Green Roof and Strategic Performance

Reza Mirzaei

Department of Architecture, Birjand Branch, Islamic Azad University, Birjand, Iran

Abstract: In developed countries, Sustainable Systems are one of the policy priorities which helps to solve various problems of cultural, social, environmental, etc. This goal, the achievement of sustainable development “environmental sustainability” is a very important topic in architecture. One of the most important things, which is neglected today, is the human need for nature. The Goal of Architects and urban planners is to dedicate most of the City areas to the significant parks and green spaces. For achieving this goal, idea of Green roof is introduced in 1970 after the first oil crisis. Green Roof used unused roof space to create Green Spaces. This idea was not only try to create a sustainable architecture, but also in terms of aesthetics is a tool in the hands of architects and designers. In this paper, we attempt to get more familiar with this idea and their implementation practices.

Key words: Green Building, Green roof, Sustainable architecture, Modular, Strategic Performance.

INTRODUCTION

Case studies and theoretical considerations showed multiple links between green buildings and overall organizational success; yet this connection is still in the formative stages. For identifying performance impacts, architecture should consider what constitutes high performance at the organizational level. For Different perspective, the concept of Success has a different meaning; Although it seems that there is a considerable agreement about the domains across which success is measured. Based on Sink view, this agreement includes factors such as: Product quality, Customer satisfaction, Capacity for innovation, Quality of work life (Employees' attitudes and job satisfaction), Employee retention, Perceived value of goods and services, Operational efficiency, And Social responsibility. The effects of Green Roof on the physical and biological environment, and also the costs of materials and installation, and any financial incentives for green roof implementation are considered in this study. Green roof can regulate the temperature in and around buildings, improve energy efficiency in buildings, reduce the urban heat island effect, retain storm water, and increase the lifespan of a roof. Furthermore, providing therapy to humans, providing space for agricultural use, improving public perception of a company or institution, improving the aesthetic environment, increasing property value, reducing noise inside a building, and providing habitat for airborne species are other benefits of Green Roof. Any man made buildings which covered with plants are considered as a Green Roof. This idea is very popular in Europe and North America. Because the Green Roof can reduce heat island effects and insulate buildings, thus decreasing heating and cooling costs. Also, They are pleasing and beautiful and they can improve air quality and manage storm water. Rating systems are developed to award companies for abiding to certain environmental guidelines, which is an additional incentive for the use of structures like green roofs. Design of Green Roof starts with a complete vision of the green roof and the building. Then, a series of questions will ask, which helps to define the various aspects of projects. Questions such as: what is the purpose of this green roof? Why build a green roof on this particular project? Will people gather on this roof to enjoy and interact with nature? If the answer is yes, are there any specific structural requirements which must be met to support this type of usage. If people are enjoying the green roof, they will need a safe and convenient means of getting up there, and also Life safety requirements may mandate the construction of railings and roof edge setbacks that ensure the safety of those using this space. Direct access doors from sections of the building serviced by elevators will allow more people to gain access. If not, and the Green Roof is a place for aesthetically pleasing rooftop, which is an alternative viable from the key areas within the building. Another answer is possible, maybe the Green Roof is only used to reduce storm water runoff, reduce energy consumption, gain LEED certification, or do all of the above, So nobody will see it. Sometimes from the beginning of the plan, architectures have a clear vision about how Green Roof Should look and what purpose it should have. However, more often the vision will evolve during the design and construction process. One may begin with a plan of a green roof with growth medium depths capable of supporting tall plants only to run up against structural loading limitations that force him or her to alter the plans to a shallower design with shorter plants. Also One may spend several months working on a project; But the green roof eliminated due to budgetary constraints.

Balancing, Need and Finances are three important factors in designing a Green Roof, which can be a simultaneously rewarding and exasperating experience. It will change an unused area into a remarkable green space.
To start, architectures should give this project every chance to succeed; So they should consider all intent and limitations specific to it. In this paper we try to discuss about design options, benefits, and ramifications. Remember that designing a Green Roof does not have a linear process, and sometimes you should revise your plan and try to improve it; even you force to reconsider it and change the whole details. In all steps of this project, you should ask questions like: Why Create This Green Roof? Why is the owner of this structure interested in building this particular green roof? To obtain the answers needed, one must ask some more specific questions about the green roof he or she wants to build. The answer can improve your vision of the Green Roof and help you to plan a better design. It’s best to start with the desired use of the rooftop space which we talk about it before. Many design considerations will need to be addressed based on building a rooftop garden versus a Green Roof. Here, we try to continue our discussion with more details.

MATERIAL AND METHODS

Structural Design:

In this part, we determined the purpose, the function, and many factors which impact the design of the green roof project. In starts, before the vision of a Green Roof completed, green roof designers must determine the structural requirements of the green roof and the structural capacity of the rooftop. This requires the involvement of a qualified structural engineer. The structure for new construction projects can be engineered to support the envisioned green roof. Of course, the Green Roofs of existing buildings will typically need to be designed based on the limitations of the structure. So for starting, get a structural evaluation of an existing rooftop; then try to plan based on these limitations. Green Roof ideas rarely available for older buildings. However, blueprints may be available from the local public works department’s archives. An Engineer needs to analysis the structure of the roof. Here, The most difficult phase of Green Roof design starts. Designing and considering all limitations force architectures to juggling back and forth between weight and structure to find the green roof construction strategies that meet the pre design intent and the structural limitations. Many green roof projects die here; those projects that survive are often the result of considerable compromise.

So If the project is a new construction, the engineer will design the structure to support the total loading. If the green roof project is planed to build on top of an existing building, the engineer will either approve the green roof design for the structure or prescribe any necessary structural enhancements. If the structural requirements for the system are above the capacity of the structure or the cost of this new structure beyond the budget, the green roof must be redesigned, and the weight reduces. If the weight and budget factors cannot be reconsidered, this particular Green Roof project cannot be built. Until now, we only focus on characteristics of a Green Roof. Now it’s time to go beyond the conceptual to identify the specific components of the Green Roof system to assess the weight of each. Various Green Roof components, their functions in the Green Roof system, and the role water plays in structural loading are important factors which should consider in planning of the project. Architecture needs to calculate the loading of the structure based on the weight of the Green Roof system at the point of saturation. System on Green Roof, fully saturated with water, is considered part of the dead load of the roof structure. Extra water flowing throughout the saturated Green Roof system is considered part of the live load. Also, snow is considered part of the live load. The engineer calculates the structural dead load, including the green roof components, and the anticipated live load. These components perform a variety of functions and some are better suitable in specific conditions. During the component selection process, many Green Roofs projects are over designed, increasing the cost of the it. While it is a natural tendency to design in every possible safeguard, doing so typically results in exceeding the project budget. The Goal is to separate necessity from overkill and design a successful Green Roof that suitable for our conditions.

Drawings:

Now, put the design into a format that conveys the vision to members of the Green Roof design and construction team. Even if the team is only one person, it is important to organize the design and concepts using drawings. Always retain each draft so you can look back at the evolution of the project. Necessary changes will be easier if you can identify the phase you need to revisit. Some designers even keep several sets of drawings which shows different options and the subsequent direction. Sketching the cross section will identify each of the components and their position in the Green Roof design. One can get a good idea of the weight and cost of this design through the development of the cross section. It's necessary to have a sketch of the roof plan view, or bird’s eye view, of the Green Roof. Then, the plant layout is developed, the various features are identified, and the construction process is organized.

Construction:

There are various commercial Green Roof systems and private designers, and different Green Roof construction methods widely used among architecture. They Consider several strategies for Green Roof construction and identify conditions which is suitable for certain strategies. Finally, the goal is to design and
build a Green Roof that meets the project’s Purpose, is completed on time, and stays within budget. A Golden principle which will help to reach this goal is to “keep it simple.” The success of an every project is somewhere between what is adequate and what is overkill.

**Modular Green Roofs:**

Modular Green Roofs are systems composed of planters which are arranged on the rooftop. Most of these products include engineered soil blends and plants based on the regional climate of the project's area. The design and installation of them are very simple, because the modules are self-contained and ready to be set in position on the rooftop. Several manufacturers market Green Roof modules which constructed of various materials and in various configurations. Pre-planted modules can position on the rooftop, and the completion of the Green Roof with a single application is possible. So this method is very suitable for rooftops with limited or difficult access. To access the roof surface, it is possible to move them easily. This characteristic helps to eliminate concerns over the repair of roof leaks or future roof alterations. The edges of the Green Roof can be defined without the use of edging or barriers to the growth. In other words, the Green Roof can be phrased: adding modules over time or if budgets increased in future, you can complete the projects. It is more difficult to fit a module with rigid material into irregularly shaped roof areas, while fabric modules have greater flexibility and are fit for these projects. However, it is possible to make a rigid module off site completely and then move it to the rooftop, and instantly produce a Green Roof; whereas fabric modules must be make in place on the rooftop.

Most modular systems are extensive Green Roofs which their growth medium depths less than 6 inches and plant palettes consisting of low lying ground covers. There are some modules with deeper units; however, the weight of deeper modules often increased once filled; so you can not move them easily. Of course, These deeper modules are capable of supporting a wider variety of plants, including native grasses, bushes, and small trees. Strategically, A mix of shallow extensive modules with deeper modules provides a green roof with the taller plants so produces a more natural green roof sheeting. It is possible to blend Concrete and synthetic paver systems with Green Roof modules to create paths and walkways through the Green Roof and create sitting and gathering areas.

Green Roof modules well suited for green roof research projects. It is very easy to outfitted them with different growth media and planting strategies to produce replicated experiments. These modules can be monitored under desired conditions and factors and they will help us learn more about Green Roofs. Also, the affordability of them makes this strategy attractive for small-class projects and school Green Roof displays. Although Green Roof modules may offer a simplistic approach to Green Roof construction, but they are not fit for every project. For example, Intensive Roof Garden requires much deeper soil to support a more diverse plant includes native plant species, bushes, and small trees. These rooftop gardens are landscaped, and using techniques and features typical of this kind of project, and conducted at ground level and can include many different features such as stone accents, labyrinths, playground equipment, and others. They are usually designed for use over structural concrete roof construction with very high loading capacities. Some underground structures are designed and completely concealing the building section that lies below the green roof. It is very difficult to accomplish this setting by using the modular approach and it may require the more traditional construction which were built in the place.

**Slope of Roof:**

Many Green Roof projects are constructed on flat rooftop surfaces, but in fact almost all roof surfaces must have some degree of slope to facilitate proper drainage. However, older structures which were actually built with rooftops that are dead level, are exceptions; because the roofing systems on these older flat roofs were made from coal tar pitch, Which is a material with a very low melting point. This Roof surface melts each year in the summer heat to self-heal cracks and splits that occur during the winter months.

In modern architecture, The use of coal tar pitch has largely been replaced by asphalt bitumen roofing systems and modern single-ply roofing membranes. Many of the older coal tar pitch roofs have been changed and modified.

Roofing minimum slope is 1/8 in/ft, although most designers used 1/4 in/ft roof slope to accommodate some deflection of the roof structure. This feature is very critical for facilitating the complete drainage of water from the roof surface because water that is allowed to pond on the roof dramatically accelerates the aging process of the roofing material. Actually, many roofing manufacturers’ warranties didn’t include the situations which the material failures in areas of the roof which caused water to pond.

Roof tops with slopes more than 2 in/ft are considered to be steep roofs which are often designated by terms indicating the rise of the roof slope over the horizontal distance covered by the roof. For instance, a roof surface that rises 4 inches for each 12 inches of horizontal building area would be termed 4/12; this designation sometimes is referred to as rise over run. Green roof projects for steep roofs (slopes more than 2/12) require additional design consideration to avoid sliding down the roof slope. There are a variety of manufactured products for this purpose, also there are some bracing strategies which using treated lumber that can be designed.
into the project. These strategies all compartmentalize the growth media into honeycomb or grid structures that are anchored in place. The growth media fill each compartment and supports the plant life that will grow to conceal the anchorage structure. A roof with slopes as great as 4/12, You can use Modular Green Roofs without any additional bracing. But for steeper slopes, you may require additional design considerations like connecting modules together and to a central anchor point along the top of the roof slope. Additionally, the modules may be made off site to allow the plant roots to bind and added stability.

**Insulation:**

A major part of roof construction is the roof insulation. Three basic strategies for roof insulation are available which are differentiated by the location of the insulation. Soft insulating material, like fiberglass or cellulose, is very popular. They are placed just above the ceiling; then the roof is constructed with a ventilated attic space between the insulation and the roofing. This method, commonly referred to as cold roof assembly, allows for an equilibrium between the temperatures above and below the roof, reducing condensation and ice damming.

In Warm roof assemblies, the roof insulation locates either just above or just below the roofing material and is commonly used in flat roof construction. Many green roofs are constructed by using rigid insulation boards made of polyisocyanurate (ISO). This insulation must be kept dry; therefore must be installed below the roofing material. It is the most common method for flat roofs in the United States. In this method leaves the roofing material exposed to the sun and weather elements, unless of course the membrane is protected by a green roof.

Roof insulation made of extruded polystyrene (such as insulations manufactured by Dow Chemical Company) can be placed on top of the roofing material; because they are impervious to water penetration. This method requires a form of ballast-like concrete pavers or a Green Roof to hold the insulation in place. The benefits of this strategy are more than traditional under-the-roofing installation. It’s possible to vertically extend the insulation to insulate the curbs and walls and covered with sheet metal or additional roofing material, keeping the roofing material insulated from UV exposure and wide temperature fluctuations, which will extend the life of the vertical flashing material. Dow Board has a higher density rating than ISO; that is, it has higher compression strength than ISO insulation. This is an important characteristic when rolling heavy equipment across the roof surface. ISO insulation has a tendency to crush or collapse under the weight of such traffic. Also ISO is damaged when you have repeated travel over the same pathway; therefore must protect the roof insulation with plywood to help distribute the weight over a larger area of the roof surface. Ballast requirement is A more subtle benefit of this roofing strategy. If utilized as ballast, elimination of the green roof would require a complete redesign of the roofing system. And is less likely to be eliminated from the project through value engineering should the project exceed its budget. The resulting additional architectural and engineering fees would offset some of the savings, making the loss of the Green Roof as an amenity less attractive.

**Drainage:**

A layer of granular material, like ravel, under a layer of filter fabric is used by Many European Green Roofs, which keeps fine particulate from migrating from the growth media. Water moves laterally across the roof surface through the gravel. This porous layer beneath the growth media is very critical to allow water drain away from the green roof. Many of the succulents used to propagate green roof needs well-drained soil to prevent disease.

It is also important to begin with a roof surface properly sloped to adequate drainage devices. Water can both promote disease and prematurely age roofing materials. Granular drainage layers, while effective for roof drainage, are heavy and tend to demand labor-intensive installation. The product, which you need, is manufactured in rolls that are easily conveyed to the rooftop and require minimal labor to install. Many of these products incorporate soft fabrics on the underside, to protect the roofing material, and filter fabric impregnated with root inhibitor on the topside. These drain root barrier composite products serve to protect the roofing, provide drainage under the growth media, and prevent damage from root penetration; all in a single application. There are green roof projects with specific elements that may require individual products to protect the root barrier. Large roofs sloping to one edge and draining to a gutter may require drainage products with oversized passageways providing for drainage of the greater amount of water.

**Realistic Expectations:**

The first and most important step toward success in this endeavor is to have realistic performance expectations from the outset. People should be more understanding about the less than attractive aspects of the green roof development process when they have been properly informed beforehand. When they have the necessary information to answer questions posed by other stakeholders, the green roof design team will not find themselves in the hot seat when the green roof plants do not mature overnight, or when other issues or complaints arise. Rather, they will shine as knowledgeable sources of green roof information while they educate these inquisitive individuals on the particulars of their green roof. It is through the having such information that
even the most skeptical maintenance technician is transformed into a green roof enthusiast, and more often, a big fan of the green roof designer.

**Coverage:**
Coverage time can vary based on the plants and the spacing of the green roof plants. Typical spacing of one plant per square foot generally achieves full coverage within the first 2 or 3 years from the planting date. Increasing the planting density to one plant every 8 inches on center will decrease the amount of time it takes for all of the bare space to fill in with plants, but will add significantly to the planting cost of the green roof project. Varying the planting density of different species used on the same roof will allow the plants to mature and achieve coverage more uniform.

**Green Performance:**
A green roofs’ appearances can change from season to season and from year to year. Some plants thrive in hot, dry summer conditions and go dormant in the cold winter; this characteristic helps these plants survive. However, dormant plants are often not very attractive during the winter season. A blend of species to include some evergreen plants will help give the green roof some winter beauty. These seasonal appearance variations are a part of the natural processes taking place on the green roof. Conversations about these appearance variations early in the design phase will go a long way to convey realistic expectations of how the green roof project may look during different times of the year.

**Irrigation:**
Some people make erroneous claims about never having to water green roofs. Therefore, it is important to clearly communicate irrigation needs with those involved in a green roof project early. The time to discuss the irrigation requirements of green roof plants is one of the first steps in this project. These are discussions that must take place early in the design phase of any green roof project. Rainwater harvesting strategies can help ease the irrigation demand on potable water sources. Once again, a written maintenance plan with clear irrigation instructions will eliminate any misunderstandings regarding the irrigation requirements of the green roof project.

**Manicuring:**
More complex green roof projects which include water features, sculptures, and sitting areas will likely require a more aggressive manicuring regime that adds to the maintenance cost. These costs need to be identified early so a long-term commitment can be made to perform the grooming and manicuring required to preserve the original design vision.

How the plant species propagate the rooftop up to nature. The natural ebb and flow of the ecosystem in those projects will determine, if some species dominate others. However, other projects will be designed with well-defined transitions between areas planted with different species. As nature’s forces begin to blur these lines of separation, a decision will need to be made as to how forcefully one is going to maintain these lines. This can include pulling out dominant plants and repopulating weaker species with new plugs or cuttings. Additionally, some species may spill out onto walkways and novegetation zones. Care must be taken when trimming these plants not to allow the cuttings to propagate in unwanted areas of the roof.

**Annuals:**
Annuals can offer diversity to a green roof project. Often during the first growing season, annuals may be incorporated into to detract attention from bare spots during the establishment period. When they fail to show up the following year, they can be missed. If one uses annuals temporary, he or she should discuss this strategy so that everyone involved realizes the annuals will not be back the next year. If annuals are to be part of the permanent planting scheme, their use must be clearly defined in the written maintenance plan. Designating areas for the use of annuals is a good way to get visitors to interact with the green roof.

**Lifespan Plants and our material have a finite life span; and you need to replace them time to time. Trees may outgrow the rooftop setting and should replace with a smaller one. Roof flashings are typically the first part of the roofing system to deteriorate and often can be replaced to extend the life of the roofing system. At some situations, the entire roofing system will need to be replaced. When you used a modular green roof system, you can move them easily and replace the roofing system. If a built-in-place green roof system has been constructed, moving and reusing plant stock can be significantly more difficult. While no one can forecast when each of the green roof components will reach the end of their life, the maintenance plan should include routine inspections to identify problem areas and early signs that replacement of the green roof component may be imminent.**
Green Roofs and Problems:

In the Green Roof system we have a root barrier to prevent plant roots from penetrating the roof membrane. So you should consider the plant root, because they can destroy the building very slowly! So you should find a way to let plants grow and stop their roots.

It has shown that the green roof planning process is complex, which causes many developers, builders, or owners to wonder if it is worth it. Some fear that they might commit to a Green Roof and then after the first year or even in the first 6 weeks it might not be “green” either in appearance or in practice.

Research—Green Roof Plants:

It is very important decision to select plant species for a green roof, it can determine the viability of the green roof over the long haul. This decision can be very complicated, but there are certain characteristics in a plant that can be helpful in the unique confines of the green roof which includes drought resistance, ability to withstand extremes of heat and cold, low growing, shallow roots, and long life expectancy.

They must also be relatively low maintenance and require little or no input. The physical characteristics of a plant are very important, but it must be considered that The cost of them should be within the Budget of the project.

Most Green Roof owners think that the green roof plants must also look good. Two groups of plants have these characteristics. When searching for plants suitable for an extensive green, you should consider the above characteristics. The Crassulaceae family is filled with plants with succulent leaves that tend to be found in dry, arid environments where water is scarce. One member of the Crassulaceae family, the genus Sedum which is matched to our conditions. Sedums can live in most drought and high-temperature situation, this plant can store water in leaves and stems and also has shallow root systems. Most Sedums are low-growing succulent plants that thrive in full sun and long dry periods, but can also withstand shade and temperature extremes. Generally it has all we needed characteristics. Many sedums are also known for the ability to easily propagate and to produce quick coverage over a roof area.

There has been some desire to use native plants on a green roof. Native plants usually do not require excessive soil preparation, fertilizers, irrigation, or pruning and also help to bring native fauna to the roof, thereby increasing urban biodiversity. But, there are two potential problems with using some native plants in a green roof environment. First, the traditional ground level garden is not like the green roof environment. There are many unique environmental challenges which is not in a traditional garden. The second problem lies within the type of native plants available in your region. Many native prairies also rely on periodic fires to maintain their natural balance, which may not be replicated on a green roof. For these reasons, many native plants have not been utilized in extensive green roof systems. With so many different plant choices, the plant selection process for the successful green roof can be difficult.

Each green roof can survive in the regional climate as well as its own specific micro climate. With these limitations, research must be done and many different climates and conditions should analyze to suggest the best green roof plant species in the region.

Each green roof designer, installer, and owner must avoid such problems. Planning and thinking can save extra cost, and will help to design a better project.

Some green roof owners wonder if they need to fertilize their green roof plants at all. But studied shows that using fertilizer at the initial plant installation is not acceptable. Unfertilized green roof systems in this study had less than 20% of their surface covered by plants at the end of the second growing season.

The last important point is the Sun. You should consider when and how the sun shines in your project. So if it shines directly, you should choose your plants which fan of direct sun; otherwise it will destroy your plants. Also remember the season and choose plants which where green all the season.

Conclusion:

Dr. Horgen and his associates believe that in the past decade we faced a shift from thinking of facilities as a way to house the workforce to thinking about the entire building portfolio of a company in strategic terms. In other words, CEOs start to think of their buildings as a way to achieve strategic corporate goals. Although the theory and research in this area is not fan of sustainable design. They argue that green technologies and design strategies will enhance interior environmental quality and thus be more conducive to human health and productivity than buildings that use standard practices. Common green building features likely will influence the environment, here is a list of some of them:

For increase air flow and reduce occupant contact with airborne microbial agents, they used advanced ventilating and mechanical systems;

For having low toxicity, they select the building materials and furnishings;

For Increased use of day lighting and for reducing energy demands and enhance interior lighting quality;

For reducing computer glare and increasing visual comfort, they include high quality, energy efficient lighting;
For increased contact with the natural environment, and having more open views to the outdoors.
For psychological reasons and for air quality enhancement, they include of plants indoors;
For greater attention to construction, maintenance and operation of buildings, they reduce build up of
microbial agents, especially in HVAC systems and construction materials.
Generally, green roof is an important factor in sustainable development and should be planned for it
seriously and it has great impact on economy of society. These effects can be listed as follows:
1. Reducing the cost of repair and renewal: The life of insulation can be accelerated with the help of green
roof. Keshtkar believes that green roof will be a protection against UV rays, hail, storms and temperature
differences. There is a possibility that if the green roof is installed in a public building, the life of insulation will
increase to 40 years or even more.
2. Energy: The energy exchange of the building will be reduced by green roofs. In hot weather when the
air temperature reached 95 degrees Fahrenheit, the roof temperature reaches 175 degrees Fahrenheit. While in
the green roof systems, the building will be cooler. Reducing the heat and making indoors cool can reduce
reflection so in an average 25 percent of a massive green roof insulation increases. A large part of our country is
in a hot and dry region, so the energy efficiency of this system is highly regarded.
3. Inhibition of flood waters: When the rain flows on the Earth and forest, it does not damage the ground, it
goes in a natural cycle. Green roof drainage system and water run-off decrease in water rate of 10 to 50 percent
and the rest become empty during the time. In the green roof system on average about 75 percent of water and
soil remains in green roof, about 25 percent of the water will overflow that occurred hours after the rain falls.
When the grass is water saturated, water slowly filtered through the soil and drainage is conveyed. Soil
sediments, leaves and other parts are trapped and water improves before transferring to another location.
4. Use of space: In the big cities overflow of buildings, population and cars make the area very limited; and
the green roofs provide additional space for activities, which is necessary. It is a very saving method, because
the cost of providing a space for people of the cities is very high. 5. Social sustainability: Use of green roof
systems can have many social benefits that help social sustainability. Green roof construction can create job
opportunities; it can exchange culture and information between residents of the building. Children can play,
adults and elders can exercise in the corner, in addition to entertainment such as circulation, reading and
spending time to use the roof.
6. Environmental sustainability: It is very important to create safe spaces and less polluted environment.
Cities often prevent herbs and nature; green roofs improve air quality and provide a place where the animal
back to life in the city. The weather in big cities is usually warm and dry and trees around the cities cannot carry
enough water to the city to keep it cool. The green roof project can solve all this issue. Also dust, particles and
hazardous materials will be reduced. Populated cities can use these green roof to improve their living
conditions. Also green roof absorbs all kinds of sound, so the noise reduction will help people to relax and
enjoy their lives. So green roof is suitable for buildings around highways. Green roof can not only a place for
people, it can be a shelter for birds and other small animals.
All these benefits can be available with a Green Roof. In this paper we try to briefly introduce more details
about it. We should consider this project in our architectural design, and used it, not just because of its
attractiveness, but also for its benefits.

REFERENCES

Simmons, Mark T., Brian Gardiner, Steve Windhager and Jeannine Tinsley, 2008. "Green Roofs are not created equal: the hydrologic and thermal performance of six different extensive green roof and reflective and non-reflective roofs in a sub-tropic climate." Urban Ecologist.
<http://Santa-monica.org/epd/scp >.