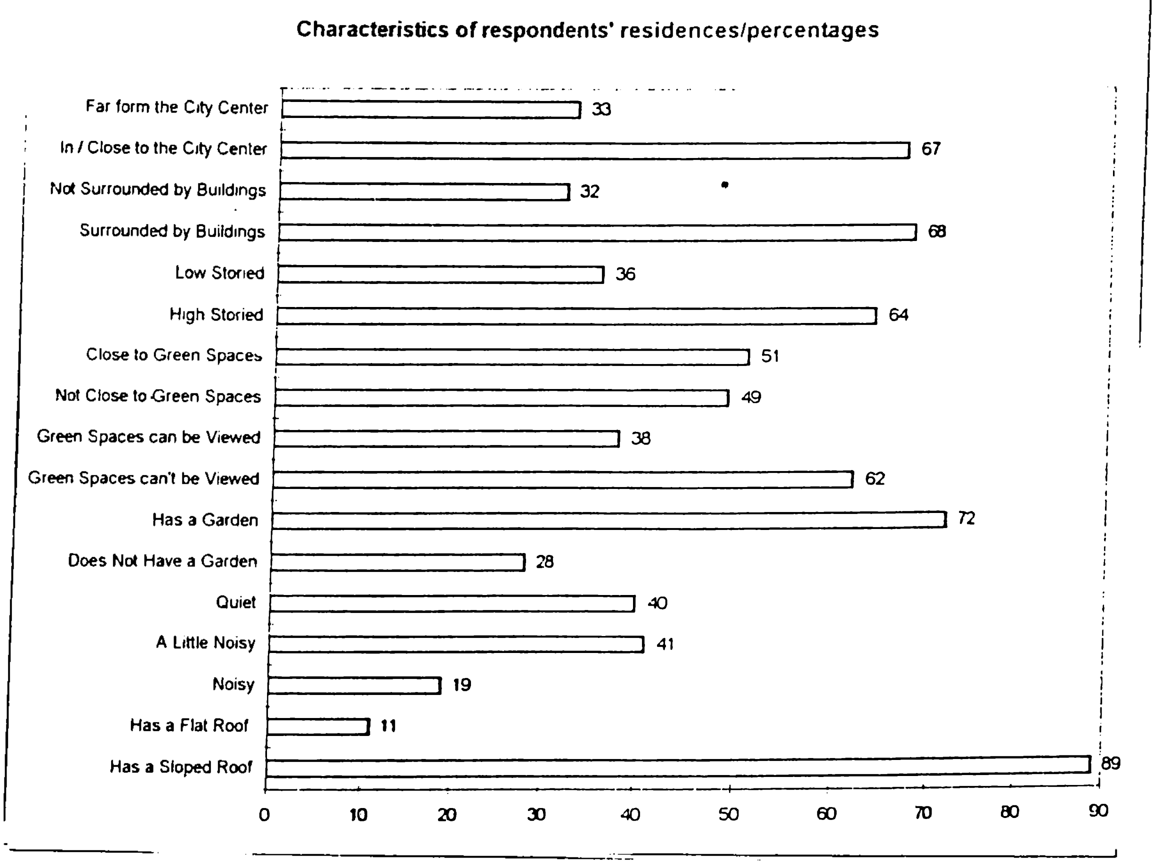


Figure 46. Distribution of the characteristics of respondents' residences.

4. 4. 3. Analysis and Results

According to the results obtained from the research, more than half of the respondents think that green spaces in Ankara are insufficient. In contrast, respondents who think that green spaces are sufficient are considerably few. Respondents' opinions about the sufficiency of the green spaces are listed in Table 7.

Table 7. Distribution of respondents' opinions about sufficiency of green spaces.

Sufficiency of Green Spaces	Number of respondents	%
Sufficient	22	9
Partially sufficient	71	28
Insufficient	137	55
No idea	20	8
Total	250	100

A large number of respondents, who think green spaces are insufficient or partially sufficient, stated that they were few in numbers. Some of them were annoyed because of lack of maintenance (Table 8).

Table 8. Reasons of insufficiency/partially sufficiency of green spaces in Ankara.

Reasons of insufficiency/partially sufficiency of green spaces	Number of respondents	%
Few in number	111	53
Lack of maintenance	39	19
Being distant	17	8
Others	41	20
Total	208	100

76% of the respondents go to green spaces; whereas respondents who do not go to green spaces are considerably few (24%). Many people may prefer going to green spaces, as they might want to be close to nature. Table 9 shows reasons of green space visits and Table 10 shows frequency of green space visits.

Table 9. Reasons of green space visits.

Reasons of green space visits	Number of respondents	%
Resting	80	42
Walking	24	13
Being close to nature	53	28
Others	32	17
Total	189	100

Table 10. Frequency of green space visits.

Frequency of green space visits	Number of respondents	%
Couple of times a week	38	20
Couple of times a month	102	54
Couple of times a year	34	18
Others	15	8
Total	189	100

70% of the respondents have a walking distance of 5-15 minutes from their residences to the nearest green space (Table 11). 52% among the working people are in 5-15 minutes walking distance from their working places to the nearest green space (Table 12). Since they do not have a very long distance to the nearest green space from their residences and working places, many people go to green spaces for resting and relaxing.

Table 11. Distribution of respondents according to walking distances from their residences to the nearest green space.

Walking distances from residences to the nearest green space	Number of respondents	%
Less than 5 minutes	46	24
5 - 15 minutes	70	38
15 - 30 minutes	46	24
More than 30 minutes	27	14
Total	189	100

Table 12. Distribution of respondents according to walking distances from their working places to the nearest green space.

Walking distances from working places to the nearest green space	Number of respondents	%
Less than 5 minutes	47	34
5 - 15 minutes	52	38
15 - 30 minutes	19	14
More than 30 minutes	19	14
Total	137	100

When the participants were asked their preferences of green spaces in terms of distance, cleanliness, activities, and privacy and quietness; many of them responded that they preferred going to green spaces that are maintained well and are clean (Table 13).

Table 13. Respondents' preferences of green spaces.

Preferences	Number of respondents	%
Nearness to residents/working places	62	25
Cleanliness	93	37
Activities	30	12
Privacy and quietness	65	26
Total	250	100

The term 'roof garden' has been heard by 39% of the respondents. The percentage of people who do not know that term is considerably high (61%). When the subjects were asked whether or not they would want roof gardens, 15% responded that they were against roof gardening. They may be against roof gardening as they might think that roof gardens would pose some problems related to waterproofing and insulation. However, 85% stated that they would want roof gardens. This may be because they may want more green spaces. Many people preferred having roof gardens at their residences (62%) (Table 14).

Table 14. People's preferences of roof gardens (first preferences).

People's first preferences of roof gardens	Number of respondents	%
At residences	132	62
At working places	26	13
At public places	55	25
Total	213	100

75% of the home owners, among the ones who wanted roof gardens, stated that they would be willing to support roof gardening financially at their residences.

After gathering data and reporting the results in terms of percentages, 8 hypothesis were defined and some of the questions were cross-tabulated. Chi-square (χ^2) test was used for the cross-tabulation.

H_0: Tendency towards roof gardens is independent of partially sufficiency / insufficiency of green spaces.

H_1: Tendency towards roof gardens is not independent of partially sufficiency / insufficiency of green spaces.

Table 15. χ^2 test for tendency towards roof gardens and partially sufficiency / insufficiency of green spaces.

	Sufficient	Partially sufficient	Insufficient	No idea	Total
Wanting roof gardens	15	62	123	13	213
Not wanting roof gardens	7	9	14	7	37
Total	22	71	137	20	250
χ^2_3=14.058, p=0.002826					

Being in 95% confidence interval, calculated χ^2 is bigger than tabular χ^2 at 0.05 level, which is $\chi^2_{0.05}$=7.81. Thus, H_0 is rejected. That means, tendency towards roof gardens is not independent of partially sufficiency/insufficiency of green spaces.

Second hypothesis is formed to check whether or not green space visits are independent of the characteristics of the places where respondents' residences are located.

H_0: Green space visits are independent of the characteristics of the places where respondents' residences are located.

H_1: Green space visits are not independent of the characteristics of the places where respondents' residences are located.

Table 16. χ^2 test for green space visits and the characteristics of the places where respondents' residences are located.

	Go to green spaces	Do not go to green spaces	Total
Distant from the city center	60	22	82
In/close to the city center	129	39	168
Total	189	61	250
	χ^2_1=0.390378, p=0.532101		
Not surrounded by buildings	63	17	80
Surrounded by buildings	126	44	170
Total	189	61	250
	χ^2_1=0.632836, p=0.426317		
Close to green spaces	101	27	128
Not close to green spaces	88	34	122
Total	189	61	250
	χ^2_1=1.554354, p=0.212494		
Green spaces can be viewed	76	23	99
Green spaces can't be viewed	113	38	151
Total	189	61	250
	χ^2_1=0.121152, p=0.727788		
Has a garden	137	42	179
Does not have a garden	52	19	71
Total	189	61	250
	χ^2_1=0.299546, p=0.584167		

Since the calculated χ^2 values for each case are smaller than the tabular χ^2 value, which is $\chi^2_{0.05}$=3.84, we cannot reject H_0. That is, green space visits are independent of the characteristics of the places where respondents' residences are located.

The third hypothesis, is formed to check whether or not green space visits are independent of the characteristics of respondents' working places.

H_0: Green space visits are independent of the characteristics of the places where respondents are working.

H_1: Green space visits are not independent of the characteristics of the places where respondents are working.

Table 17. χ^2 test for green space visits and the characteristics of the places where respondents are working.

	Go to green spaces	Do not go to green spaces	Total
Distant from the city center	24	8	32
In/close to the city center	113	30	143
Total	137	38	175
	χ^2_1=0.248704, p=0.617989		
Not surrounded by buildings	42	9	51
Surrounded by buildings	95	29	124
Total	137	38	175
	χ^2_1=0.700419, p=0.402643		
Close to green spaces	63	19	82
Not close to green spaces	74	19	93
Total	137	38	175
	χ^2_1=0.192544, p=0.660807		
Green spaces can be viewed	51	18	69
Green spaces can't be viewed	86	20	106
Total	137	38	175
	χ^2_1=1.281288, p=0.25766		
Has a garden	66	22	88
Does not have a garden	71	16	87
Total	137	38	175
	χ^2_1=1.124173, p=0.289022		

Since the calculated χ^2 values for each case are smaller than the tabular χ^2 value, which is $\chi^2_{0.05}$=3.84, we cannot reject H_0. That is, green space visits are independent of the characteristics of the places where respondents are working.

The fourth hypothesis, is formed to check whether or not frequency of green space visits are independent of the characteristics of the places where respondents' residences are located.

H_0: Frequency of green space visits are independent of the characteristics of the places where respondents' residences are located.

H_1: Frequency of green space visits are not independent of the characteristics of the places where respondents' residences are located.

Table 18. χ^2 test for the frequency of green space visits and the characteristics of the places where respondents' residences are located.

	Couple of times a week	Couple of times a month	Couple of times a year	Others	Total
Distant from the city center	9	38	10	3	60
In/close to the city center	28	65	24	12	129
Total	37	103	34	15	189
	χ^2_3=3.240564, p=0.356001				
Close to green spaces	23	38	11	3	62
Not close to green spaces	14	65	23	12	127
Total	37	103	34	15	189
	χ^2_3=3.69245, p=0.296646				
Green spaces can be viewed	20	34	17	5	76
Green spaces can't be viewed	17	69	17	10	113
Total	37	103	34	15	189
	χ^2_3=6.821154, p=0.077822				
Has a garden	29	71	27	10	137
Does not have a garden	8	32	7	5	52
Total	37	103	34	15	189
	χ^2_3=2.368912, p=0.499448				

Since the calculated χ^2 values for each case are smaller than the tabular χ^2 value, which is $\chi^2_{0.05}$=7.81, we cannot reject H_0. Therefore, frequency of green space visits are independent of the characteristics of the places where respondents' residences are located.

The fifth hypothesis, is formed to check whether or not frequency of green space visits are independent of the characteristics of the places where respondents are working.

H_0: Frequency of green space visits are independent of the characteristics of the places where respondents are working.

H_1: Frequency of green space visits are not independent of the characteristics of the places where respondents are working.

Table 19. χ^2 test for the frequency of green space visits and the characteristics of the places where respondents are working.

	Couple of times a week	Couple of times a month	Couple of times a year	Others	Total
Distant from the city center	6	14	2	2	24
In/close to the city center	16	70	18	9	113
Total	22	84	20	11	137
	χ^2_3=2.276597, p=0.517019				
Close to green spaces	10	40	9	5	64
Not close to green spaces	12	44	11	6	73
Total	22	84	20	11	137
	χ^2_3=0.072276, p=0.994943				
Green spaces can be viewed	10	31	6	5	52
Green spaces can't be viewed	12	53	14	6	85
Total	22	84	20	11	137
	χ^2_3=1.364924, p=0.713777				
Has a garden	13	41	9	4	67
Does not have a garden	9	43	11	7	70
Total	22	84	20	11	137
	χ^2_3=1.728211, p=0.63068				

Since the calculated χ^2 values for each case are smaller than the tabular χ^2 value, which is $\chi^2_{0.05}$=7.81, we cannot reject H_0. That means, frequency of green space visits are independent of the characteristics of the places where respondents are working.

The sixth hypothesis, is formed to check whether or not preferences for roof gardens are independent of the characteristics of the places where respondents' residences are located.

H_0: First preferences for roof gardens are independent of the characteristics of the places where respondents' residences are located.

H_1: First preferences for roof gardens are not independent of the characteristics of the places where respondents' residences are located.

Table 20. χ^2 test for the first preferences for roof gardens and the characteristics of the places where respondents' residences are located.

	At residences	At working places	At public places	Total
Distant from the city center	44	10	42	96
In/close to the city center	88	16	13	117
Total	132	26	55	213
	χ^2_2=29.51622, p=3.81E-07			
Not surrounded by buildings	39	11	17	67
Surrounded by buildings	94	16	36	146
Total	133	27	53	213
	χ^2_2=1.369534, p=0.504208			
Low story	45	9	19	73
High story	87	17	36	140
Total	132	26	55	213
	χ^2_2=0.005109, p=0.997449			
Close to green spaces	65	12	30	107
Not close to green spaces	67	14	25	106
Total	132	26	55	213
	χ^2_2=0.634013, p=0.728326			
Green spaces can be viewed	43	11	26	80
Green spaces can't be viewed	89	15	29	133
Total	132	26	55	213
	χ^2_2= 3.860539, p=0.145109			
Has a garden	95	17	41	153
Does not have a garden	37	9	14	60
Total	132	26	55	213
	χ^2_2= 0.735515, p=0.692285			

Being in 95% confidence interval, the calculated χ^2 value for the first case is bigger than the tabular χ^2 value, which is $\chi^2_{0.05}$=5.99. Therefore, H_0 is rejected. That means, first preferences for roof gardens are not independent of the distance of the residences from the city center. However, in the other cases, calculated χ^2 values are smaller than the tabular χ^2 value, $\chi^2_{0.05}$=5.99. Hence, we cannot reject H_0. Although first preferences for roof gardens are not independent of the distances of the residences from the city center, they are independent of the surrounding buildings, being low or high story buildings, being close/not close to green spaces, views, and having/not having gardens.

The seventh hypothesis, is formed to check whether or not preferences for roof gardens are independent of the characteristics of the places where respondents are working.

H_0: First preferences for roof gardens are independent of the characteristics of the places where respondents are working.

H_1: First preferences for roof gardens are not independent of the characteristics of the places where respondents are working.

Table 21. χ^2 test for the first prefernces for roof gardens and the characteristics of the places where respondents are working.

	At residences	At working places	At public places	Total
Distant from the city center	16	3	6	25
In/close to the city center	78	23	23	124
Total	94	26	29	149
	χ^2_2=0.832943, p=0.659369			
Not surrounded by buildings	26	7	9	42
Surrounded by buildings	68	19	20	107
Total	94	26	29	149
	χ^2_2=0.149598, p=0.92793			
Low story	23	8	13	44
High story	71	18	16	105
Total	94	26	29	149
	χ^2_2=4.437772, p=0.10873			
Close to green spaces	43	16	15	74
Not close to green spaces	51	10	14	75
Total	94	26	29	149
	χ^2_2=2.093333, p=0.351106			
Green spaces can be viewed	31	14	16	61
Green spaces can't be viewed	63	12	13	88
Total	94	26	29	149
	χ^2_2=6.684699, p=0.035354			
Has a garden	42	18	18	78
Does not have a garden	52	8	11	71
Total	94	26	29	149
	χ^2_2=6.284662, p=0.043182			

Since the calculated χ^2 values for the first four cases are smaller than the tabular χ^2 value, which is $\chi^2_{0.05}=5.99$, H_0 cannot be rejected. That means, first preferences for roof gardens are independent of the distance of the working places from the city center, the surrounding buildings, being low or high story buildings, and being close/not close to green spaces. However, in the last two cases, calculated χ^2 values are bigger than the tabular χ^2 value, which is $\chi^2_{0.05}=5.99$, being in 95% confidence interval. Therefore H_0 is rejected. That is, first preferences for roof gardens are not independent of views and having/not having gardens at working places.

The last hypothesis, is formed to check whether or not willingness to support roof gardens financially is independent of the income levels of the respondents.

H_0: Willingness to support roof gardens financially is independent of the income levels of the respondents.

H_1: Willingness to support roof gardens financially is not independent of the income levels of the respondents.

Table 22. χ^2 test for respondents' willingness to support roof gardens financially and income levels of the respondents.

	willing to support roof gardens financially	not willing to support roof gardens financially	Total
<25 million TL.	35	10	45
25 - 60 million TL.	67	25	92
61 - 100 million TL.	25	10	35
>100 million TL.	14	3	17
Total	141	48	189
	χ^2_3=1.117754, p=0.77279		

As the calculated χ^2 value is smaller than the tabular χ^2 value, $\chi^2_{0.05}$=7.81, we cannot reject H_0. That is, willingness to support roof gardens financially is independent of income levels of the respondents.

4. 4. 4. Discussion and Sugesstions for Roof Gardening in Ankara

According to the results obtained from the research, 55% of the respondents think that green spaces are insufficient, and 28% think that they are partially sufficient. (Table 7). 53% among them state that green spaces are few in number (Table 8). 89% of the respondents, who think that green spaces in Ankara are partially sufficient or insufficient, want roof gardens. 11% of the participants do not want roof gardens although they think that green spaces in Ankara are partially sufficient or insufficient. On the other hand, the percentage of respondents who are satisfied with the sufficiency of green spaces is 9% (Table 7). In spite of being satisfied with the sufficiency of green spaces, 68% of them want roof gardens as they might think the more the green spaces, the better the environment. From the results of the research, we understand that most of the respondents want roof gardens (85%). Since tendency towards roof gardens is not independent of the sufficiency of green spaces (Table 15), people may want roof gardens as they might think that roof gardens will contribute to the green spaces within the city. As people are not happy with the sufficiency of green spaces and most of them complain about lack of green spaces in number, roof gardening may be a way of augmenting green spaces in Ankara.

76% of the respondents go to green spaces. Visiting green spaces are independent of the characteristics of the places where respondents' residences are located and where they are working (Tables 16-17). Also, frequency of green space visits is independent of the characteristics of the places where respondents' residences are located and where they are working (Tables 18-19). More than half of the respondents go to green spaces a couple of times a month (Table 10), mostly for resting (Table 9). This may be because, they may enjoy relaxing and resting at places that are naturalistic and/or alike naturalistic.

62% of the respondents among those who are for roof gardening (213 out of 250) want roof gardens at their residences (Table 14). When the first preferences of the respondents are concerned, we can see that most of them are those who live in/close to the city center (117 out of 213). 75% (88 out of 117; see Table 20) among those living in/close to the city center prefer having roof gardens at their residences.

However, when we have a look at the first preferences of respondents living distant from the city center, we can see that the percentage decreases to 46% (44 out of 96; see Table 20). Therefore we can infer that, people living in the city center want roof gardens more than those living far from the city center as the city center is congested and there are few number of green spaces within the city center.

85% of the respondents among those who are working (149 out of 175), are for roof gardening. 72% of the respondents who cannot view green spaces from their working places (63 out of 88; see Table 21), prefer having roof gardens at their residences. Also, 51% of the respondents who can view green spaces from their working places (31 out of 61; see Table 21), prefer having roof gardens at their residences. Similar to the previous case, more than half of the respondents who are working at places where there are not gardens, want roof gardens at their residences (52 out of 71; see Table 21). 54% of the respondents (42 out of 78; see Table 21), working at places where there are gardens, also want roof gardens at their residences. It is understood that people want roof gardens at their residences mostly. This may be because, they might prefer relaxing at their homes after spending time at their working places.

Respondents' willingness to support roof gardens financially is independent of their income levels (Table 22). 75% of the home owners (141 out of 189), who want roof gardens, are willing to support roof gardening at their residences. This is quite considerable. If roof gardening is encouraged and people are informed about roof gardening, a high number of people may support it.

Roof gardening can be encouraged at some cluster type residences and also at some other buildings since a high number of respondents' first preferences were to have roof gardens at their residences (Table 14). Existing flat roofs of some residences can be designed as roof gardens after taking precautions against loading, providing waterproofing and good drainage. Loads can be reduced to some extent by use of styrofoam slabs and lightweight planters. Waterproofing can be provided by placing waterproofing membranes which are very common today. Problems with drainage can be solved by improving the slope of the roof and using appropriate drainage materials. Architects can be encouraged to design ziggurat like buildings, so that people can enjoy terraces of their residences which could be extensions of their flats.

Since roof gardening had not been heard by a high number of people (61% of the respondents), roof gardening should be promoted. This could be achieved by constructing a public roof garden complex within the city, so that many of the citizens will come across with that concept and enjoy the roof garden.

Constructing roof gardens at working places will probably improve interaction between people, and provide nearby spaces for recreation during lunch hours.

In order to improve urban green system of Ankara, planners and designers should offer various sorts of green spaces in a well-distributed pattern. In this regard, roof gardening can contribute to the urban green system of the city. In this sense, at places where there are lots of buildings and the building structures permit, green spaces can be created on the tops of buildings by constructing roof gardens. Underground structures, such as underground garages could be built within the city, and roofs of those structures could be utilized as passive and/or active green spaces. Thus, the amount of urban green space per person in Ankara could be augmented to some extent.

5. CONCLUSION

As planners and designers, our role as shapers of the habitat require ecological and social responsibility. Microclimatic optimization, effectual and efficient realizations and satisfactions of human well-being should be concerned in every project and site. Ecological architecture could be one of the criteria giving ways to designs of both residential and public spaces.

Roof gardening is a way of making cities greener. There are many square meters of roofs which are generally unused. If these roofs were designed as gardens, more green spaces would be created in cities. Although roof gardens cannot provide all the functions that conventional green spaces do, their contributions to cities should not be overlooked. Adverse effects of urbanization could be reduced to some extent by creating more green spaces within cities. Roof gardens contribute to the ecology, aesthetics and recreational areas of cities. A roof garden improves the microclimate of that particular area where it is constructed. On the other hand, proper distribution of roof gardens throughout a city improves the macroclimate of that city. By roof gardening, we can give two functions to a certain place and create man-made environments in a naturalistic sense. Terraces at residences could be utilized as roof gardens where people can relax and enjoy hobby gardening. Hence, architects should be encouraged to design buildings where nature could be recognized to some extent.

Common spaces could be created for the use of employees of public and private enterprises, so that the employees can interact with each other in naturalistic spaces. Constructing roof gardens at public places, such as shopping malls, cinemas, garages, bus and train stations, airports, museums, will contribute to urban green space systems of cities being passive and/or active green spaces.

Creating a roof garden requires collaboration of planners and designers. Architects, landscape architects, urban planners, structural engineers, services engineers should work hand in hand in order to create roof gardens. By this way, beautiful gardens can be enjoyed on roofs by careful integration of organic requirements of living plants and engineering requirements of structures. Architects should be encouraged to design buildings inviting roof gardens, so that those structures can be used for hobby gardening and some other recreational facilities. These places can also be utilized as public places. Landscape architects and urban planners should work to improve urban green systems in cities by creating green spaces both at ground level and above ground level. They can offer roof gardens as a contribution to urban green space system of cities. Civil engineers and services engineers should develop new techniques that are more appropriate for gardening on rooftops.

Roof gardening could be studied further by focusing on its economical aspects. For instance, impacts of roof gardens on economics of cities, and impacts of cost of land on roof gardening could be studied further. Also, the questionnaire of this study could be improved by asking some of the questions more specifically. The subjects could be asked questions about the type of activities and spaces they would prefer at roof gardens, so that some design criteria could be suggested in the form of a checklist in relation to activities, and spaces, being introvert or extrovert. Another further research may focus on construction of a roof garden within the city and observation of the suitability of plants by considering loads, waterproofing, drainage, irrigation requirements, soil depth, and climatic factors. Hence, possible ways of roof gardening might be suggested for old and new buildings by making observations and carrying out experiments.

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APPENDICES

APPENDIX A

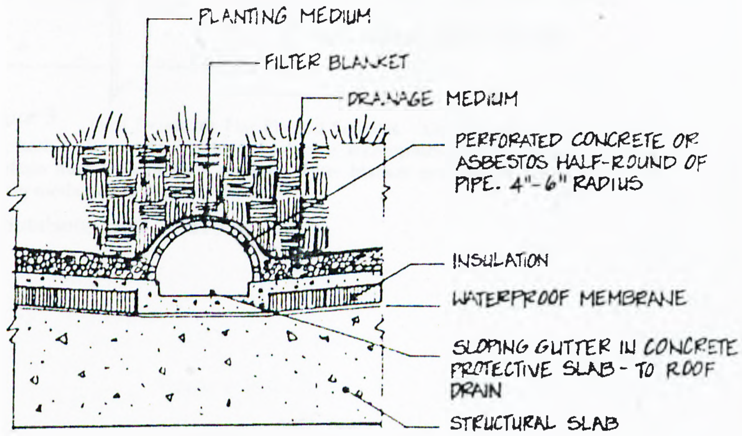

Figure 1 Half-Round Drainage Channel under Planting. A sloping drainage channel formed in the concrete protective slab is covered with half-round perforated pipe in 2- to 3-ft (0.6 to 0.9m) lengths and a filter blanket.

(Osmundson, 1988, p. 610-3)

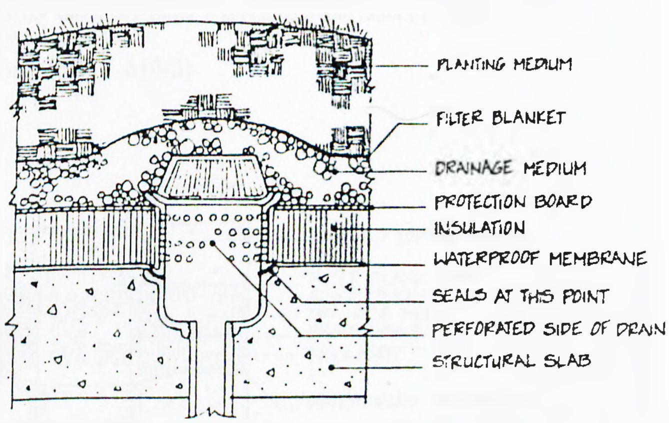

Figure 2 Roof Drain under Planting Area. Insulation layer placed directly on waterproof membrane with perforated protection board to prevent damage to insulation. Water reaching the insulation is carried off through the roof drain.

(Osmundson, 1988, p. 610-3)

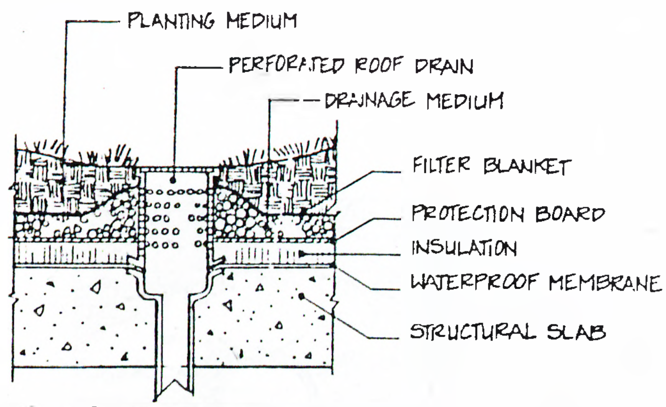

Figure 3 Roof Drains for Flat Planted Surfaces. On flat planted surfaces, both surface and subsurface drainage is accomplished with perforated roof drain flush with planting medium. Filter blanket prevents seepage of planting medium into the draining layer.

(Osmundson, 1988, p. 610-3)

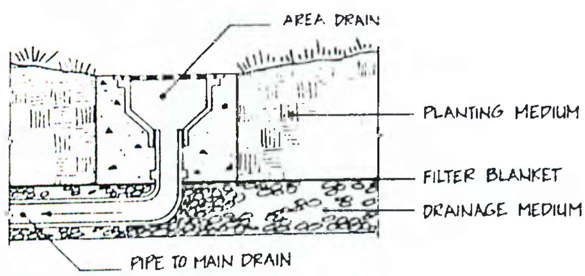

Figure 4 Drains for Low Areas. When low places occur on the surface not near a major subsurface drain, a lateral pipe and drain can carry water quickly to the main drain.

(Osmundson, 1988, p. 610-3)

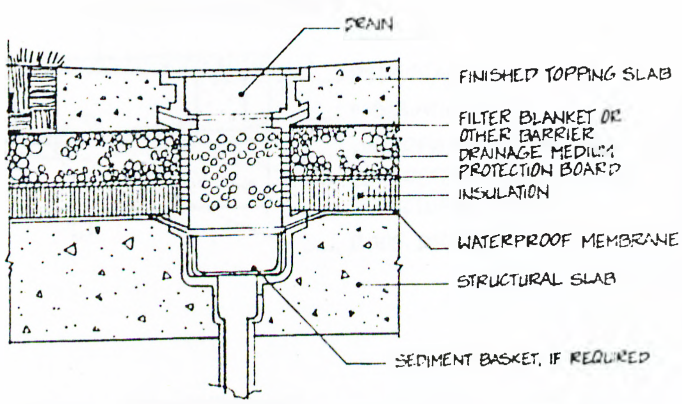

Figure 5 Drains for Paved Areas near Planting Beds. For drains in paving near an area of planting medium, topping slab is installed directly on the drainage medium after filter blanket is first placed to prevent loss of wet concrete into the drainage medium.

(Osmundson, 1988, p. 610-3)

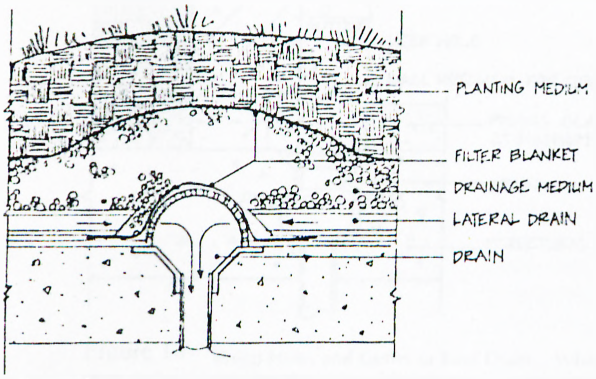

Figure 6 Main Roof Drain under Planting. Main roof drain can be located under a thickened section of the drainage medium, which is protected by a filter blanket. A second filter blanket over the drain strainer and the ends of the lateral drain pipes prevents plugging of drain openings by planting medium.

(Osmundson, 1988, p. 610-3)

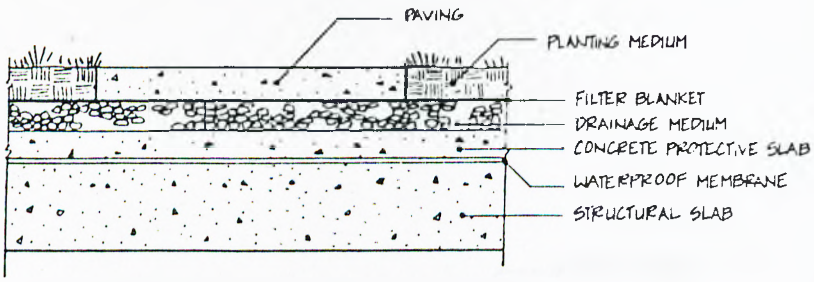

Figure 7 Subsurface Drainage under Paving. Paved area is placed directly on surface of the drainage medium to allow a continuous subsurface drainage layer sloped toward the roof drains. Filter blanket prevents wet concrete from penetrating drainage material. Drainpipe under the paving at intervals improves drainage.

(Osmundson, 1988, p. 610-4)

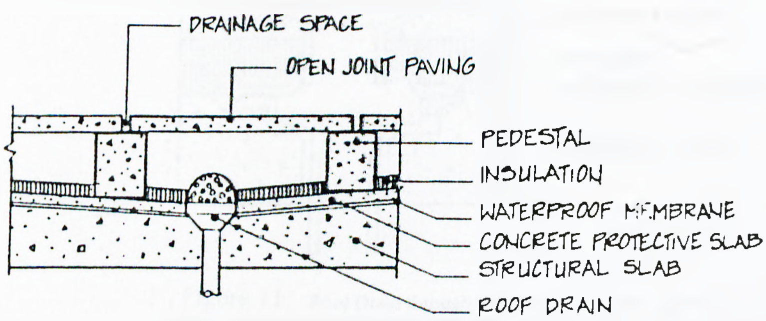

Figure 8 Subsurface Drainage for Paving on Pedestals. Pedestal-mounted, removable, open-joint paving provides positive drainage, adjustable heights, and easy access to the roof surface for cleaning or repair. Insulation is fitted between the pedestals.

(Osmundson, 1988, p. 610-4)

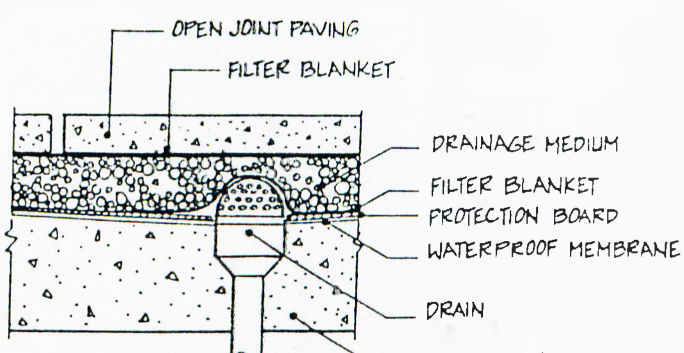

Figure 9 Subsurface Drainage under Paving on Grade. In open-joint paving without pedestals, where no insulation is needed, filter blanket is held to the protection board by mastic or hot tar at its outer edges to prevent seepage of silt into the drain, and the gravel drainage layer is compacted with a 400-lb (180-kg) roller.

(Osmundson, 1988, p. 610-4)

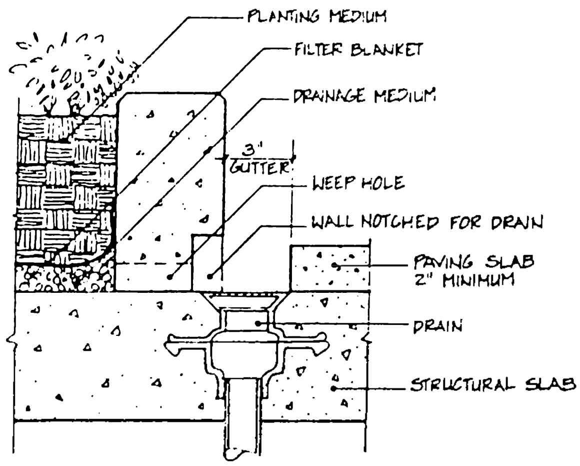

Figure 10 · Weep Holes and Gutter to Roof Drain. Where a waterproof roof is not necessary, paving slab is poured directly onto the structural slab. Planting medium behind wall is drained through weep holes to an open gutter.

(Osmundson, 1988, p. 610-5)

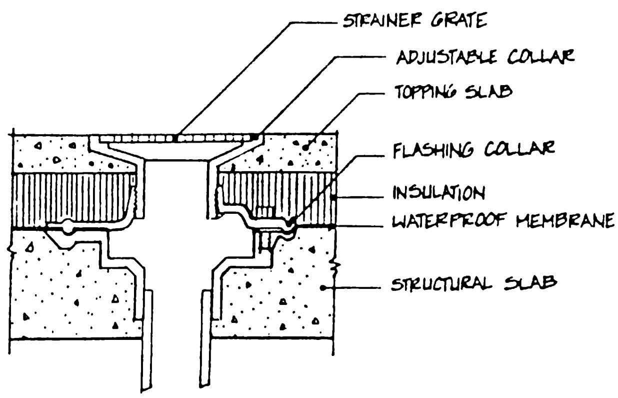

Figure 11 Roof Drain through Topping Slab. Basic method used to drain a roof which has a topping slab protecting the waterproof membrane. Insulation is optional. Common when roof plantings are held in pots or tubs only, or when the deck includes no plantings at all.

(Osmundson, 1988, p. 610-5)

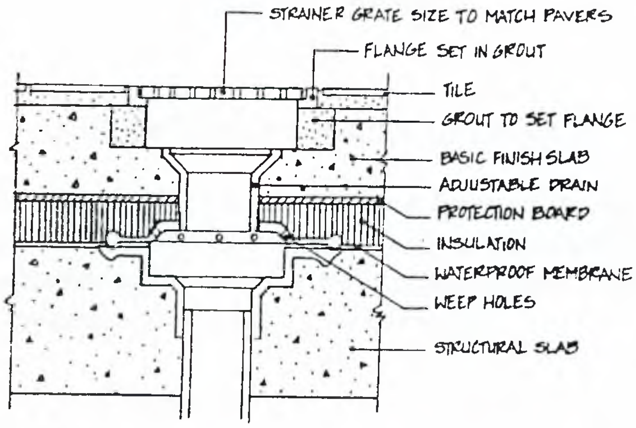

Figure 12 Square Surface Drain. A typical round drain is installed with its grating below the top of the basic finish slab, to allow installation of a square grill on a square-patterned surface. The finish slab is formed with an indentation for the grout.

(Osmundson, 1988, p. 610-5)

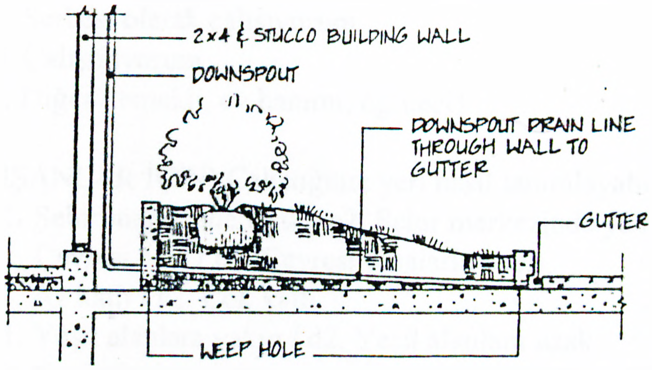

Figure 13 Drainage through Raised Planting Bed. Raised planting areas can be separated from a porous building wall to protect it from soil dampness. Allow clearance for repairs. Downspouts are brought through the planting bed to a walkway gutter. The back space is drained by weep holes through the drainage medium to the front gutter and/or by slope to either end of the back space.

(Osmundson, 1988, p. 610-5)

APPENDIX B

QUESTIONNAIRE FORM (ORIGINAL)

Bu anket, Bilkent Üniversitesi İç Mimari ve Çevre Tasarımı Bölümü'nde yürütülmekte olan bir araştırmaya ışık tutmak amacıyla hazırlanmıştır. Anket formunu cevaplandırırken adınız ve soyadınız sorulmayacaktır. Anket formu gizli tutulacaktır. Yardımlarınız için şimdiden teşekkür ederiz.

Anket No: Cinsiyet: E K Tarih: Yer:

1. Yaşınızın aşağıdaki gruplardan hangisine dahil olduğunu öğrenebilir miyiz?
   a. 16 - 25
   b. 26 - 35
   c. 36 - 45
   d. 46 - 55
   e. 56 - 65
   f. 66 ve üstü

2. Lütfen size en uygun seçeneği belirtiniz.
   a. Bir kamu kuruluşunda çalışıyorum.
   b. Özel bir kuruluşta çalışıyorum.
   c. Serbest olarak çalışıyorum.
   d. Çalışmıyorum.
   e. Diğer (emekli, ev hanımı, öğrenci)

3. (ÇALIŞANLAR İÇİN) Çalıştığınız yeri nasıl tanımlayabilirsiniz?
   a1. Şehir merkezine uzak / a2. Şehir merkezinde ya da şehir merkezine yakın
   b1. Çevresi açık / b2. Çevresi binalarla kaplı
   c1. Az katlı / c2. Çok katlı
   d1. Yeşil alanlara yakın / d2. Yeşil alanlara uzak
   e1. Yeşil alanlara bakıyor / e2. Yeşil alanlara bakmıyor
   f1. Bahçesi var / f2. Bahçesi yok
   g1. Sakin / g2. Az gürültülü / g3. Gürültülü
   h1. Çatısı düz (teras var) / h2. Çatısı eğimli (kiremitli)
   i. Diğer

4. Oturduğunuz yeri nasıl tanımlayabilirsiniz?
   a1. Şehir merkezine uzak / a2. Şehir merkezinde ya da şehir merkezine yakın
   b1. Çevresi açık / b2. Çevresi binalarla kaplı
   c1. Az katlı / c2. Çok katlı
   d1. Yeşil alanlara yakın / d2. Yeşil alanlara uzak
   e1. Yeşil alanlara bakıyor / e2. Yeşil alanlara bakmıyor
   f1. Bahçesi var / f2. Bahçesi yok
   g1. Sakin / g2. Az gürültülü / g3. Gürültülü
   h1. Çatısı düz (teras var) / h2. Çatısı eğimli (kiremitli)
   i. Diğer

5. Aylık geliriniz aşağıdaki gruplardan hangisine girmektedir?
   a. 25 milyon TL.den az
   b. 25 - 60 milyon TL.
   c. 61- 100 milyon TL.
   d. 100 milyon TL.den fazla

6. Ankara'daki yeşil alanları yeterli buluyor musunuz?
   a. Evet
   b. Kısmen
   c. Hayır
   d. Fikrim yok

7. (KISMEN YA DA HAYIR DİYENLER İÇİN) Ankara'daki yeşil alanları hangi bakımlardan yetersiz buluyorsunuz?
   a. Sayı olarak az
   b. Bakım yetersiz
   c. Mesafe uzak
   d. Diğer (lütfen belirtiniz)

8. Yeşil alanlara gider misiniz?
   a. Evet
   b. Hayır (HAYIR DİYENLER 13. SORUDAN DEVAM EDECEKLER)

9. Yeşil alanlara niçin gidersiniz?
   a. Dinlenmek için
   b. Yürüyüş yapmak için
   c. Doğayla başbaşa kalmak için
   d. Diğer (lütfen belirtiniz)

10. Yeşil alanlara ne kadar sıklıkta gidersiniz?
   a. Haftada birkaç kere
   b. Ayda birkaç kere
   c. Yılda birkaç kere
   d. Diğer (lütfen belirtiniz)

11. Oturduğunuz yere en yakın yeşil alana ulaşmak, yürüyerek ne kadar zamanınızı alıyor?

a. 5 dakikadan az
b. 5 - 15 dakika
c. 15 - 30 dakika
d. 30 dakikadan fazla

12. (ÇALIŞANLAR İÇİN) Çalıştığınız yere en yakın yeşil alana ulaşmak, yürüyerek ne kadar zamanınızı alıyor?

a. 5 dakikadan az
b. 5 - 15 dakika
c. 15 - 30 dakika
d. 30 dakikadan fazla

13. Lütfen aşağıdakilerden size en uygun olan seçeneği işaretleyiniz.

a. Evime / işyerime yakın yeşil alanlara gitmeyi tercih ederim.
b. Bakımlı, temiz alanlara giderim.
c. Çeşitli etkinlik olanağı olanlara giderim.
d. Sakin, kullanıcı sayısı az olan yeşil alanlara giderim.

14. Çatı bahçesi terimini daha önce hiç duydunuz mu?

a. Evet
b. Hayır (HAYIR DİYENLER İÇİN AÇIKLAMA YAPILACAKTIR)

Binaların ya da yeraltı otoparklarının üstündeki bitkilendirmeye çatı bahçesi denir.

15. Oturduğunuz ve/veya çalıştığınız yerde, ya da kamuya açık alanlarda çatı bahçesi bulunmasını ister miydiniz?

a. Evet
b. Hayır

16. (EVET DİYENLER İÇİN) Lütfen aşağıdaki seçenekleri öncelik sırasına göre sıralayınız.

( ) a. Oturduğum yerde çatı bahçesi olmasını isterim.
( ) b. Çalıştığım yerde çatı bahçesi olmasını isterim.
( ) c. Kent içinde; örneğin, alışveris merkezi, sinema gibi herkesin gidebileceği yerlerde çatı bahçesi olmasını isterim.

17. Oturduğunuz binada eğer kat maliki iseniz, bir çatı bahçesi oluşturulması gündeme gelse, buna parasal katkıda bulunmak ister misiniz?

a. Evet
b. Hayır

BİZE ZAMAN AYIRDIĞINIZ İÇİN TEŞEKKÜR EDERİZ!

QUESTIONNAIRE FORM (ENGLISH VERSION)

This questionnaire has been prepared to conduct research at Bilkent University, Department of Interior Architecture and Environmental Design. Your name will not be asked while you are answering the questions. The questionnaire form will be kept confidential. Thank you for your participation.

Questionnaire no: Gender: M F Date: Place:

1. May I learn which age group you are in?
   a. 16 - 25
   b. 26 - 35
   c. 36 - 45
   d. 46 - 55
   e. 56 - 65
   f. 66 +

2. Please identify the choice that suits you.
   a. I am employed by a public enterprise.
   b. I am employed by a private enterprise.
   c. I work privately.
   d. I am not working.
   e. Other (retired, housewife, student)

3. (FOR THOSE WHO ARE WORKING) How can you characterize the place where you are working?
   a1. Distant from the city center / a2. In / close to the city center
   b1. Not surrounded by buildings / b2. Surrounded by buildings
   c1. Low story / c2. High story
   d1. Close to green spaces / d2. Distant from green spaces
   e1. Green spaces can be viewed / e2. Green spaces cannot be viewed
   f1. Has a garden / f2. Does not have a garden
   g1. Not noisy / g2. Little noisy / g3. Noisy
   h1. Has a flat roof (terrace) / h2. Has a sloping roof (tiled roof)
   I. Others (Please specify)

4. How can you characterize the place where you are living?
   a1. Distant from the city center / a2. In / close to the city center
   b1. Not surrounded by buildings / b2. Surrounded by buildings
   c1. Low story / c2. High story
   d1. Close to green spaces / d2. Distant from green spaces
   e1. Green spaces can be viewed / e2. Green spaces cannot be viewed
   f1. Has a garden / f2. Does not have a garden
   g1. Not noisy / g2. Little noisy / g3. Noisy
   h1. Has a flat roof (terrace) / h2. Has a sloping roof (tiled roof)
   I. Others (Please specify)

5. Which of the following groups does your monthly income fall into?
   a. Less than 25 million TL.
   b. 25 - 60 million TL.
   c. 61 - 100 million TL.
   d. More than 100 million TL.

6. Do you think the green spaces in Ankara are sufficient?
   a. Yes, they are sufficient.
   b. They are partially sufficient.
   c. They are insufficient.
   d. I do not have an idea.

7. (FOR THOSE WHO ANSWERED THE PREVIOUS QUESTION AS PARTIALLY SUFFICIENT OR INSUFFICIENT) Why do you think the green spaces in Ankara are partially sufficient or insufficient?
   a. They are few in number.
   b. There is lack of maintenance.
   c. They are too distant.
   d. Others (please specify)

8. Do you go to green spaces?
   a. Yes
   b. No (THOSE WHO DO NOT GO TO GREEN SPACES PLEASE SKIP TO QUESTION 13)

9. Why do you go to green spaces?
   a. In order to rest
   b. In order to walk
   c. In order to be close to nature
   d. Others (Please specify)

10. How often do you go to green spaces?
   a. A couple of times a week
   b. A couple of times a month
   c. A couple of times a year
   d. Others (Please specify)

11. How long does it take you to go to the nearest green space from your residence?
a. Less than 5 minutes
b. 5 - 15 minutes
c. 15 - 30 minutes
d. More than 30 minutes

12. (FOR THOSE WHO ARE WORKING) How long does it take you to go to the nearest green space from your working place?
a. Less than 5 minutes
b. 5 - 15 minutes
c. 15 - 30 minutes
d. More than 30 minutes

13. Please identify the choice that suits you the best.
a. I prefer going to green spaces that are close to my home / working place.
b. I prefer going to green spaces that are maintained well and clean.
c. I prefer going to green spaces that offer various activities.
d. I prefer going to green spaces that have a few number of visitors.

14. Have you ever heard the term roof garden?
a. Yes
b. No (ROOF GARDEN WILL BE DEFINED FOR THOSE WHO DO NOT KNOW THIS TERM)

Gardens on tops of buildings or underground garages are called roof gardens.

15. Would you like to have a roof garden at your residence and/or working place, and at other public places?
a. Yes
b. No

16. (FOR THOSE WHO SAY YES) Please designate the choices according to your preferences.
( ) a. I would prefer having a roof garden at my residence.
( ) b. I would prefer having a roof garden at my working place.
( ) c. I would prefer having roof gardens at public places; such as shopping malls, cinemas.

17. Would you like to support the construction of a roof garden financially at your residence if you are the home owner?
a. Yes
b. No

THANK YOU FOR YOUR PARTICIPATION!