Global Scientific JOURNALS
GSJ: Volume 9, Issue 10, October 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

A Parsimonious Terrace Gardening Technique

Hemant Diyalani, Architect, AW Design. India
Affiliation (s) – COA, IIID
diyalanihemant@gmail.com

***Abstract*— Since the beginning of construction, forests have paid the price to provide for our shelter and infrastructure. Also, building structures has become inexorable as we are continuously moving towards development. This has caused massive destruction of our environment as a whole. So, to keep pace with this development and protect our environment at the same time, our buildings need to deliver better; not just in terms of technology but sustainability.**

Terrace gardening can be an easy way to revive what gets destroyed while building any structure, but it often happens to be too expensive. A different technique for terrace gardening that is pocket friendly and does not compromise with the fundamental conditions necessary to grow crops on built structures is needed for the concrete jungle that is growing around us to mellow down its brutality on our natural jungles. This can ensure revival of biodiversity on built structures, more than what was destroyed while building them because as we go vertical in a building, we have more surface area for terrace gardening on each level.

Index Terms—*Sustainability, Corrugated Polypropylene Sheets.*

I. INTRODUCTION

Certainly people are concerned about the effects of global warming on this planet, yet only a handful actually participate on an individual level in mitigating its adverse impacts. The situation is such because people don't see any direct tangible benefits of participating in such activities to mitigate global warming; as the common consensus is that their individual efforts would be negligible as compared to the enormity of this problem. So, rather than trying to mitigate this issue, people tend to overlook it and rather continue contributing to the problem.

We will have a winner if there could be a solution that primarily works towards mitigating the effects of global warming but also benefits the individual directly. Surprisingly, such a solution already exists; that is terrace or roof gardening. However, people are reluctant to adopting it due to its high installation cost, leakage problems after installation, pre-structural planning for installation and more.

To encourage people to adopt terrace gardening, we need a more frugal technique that addresses all such issues in the prevailing technique. A pocket friendly terrace gardening technique will encourage people to vegetate their terraces and grow plants of their choice. This will not only make the people self-dependent in terms of growing their own food but it will also reduce urban heat island effect, benefit the biodiversity and ultimately begin to mitigate global warming.

II. PREVAILING TERRACE GARDENING TECHNIQUE

The existing terrace or roof gardening system is multiple fold and has to be made in layers. Starting with the layer of plaster board or any other false ceiling material, which is beneath the concrete slab. Then is the layer of concrete slab which is the load bearing layer of the entire system. The next layer is the vapor control layer which doesn't allow the warm moist air to pass through the concrete slab and into the living space, thus preventing the interior space from being humid and damp. To follow comes the insulation layer which is to protect the plants and soil from excessive building heat which rises up and can harm the plants through heat transmission from the concrete layer. Next to come is the waterproofing layer which obviously prevents the water seepage into the building through all the layers beneath. To prevent roots of the plants to penetrate through all these layers, the next layer is of a root barrier. The roots of the plants tend to move in any direction in search of nutrition. While on ground they can go deep up to hundreds of meters. Thus, this layer is responsible to frustrate these roots from piercing through different layers and enter into the living space damaging the concrete deck. Then a layer is laid to install the drain lines or reservoir lines for proper evacuation of excess water. This is important to ensure there is no water logging that may cause leakages. Also, this layer provides the soil with water when dry. The next layer is a filter layer which filters soil and holds all the nutrients and minerals in the soil and stop them from draining in the drainage layer. It just lets the excess water pass through it avoiding stagnation of water. The last layer is of the soil substrate, responsible for plant growth.

Fig. 1_Layers in prevailing terrace gardening technique [1]

III. CHALLENGES WITH PREVAILING TECHNIQUE

With so many layers under the growing substrate, the current terrace gardening technique ends up being an expensive affair. This is a major repellant for the people willing to adopt terrace gardening. Also, these layers need careful and skillful installation or else problems like water ingress can incur extra repair costs. These many layers add to

the dead load on the roof slab, and so require a concrete slab that can take that extra load. This adds to the structural cost of such a building with a terrace garden. Also, if a roof slab is not structurally pre-designed for a terrace garden, installing a garden over it with the current technique could be dangerous due to the extra dead load.

IV. Key Change Proposed in the prevailing Technique-Corrugated Polypropylene Sheets

The proposed technique is developed with an objective of reducing layers in the prevailing technique, hence bringing down the cost of installing a terrace garden. For this purpose, corrugated polypropylene sheets have been introduced in the proposed technique to directly replace some of the layers in the prevailing technique.

Corrugated polypropylene sheets have two horizontally parallel sheets with vertical parallel strips in between them. This sheet design makes the sheet strong and lightweight and the vertical strips are placed at a distance creating channels between the parallel vertical strips. These sheets are not just strong and light weight but also cheap, ranging from ₹50/- per kilogram to ₹1,000/- per kilogram depending on the quality of the sheet. Approximately one kilogram of sheet can cover almost 2 square meters of area when laid flat as in the proposed technique.

These sheets will mainly replace the waterproofing layer in the prevailing technique, that accounts for a huge portion of the cost of terrace gardening. These sheets are highly impermeable as observed after a 24 hours soak test where water absorbed by the sheet material (polypropylene) was less than 0.01% of its weight in water [2]. This makes polypropylene sheets apt for applications where they have to be totally immersed under water.

Fig. 2_ Corrugated Polypropylene Sheets [2]

V. Properties of Corrugated Polypropylene Sheets

Polypropylene is a rigid, crystalline thermoplastic, that is produced from propene or propylene monomer. It's one of the cheapest plastics available today and is used in applications both as a plastic and a fiber in various industrial sectors [2]. Polypropylene has a low density compared to other commonly used plastics, which makes it light weight substitute for other plastics [3]. Also, it is easy to recycle polypropylene by simply heating it to its melting point of 130 degrees Celsius and then molding it into the desired shape with minimum degradation in quality [3]. This makes polypropylene sheets a sustainable option over any other plastic.

Polypropylene is observed to having a higher resistance to chemicals when compared to polyethylene or regular plastic. It can resist many organic solvents, acids, and alkalines while being susceptible to attack from oxidizing acids, chlorinated hydrocarbons, and aromatics [2].

Polypropylene sheets have a tensile strength of around 4,800 psi, that is better than many other materials in the same category. This allows these sheets to withstand fairly heavy loads, despite being lightweight [2].

VI. Environmental Impacts of Corrugated Polypropylene Sheets

Production of polypropylene leaves almost three times lesser carbon footprint than many other commonly used plastics [4]. Manufacturing of polypropylene not only emits lesser greenhouse gases than manufacturing of other plastics but it also takes lesser time to naturally degrade when dumped underground. While other plastics may take up to 500 years to degrade, polypropylene takes around 20-30 years [4].

Polypropylene sheets have an easy recyclability than various other commonly used plastics. These sheets can be completely recycled without emission of any harmful gases, making it the perfect sustainable plastic [4]. Also, it is very unlikely of polypropylene sheets to have any adverse effects on human health due to its high thermal tolerance which prevents it from releasing any toxic gases due to excessive heating [4].

VII. Proposed Technique

The spine in the proposed technique, that is the 'corrugated polypropylene sheets' would need a little customizing prior to being used in this system. The top of the sheet will have to be punctured at fixed distances right above the channels formed between the parallel vertical strips in the sheet. These punctures would be responsible for drainage of water that will seep through the soil substrate. The water will pass through these punctures, into the channels of the sheet and finally into the storm water drainage pipe.

To prevent essential nutrients from getting washed away, a filter layer will have to be placed between the corrugated polypropylene sheet and the soil substrate. Thus, the proposed roof gardening system would comprise of only three layers, that is, corrugated polypropylene sheet, a filter layer and the soil substrate. Based on different climate types or buildings types, if necessary, an insulation layer shall be introduced beneath the corrugated polypropylene sheet if thermal simulation results of such a terrace show excessive heat transmission from the roof slab that may prove to be unfavorable for the plants to sustain.

Due to the properties of corrugated polypropylene sheets, it can replace 4 layers in the prevailing roof gardening technique, that is the drainage layer, root barrier layer, protection mat and water proofing layer. The process of drainage through these sheets has been discussed above. These sheets being made of polypropylene will block the plant roots from penetrating through them. Also, having very high impermeability, these sheets will act as a water proofing layer too.

In the proposed system, the roof will have to be made at a gradient of 2% for providing drainage slope. Once the sheet is placed at the slightly pitched roof, the water which would seep into the channels of the sheet would travel straight to a roof drain pipe channel made at the edge of the roof. From there the water will move into the waste water pipe through a nanhi trap and finally into the ground to further enrich the ground soil quality and improve the water table. Also, this system will act as a rainwater harvesting technique as the water run-off will be soaked by the soil and drained into the ground.

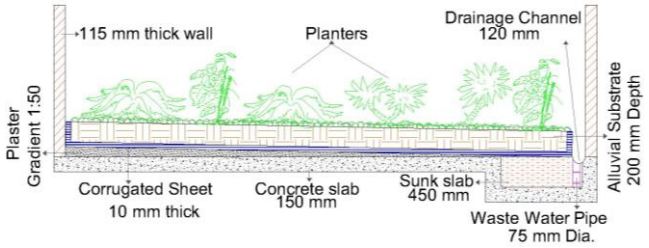

Fig. 3_ Proposed technique section

VIII. S.W.O.T. ANALYSIS

A. *Strength*

It is an easy to install, economic technique that can be executed in any place that has access to corrugated polypropylene sheets. All native plants in a particular region can be grown by this technique in that region. The only alteration needed would be the depth of soil substrate as per different plant types. In case of higher soil substrate depths, hence higher dead load, more than one sheets can be placed at perpendicular orientations to be able to carry the load.

Not only the system will optimally use the terrace space but it will improve the energy efficiency of the building as the space beneath the roof garden will have more thermal comfort, thus reducing active cooling requirements.

A roof garden will certainly add to the aesthetics of a building and its surroundings as it will improve the biodiversity in the area. It will attract many birds and insects towards it adding to the fauna of the locality. It will improve the air quality around the building. It will be a place to relax right at our home yet close to nature. Also, such a terrace garden can be a source of generating money if someone decides to grow crops, fruits or vegetables over it.

Terrace gardens can help duplicate the original topography that was altered to make that very building. The vegetation that was destroyed in the process can be replenished over a roof garden, achieving 100% or more green cover on such a site.

Being economic almost everyone would want to adopt it as it has too many perks for a low cost. Being easy to install no skilled labor is required to develop such a roof garden.

B. *Weakness*

Installation of this system may not be possible in buildings with extremely compromised structure. The structural compromise could be due to aging of the building or a natural calamity, etc. Such a building cannot have this roof garden as adding any dead load on such a structure can prove to be fatal. Also, roof gardens may lead to algal growth on the walls of the building and may attract unwanted flora or fauna.

C. *Opportunity*

The system can help achieve 100% of site area or more as green cover. This can be helpful in getting the best rating for the building from LEED (Leadership in Energy and Environmental Design), GRIHA (Green Rating for Integrated Habitat Assessment) or IGBC (Indian Green Building Council). The system will certainly improve the energy efficiency of the building and reduce operational costs.

With this system residential buildings can also become urban farms where people are self-sufficient in growing their own food.

If adopted by every building in a city, the cityscape would change from being a pale concrete jungle to a lush green urban forest. This could also be a big step towards mitigating the problem of global warming.

The rules imposed on buildings could be alleviated for people opting roof top garden so that more people and corporates are encouraged to adopt this system. Also, subsidies could be introduced for such population deciding to install a roof top garden.

D. *Threat*

Illegal crops could be easily grown with such system as roofs being personal property, won't invite much scrutiny. Also, a few dangerous insects or invertebrates could find their way into the garden which can prove dangerous for the occupants. If there happens to be algal growth on the roof top, that might spoil the buildings aesthetics. Also, if there are any penetrations in the sheet due to point impact, it could lead to water leakages in the building.

CONCLUSION

The proposed technique is easy to execute and any type of building can inhabit it unless its structure is compromised. This would indeed make our cities a better place to live in with all the modern comforts along with the primitive nature of comfort on the roof top, that is the terrace garden. The urban fabric will have more shades of green than grey.

In order to make this idea more accessible, subsidies or loans at a low interest could prove to be a boon as people would latch on to any opportunity to make their cities green again given a chance.

REFERENCES

[1] https://agritech.tnau.ac.in/horticulture/horti_Landscaping_roofgarden.html, Sunday, September 26, 2021, 2230hrs.
[2] http://plasmix.in/polypropylene-corrugated-sheet-manufacturers-india.html, Wednesday, September 30, 2021, 1250hrs.
[3] https://www.creativemechanisms.com/blog/all-about-polypropylene-pp-plastic, Tuesday, October 05, 2021, 2005hrs.
[4] https://small99.co.uk/materials/is-polypropylene-sustainable/, Tuesday, October 05, 2021, 2125hrs.