Waterproofing of Planter boxes, on terrace

[Excerpts from ReBuild, Vol. 5 No. 1 (Jan-Mar 2011), pp-15]

1.0 Introduction

Planters provide an elegant way to display a variety of flowers however, planters made of decorative stone or brick are prone to leaking around the seams and joints and in most cases seepage of water takes place through the roof slab thus damaging the roof slab and causing corrosion of reinforcement. The water leaking out of these crevices is laden with minerals and other deposits that can cause stains. It's easy to prevent these issues by waterproofing the inside walls of planter, so the water will only drain out the bottom as intended.

The planters on a roof garden may be designed for a variety of functions and vary greatly in depth to satisfy aesthetic and recreational purposes. These planters can hold a range of ornamental plants: anything from trees, shrubs, vines, or an assortment of flowers. As aesthetics and recreation are the priority they may not provide the environmental and energy benefits of a green roof. Planting on roof tops can make urban living more self-sufficient and make fresh vegetables more accessible to urban people. The urban kitchen garden concept works on the potted plant model; it averts the bottlenecks of waterproofing of entire roofs, the major hassle in establishing a terrace garden. One can have the vegetable farm on their terrace, where they can grow everything in pots with proper waterproofing and drainage system. But all these required a proper waterproofing system.

2.0 Waterproofing System

Planters are structures made from masonry or concrete. Waterproofing for planters is usually applied between the masonry or concrete structure and the planting material and liquid being contained. The most significant of these is the necessity for adequate drainage. Planter boxes must have a graded base to the drainage outlet and the drainage system must prevent the water level from rising above the overflow level of the membrane. A filtered drainage riser must also be provided to relieve hydrostatic pressure, to provide access for cleaning, and as an emergency overflow in the case of excessive rain. The following characteristics should be considered when selecting waterproofing materials for these structures. The materials must be:

- Safe for use in direct contact with planting materials (e.g., soil, fertilizer) intended to support plant life
- Be able to resist root penetration
- Resistant to and unaffected by the solid materials and liquid water it is containing and function under constant submersion and potentially high levels of hydrostatic pressure
- Able to resist the combined effects of exposure to sunlight, weather and intermittent wetting when exposed above the planting material's surface
- Compatible with and able to conform to the surfaces to which it is installed, including rough concrete walls, masonry and work slabs

The following waterproofing materials are appropriate for use as waterproofing membranes for planters:

- APP and SBS polymer-modified bitumen sheet membrane
- Self-adhering, polymer-modified bitumen sheet membrane
- EPDM membranes
- Fluid-applied elastomeric materials
- Cementitious waterproofing

The waterproofing membrane must be extended up the sides of the planter box to a minimum height of 100 mm above the soil level and must be protected with a drainage cell wrapped in geo-textile fabric or a similar suitable material The top edge of the membrane must be appropriately sealed and protected with either a flashing or capping tile or similar. The detail of waterproofing system of a planter box is shown in Fig. 1.

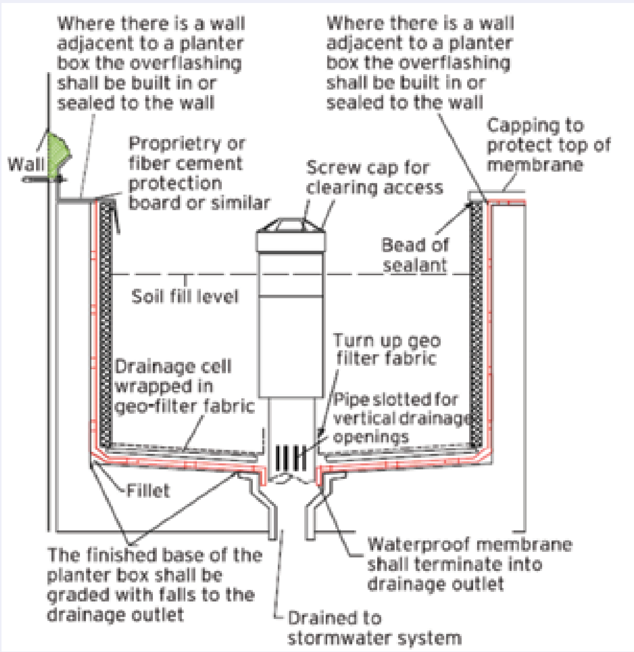

Fig. 1: Surface preparations

3.0 Conclusion

Care must be taken when selecting the type of plants to be grown in planter boxes. Those with aggressive root systems that may damage the membrane or clog the drainage system should be avoided. Trees or shrubs should not be planted that grow and cause damage to the planter. Finally, planter boxes require regular inspection and maintenance, perhaps more than any other membrane system. Prompt repair and maintenance should be undertaken based upon these inspections.

The First Green Roof of India – A Case Study

[Excerpts from Guest feature article "Green Buildings in India" by Christine Thüring,http://www.greenroofs.com/content/guest_features005.htm]

1.0 Introduction

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the growth of industry in India, by partnering industry and government alike through advisory and consultative processes. The CII-Sohrabji Godrej Green Business Centre (also known as CII or CIIGBC) at Hyderabad (Fig. 1) is the first "LEED Platinum" building in India inaugurated in 2004 and as an entity the centre is a unique and successful model of the public-private partnership between the Government of AP, Godrej & Boyce Mfg Co and the Confederation of Indian Industries, with technical support from USAID. During this decade IGBC is promoting the concept of green buildings in India. The beneficial facts of green building as compared with normal buildings are given below:

- 35% reduction in potable water use
- 50% savings in overall energy consumption
- 88% reduction in lighting consumption
- 80% of materials used are either recycled or recyclable
- 20% of the building's energy requirement is provided by photovoltaics
- 15-20% less load on AC by using aerated concrete blocks in facades
- Zero water discharge building
- 90% of the building is daylit
- 75% of occupants have an outside view

Fig. 1: An aerial view of The CII-Sohrabji Godrej Green Business Centre (also known as CII or CIIGBC), Hyderabad

This centre serves as a demonstration, but is also considered an experiment "to see what can be achieved." It comprises a balance between imported and locally-available technologies, with some imports currently being indigenised. From performance windows to waterless urinals, wind towers and biological water treatment ponds, this building is as modern as it gets. Of the 20,000 ft^2 footprint, 55% of the CII-building is covered by an extensive green roof (Fig. 2). The green feature the CII building with great value is the "roof garden" because of its insulating qualities. Measurements attest that the green roofs provide valuable insulation for the conference centre and offices, but this benefit is not likely to be perceptible under the concrete walkways. Given the minimal highlights or information about the green roofs at the CII building, it is clear that they are only part of a much greater package.

Fig. 2: Extensive green roofs, or roof gardens, cover 55% total roof surface area.

2.0 Concept and Design of Green Roof at The CII-Sohrabji Godrej Green Business Centre

The green roofs on the curvy building are divided into parcels that are separated by parapets. On top of a concrete roof, the green roof system begins its build-up with three layers of waterproofing. A leaky waterproofing is the paramount concern with regard to green roofs. All wastewater and runoff generated by the building is recycled by "root zone treatment", where specially selected plants purify and filter the water that irrigates them (Fig. 3). Water leaving the "root zone treatment" is directed to one of three ponds, (Fig. 4) thereafter to be used for domestic purposes. The building achieves a 35 percent reduction of municipally supplied potable water, in part through the use of low-flush toilets and waterless urinals.


Fig. 3: Extensive green roofs, or roof gardens, cover 55% of the total roof surface area.

The green roof system comprises 50 mm of sandy soil topped with the same pervious paver blocks used at grade, and overlain with a uniform grass sod. In their appearance and composition, the green roofs are identical to the grassy pedestrian and parking areas at grade. The section of the CII green roof shown in Figure 5 reveals a section of structural pavers where the sod is thinned, likely a seam. It can also be noted that the puddling is in the next level up.


Fig. 5: Above figure reveals a section of structural pavers where the sod is thinned, likely a seam

The grassy rooftops were being irrigated to the point of puddling. The pervious paver blocks prevented any compaction. Water is definitely a key design consideration for green buildings in India, where a hot and dry season is sandwiched by two monsoons (SW Summer Monsoon and NE Retreating monsoon). Of the 810 mm annual precipitation in Hyderabad, for example, most of it occurs during the monsoon months of June – October. As part of the zero discharge design, recycled water from the building is used for irrigation and any runoff is directed to percolate at grade (Fig. 6 & 7). During the dry season, the green roofs are irrigated daily.

3.0 Conclusion

India is in a fascinating position with regard to issues of global sustainability and the environment. Rather than playing catch-up with the West, it has begun to tap into cutting edge technology and enforce visionary policies, all the while maintaining clear sight of its traditions, which may hold immense meaning for the global economy and the global environment. With the world's 12th largest economy at market exchange rates and the 4th largest in purchasing power, it is one of the world's fastest growing economies. Still a developing nation, however, India is not bound by the Kyoto Protocol and suffers from various internal issues, such as its emissions are growing as steadily as its economy, its middle class, the use of motorized vehicles, and the trendiness of shopping malls. In Hyderabad, the construction sites and the visibly burgeoning middle class have presented the concepts of a global ecological footprint on perfect display. What will our world be like when the new transportation infrastructure is in place, and the up-scale residences occupied? Will green buildings in India assume their true potential? Will green technology assume the dominant status quo that so many states would like but few will commit to?

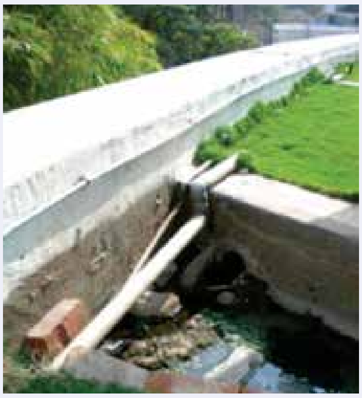
Fig. 6: Water recycling in green roof system


Fig. 7: Being the first of its kind on the subcontinent, the green roof's drainage system is exemplary of pioneering resolve and locally-inspired innovation.

Performances of Green/ Vegetative Roof System

[Excerpts from "Digging into Green", Professional Roofing of NRCA, October 2011, pp.31-36]

1.0 Introduction

Urban areas face numerous environmental challenges because of their dense human populations and high percentage of impervious surfaces, such as rooftops and parking lots. As world population increases and urban populations expand, finding solutions to environmental issues becomes increasingly imperative to maintain viable and habitable cities.

Despite consisting largely of a built environment, urban areas still may contain diverse ecosystems, all of which provide various services that help maintain life. Trees, parks, gardens, rivers, streams and lakes offer air filtration, noise reduction, food production, micro-climate regulation, rainwater infiltration, flood control and recreation. Finding ways to improve expand or increase the number of urban ecosystems may offer solutions to many environmental challenges by green or vegetative roofing. The some of the performances of such green roofing are being discussed in subsequent sections.

2.0 Storm water runoff

The design of a vegetative roof system significantly affects the quantity and quality of storm water runoff. Key design factors include the type of growth media, its depth, the plants selected, the type of system (built-in-place or modular) and fertilization regime. In a field study at SIUE using built-in-place vegetative roof models, Green Roof Blocks (modular units) and model roof decks with standard black EPDM membrane only, storm water runoff quantity and quality were monitored for almost for three years. The vegetative roof growth media was composed of 80 percent Arkalyte (a 6- to 9-mm expanded clay) and 20 percent composted pine bark. Results indicate a 10-cm built-in-place system is the best choice among 5-cm, 15-cm and 20-cm depths for a green roof in the Midwest in terms of storm water retention and plant coverage by sedum. This depth provides the same storm water retention and plant coverage as deeper depths but costs and weighs less, resulting in potential installation and structural savings.

A 5-cm medium depth is inadequate to provide sufficient plant growth to reach 100 percent roof coverage in a reasonable time, an important factor for visible vegetative roof systems. However, 100 percent of the sedums planted in the 5-cm growth media depth have survived during the subsequent six-year period. Sacrificing 100 percent roof coverage by using a 5-cm growth media depth or greater planting density with a 5-cm depth may be a viable option for those wishing to have a vegetative roof system on a facility that cannot accept a higher weight load.

In a second study on SIUE's Engineering Building roof, two modular systems (Green Roof Blocks and Green Paks) were used to evaluate water loss through evapotranspiration. Both systems were 10 cm deep. Various growth media were used in a ratio of 80 percent inorganic to 20 percent composted pine bark.

In general, the bag system (Green Paks) lost more water than the tray system (Green Roof Blocks) for all media types. Typically, the growth media Arkalyte lost the least water and had the lowest sedum roof coverage while lava (natural volcanic rock) lost the most water and had the highest sedum roof coverage. The greater water loss from lava may be a result of the relatively high percentage of plant coverage and its porous surface. The porosity may allow water to be more readily available to the plants, which results in greater coverage, and may enhance evaporative losses from exposed media.

Although greater medium depths appeared to reduce nitrate concentration, their greater roof-loading weight must be considered. Vegetative roof systems appear to slightly reduce the pH of runoff compared with a typical EPDM roof, and it appears plants have more effect on pH reduction than the growth media.

Vegetative roof systems are an important tool to ad-dress storm water runoff quantity, particularly in urban areas. Questions remain regarding their effect on the runoff's quality. It is clear the design of a vegetative roof system (type of system, growth media depth, type of growth media, plant choice, etc.) is critical to the roof system's ultimate performance and that the performance will change as plant coverage increases and growth media weathers. A roof system's desired performance must be balanced with the site's design constraints, such as load limits and aesthetic requirements.

3.0 Roof runoff quality

In an urban environment, roof runoff can contain pollutants such as pesticides, hydrocarbons and heavy metals. These pollutants may originate from the roofing materials, gutters or other building components. Rain, snowfall and dry deposition can be other sources of pollutants in roof runoff.

Because vegetative roof systems retain storm water, you may assume pollutants also would be retained. This is not always the case. Recent work by our research group and others has shown some materials intended for use in vegetative roof systems could release heavy metal pollutants into the environment.

There are a variety of media that have been considered as substrates for vegetative roof systems. Some substrates are used in their natural form (such as gravel and lava rock). More commonly, substrates for vegetative roof systems are natural materials that either are blended with other materials or modified to alter their characteristics (such as diatomaceous earth, expanded clays or shale). Waste materials, byproducts from industry and some recycled materials (such as coal bottom ash, blown glass and crushed brick) also are proposed substrates. The chemical composition of these potential substrates often varies, is proprietary or simply not available. A lack of information makes it difficult to determine whether a substrate would be a source of pollutants without testing it for the presence of heavy metals.

Several observations made in the field study suggested heavy metals in the runoff may have come from the vegetative roof system structure (either the materials that comprise the modular system or components of the built-in-place system) rather than the substrate that filled each vegetative roof.

4.0 Thermal performance

Greening the building envelope is considered to deliver several thermal benefits, such as reducing heating and cooling energy costs and decreasing the heat island effect in highly populated cities. Fig. 1 illustrates the change in ambient temperature caused by the heat island effect in urban and rural areas.

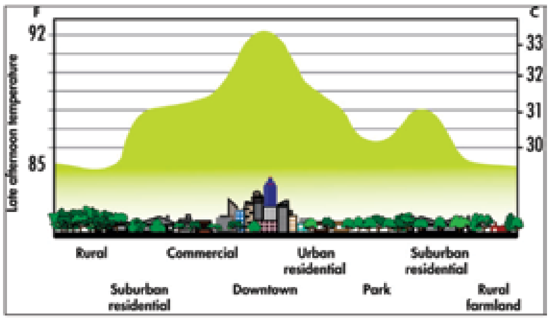

Fig. 1: Temperature variation caused by the heat island effect

G.R.E.E.N. theoretically and experimentally studies vegetative roof systems' energy saving benefits. For the heat transfer analysis, the plant canopy and growth medium regions can be combined to form a single do-main. An energy balance can be defined between the plant canopy-growth medium coupling and remaining roof layers. This analysis involves radiative and convective heat transfer to and from the vegetation's upper surface and conduction through the coupled system and the roof system layers below, such as the roof membrane, insulation and structural materials of the roof deck and building.

By obtaining varying daily outside temperatures, irradiation values and convective heat transfer coefficient, heat fluxes through different roof systems can be computed and compared for energy analysis.

5.0 Wind uplift

Wind uplift of vegetative roof system components and systems has been a topic of considerable debate recently. There are ongoing efforts to develop a wind standard and wind design guidelines for vegetative roof systems. However, other than some anecdotal evidence in the U.S. of a few vegetative roof systems that have survived significant wind events, little scientific testing has been presented or published that would steer development of standards or guidelines.

At the conclusion of our tests, all fully vegetated modules reached wind speeds of 120 mph for five minutes in the wind tunnel with no displacement of growth media. We also determined there is a minimum level of vegetation required to bind the green roof growth media. In all tests with partially vegetated modules (less than 100 percent roof surface coverage by vegetation, modules vegetated before testing), scouring of growth media occurred after reaching wind speeds of 75 mph. In tests using only growth media (no vegetative roof coverage), scour occurred at wind speeds as low as 30 mph. Therefore, 100 percent vegetation coverage or a binding agent is necessary to bind the growth media to prevent scour at wind speeds above 75 mph.

In addition, two of the four binding agents evaluated in this experiment prevented wind scour of growth media. No wind scour was observed at 140 mph when a commercial liquid binding agent was applied 48 hours before testing to a module containing only growth media. In addition, no wind scour was observed at 140 mph when a commercial liquid binding agent was applied to a partially vegetated module 48 hours before testing. Further, no wind scour was observed with speeds above 120 mph when 100 percent natural burlap was used as a surface treatment.

6.0 Conclusion

It is important to understand the performance of vegetative roof systems and their components, yet we still have more work to do. With the improvement in technology and new innovative vegetative roof systems, there also are more questions about performance and standards.

Green, or vegetative, roof systems are one of the ways we can introduce and improve ecosystem services in urban areas. Vegetative roofs can manage storm water runoff, reduce energy use and noise, mitigate the urban heat island effect, alleviate air pollution, increase biodiversity and wildlife habitat, and add value to a building.