



# RECONNECTING THE GREEN IN URBAN HOUSING

Author - Nitin V Kulkarni.

Student – School of Planning Architecture and Design Excellence.  
Hindustan institute of technology and sciences, Chennai, India

Co Author - Prof Muthaiah. KT.

Associate Professor – School of Planning Architecture and Design Excellence.  
Hindustan institute of technology and sciences, Chennai, India

## ABSTRACT

Urbanization is phenomenon happening all over the world at various levels from international level to the migration of rural population to urban level. This poses the question of accommodating needs of the population in terms of both infrastructure and the housing sector. The urban growth pattern on one side is moving towards fulfilling the demand on the other side is losing the connect to the nature. This lack of connect with green (nature) is adversely affecting at the various levels from the climatic to the psychological growth of the urban dwellers. The gap between the both i.e. the lack of green and the urban housing needs to bridged. The green spaces play important role in in establishing healthy relationship in terms of physical, Psychological, emotional and also economic well-being between the occupants and the nature (flora and fauna) especially in the urban residential sector. The urban housing in the current scenario needs to address the issue of the mundane development by having holistic integrated approach that focuses on overall well-being. The objective of the review paper is to understand the relation of green spaces in urban housing and the impact of incorporating biophilia in urban housing. The methodology of the study includes qualitative and quantitative analysis and the literature reviews of journals articles and guidelines relating to urban housing development. The study area of the paper is limited to the urban housing.

**KEY WORDS** – Urban, Housing, Green spaces, Biophilia.

## 1.1 INTRODUCTION –

Urbanization - India is a country with lot of diversities, with a population of more than 1.25 Billion people. As per United Nations the estimated population of people in Urban cities will reach 70% by 2050. The growth of the population in urban cities has gone from 756 million in 1950 to 4 Billion in 2014. (United Nations. 2014). The Indian rural population in the view of industrialization, booming economy, better health infrastructure and education in urban cities is looking to migrate to the urban cities for better quality of life. As the Urbanization resulting in huge demand to accommodate the needs of the people and to facilitate the ease of living (transportation, infrastructure etc.). The current rate of urbanization in India is 0.25% and is expected to double by 2050. With the rapid urbanization the demand of the Infrastructure, housing is high and needs to be catered. In this regard the physical development is happening in urban sector and as a result of this the green cover of the cities are getting reduced in a significant quantity. As per WHO recommendation the required Urban Green Space (UGS) per capita is 9 Sqm and as per URDPFI it is desired to have 10-12 Sqm per person (Source- URDPFI). Whereas as per the data available the major cities in India are offering much lesser than the recommended value of 9 Sqm / person. For example Mumbai offers 1.1 Sqm/person, Chennai 0.8 Sqm/person, Bengaluru 2.1 Sqm/person.

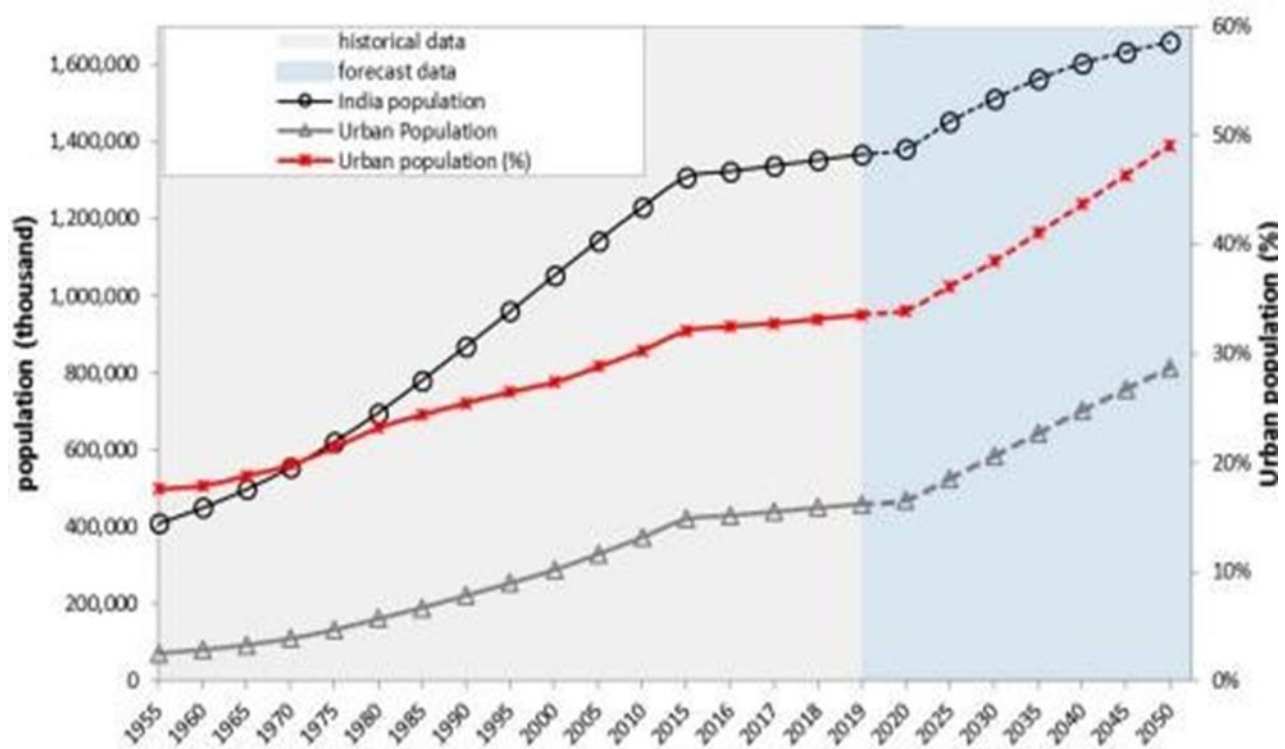


Figure – 1.1 India's population growth and urbanization trend since 1955. Source - <http://www.mdpi.com/journal/urbansci>

**1.2 BENEFITS AND USABILITY OF GREEN SPACES** - The literature study of various papers reveal the importance of green space in the urban sector. The presence of green space is directly connected to the overall well-being of the occupants and the users. The overall well-being comprises not only of physical well-being but also psychological and Emotional well-being. The green space encourages participation at community level in multi dwelling residential units across various age groups. The

interesting observation from the literature study was that people prefer the residential areas with close proximity of the green spaces like parks or community spaces. The closer the proximity are found to be economically are more expensive. Also it adds to the mental and emotional well-being in addition to the physical well-being across various age groups. Studies show that the families with children are more inclined towards having presence of green in close proximity. The lack of green spaces also influences the residents to relocate from the area. The usability of the green space also differs with the spatial arrangements like courtyards, community parks and also the age groups. The higher age groups prefer to be connected with green more visually rather than participatory space, while the younger age groups prefer more to be participatory in the green space rather than being just visually connected with the green space.

Studies also show that in low rise high density housing the balconies of the units is the exclusive open and green spaces as they lack the spread of green spaces in the ground levels and the terrace sky garden can be used as the community space. The balconies are private spaces that act as buffer zone in terms of privacy, Noise reduction and also the owners a sense of private gardens. The various international standards for open space are as follows.

Apartments structure /number of rooms/	S	1	1.5	2	2.5	3	3.5	4	4.5	5
Serbian standards for minimal surfaces for balcony/terrace (m <sup>2</sup> )	-	1.0	1.3	2.0	2.0	3.0	3.0	3.0	3.0	3.0
English national standards for social housing (m <sup>2</sup> )	-	-	-	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Republic of Ireland (m <sup>2</sup> )	-	-	-	5.0 (1.5m)	-	7.0 (1.8m)	-	9.0 (2.0m)	-	-
<b>Recommendation (m<sup>2</sup>)</b>	<b>2.0</b>	<b>2.0</b>	<b>2.5</b>	<b>3.0</b>	<b>3.5</b>	<b>4.0</b>	<b>4.5</b>	<b>5.0</b>	<b>5.5</b>	<b>6.0</b>

Table 1.2 Showing recommended private open spaces as per units.

Source - Influence of private open spaces on the quality of living in low-rise high density housing. Danijela Milanović, Ljiljana Vasilevska.

The preference of open spaces was more towards green space giving a sense of privacy and should have smaller opening towards roads or neighbouring property. These kind of open spaces with bit of green in the balconies are value addition in terms of psychological and emotional benefits and hence contributing to the overall well-being of the dwellers in the challenging compact residential development. This kind of residential development in affordable range. On the other hand with the scarcity of land in areas like CBD and land prices reaching new heights, it becomes evident to have the vertical development resulting in high rise residential dwelling. The higher the building height the more the capital cost, also more disconnected to the ground and the nature. The absence of private open spaces like balconies and sky gardens will result is more discomfort and at all levels. As the high rise development involves lot of services and also involves high cost both capital and operational cost it becomes more expensive for affordable sector and is only suitable for high income group.

**1.3 BIOPHILLIC APPROACH** - Biophillic is Greek word which means “Love for life”. Biophillic design is an approach that encourages in human interaction with the green spaces. The main idea of biophillic approach is to bring the qualitative change in the space. Qualitative change by having constant engagement with the green at various levels like visual connection, rejuvenating sensory organs with the presence of the natural elements like water, the textures, smell or odour etc. The quantitative change is to make the space feel more stress free and thereby reduce mental stress levels and facilitate better quality of living also helps in bettering the productivity and efficiency. The relationship

between nature and human through Biophillic Architecture is expressed broadly in 3 categories and 14 patterns. 3 categories include Nature in the space, Natural analogues and Nature of the space. 14 pattern and their effects are given below.

14 PATTERNS	• STRESS REDUCTION	COGNITIVE PERFORMANCE	EMOTION, MOOD & PREFERENCE	
NATURE IN THE SPACE	<b>Visual Connection with Nature</b>	<ul style="list-style-type: none"> <li>Lowered blood pressure and heart rate (Brown, Barton &amp; Gladwell, 2013; van den Berg, Hartig, &amp; Staats, 2007; Tsunetsugu &amp; Miyazaki, 2005)</li> </ul>	Improved mental engagement/ attentiveness (Biederman & Vessel, 2006)	Positively impacted attitude and overall happiness (Barton & Pretty, 2010)
	<b>Non-Visual Connection with Nature</b>	<ul style="list-style-type: none"> <li>Reduced systolic blood pressure and stress hormones (Park, Tsunetsugu, Kasetani et al., 2009; Hartig, Evans, Jamner et al., 2003; Orsega-Smith, Mowen, Payne et al., 2004; Ulrich, Simons, Losito et al., 1991)</li> </ul>	Positively impacted on cognitive performance (Mehta, Zhu & Cheema, 2012; Ljungberg, Neely, & Lundström, 2004)	Perceived improvements in mental health and tranquility (Li, Kobayashi, Inagaki et al., 2012; Jahncke, et al., 2011; Tsunetsugu, Park, & Miyazaki, 2010; Kim, Ren, & Fielding, 2007; Stigsdottir & Grahn, 2003)
	<b>Non-Rhythmic Sensory Stimuli</b>	<ul style="list-style-type: none"> <li>Positively impacted on heart rate, systolic blood pressure and sympathetic nervous system activity (Li, 2009; Park et al, 2008; Kahn et al., 2008; Beauchamp, et al., 2003; Ulrich et al., 1991)</li> </ul>	Observed and quantified behavioral measures of attention and exploration (Windhager et al., 2011)	
	<b>Thermal &amp; Airflow Variability</b>	<ul style="list-style-type: none"> <li>Positively impacted comfort, well-being and productivity (Heerwagen, 2006; Tham &amp; Willem, 2005; Wigó, 2005)</li> </ul>	Positively impacted concentration (Hartig et al., 2003; Hartig et al., 1991; R. Kaplan & Kaplan, 1989)	Improved perception of temporal and spatial pleasure (alliesthesia) (Parkinson, de Dear & Candido, 2012; Zhang, Arens, Huizenga & Han, 2010; Arens, Zhang & Huizenga, 2006; Zhang, 2003; de Dear & Brager, 2002; Heschang, 1979)
	<b>Presence of Water</b>	<ul style="list-style-type: none"> <li>Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure (Alvarsson, Wiens, &amp; Nilsson, 2010; Pheasant, Fisher, Watts et al., 2010; Biederman &amp; Vessel, 2006)</li> </ul>	Improved concentration and memory restoration (Alvarsson et al., 2010; Biederman & Vessel, 2006) Enhanced perception and psychological responsiveness (Alvarsson et al., 2010; Hunter et al., 2010)	Observed preferences and positive emotional responses (Windhager, 2011; Barton & Pretty, 2010; White, Smith, Humphries et al., 2010; Karmanov & Hamel, 2008; Biederman & Vessel, 2006; Heerwagen & Orians, 1993; Ruso & Atzwanger, 2003; Ulrich, 1983)
	<b>Dynamic &amp; Diffuse Light</b>	<ul style="list-style-type: none"> <li>Positively impacted circadian system functioning (Figueiro, Brons, Pitnick et al., 2011; Beckett &amp; Roden, 2009)</li> <li>Increased visual comfort (Eljyezadi, 2012; Kim &amp; Kim, 2007)</li> </ul>		
	<b>Connection with Natural Systems</b>			Enhanced positive health responses; Shifted perception of environment (Kellert et al., 2008)

NATURAL ANALOGUES	Biomorphic Forms & Patterns	*			Observed view preference (Vessel, 2012; Joye, 2007)
	Material Connection with Nature			Decreased diastolic blood pressure (Tsunetsugu, Miyazaki & Sato, 2007) Improved creative performance (Lichtenfeld et al., 2012)	Improved comfort (Tsunetsugu, Miyazaki & Sato 2007)
	Complexity & Order	*	Positively impacted perceptual and physiological stress responses (Salingaros, 2012; Joye, 2007; Taylor, 2006; S. Kaplan, 1988)		Observed view preference (Salingaros, 2012; Hägerhäll, Laike, Taylor et al., 2008; Hägerhäll, Parcella, & Taylor, 2004; Taylor, 2006)
NATURE OF THE SPACE	Prospect	*	Reduced stress (Grahn & Stigsdotter, 2010)	Reduced boredom, irritation, fatigue (Clearwater & Coss, 1991)	Improved comfort and perceived safety (Herzog & Bryce, 2007; Wang & Taylor, 2006; Petherick, 2000)
	Refuge	*		Improved concentration, attention and perception of safety (Grahn & Stigsdotter, 2010; Wang & Taylor, 2006; Wang & Taylor, 2006; Petherick, 2000; Ulrich et al., 1993)	
	Mystery	*			Induced strong pleasure response (Biederman, 2011; Salimpoor, Benovoy, Larcher et al., 2011; Ikemi, 2005; Blood & Zatorre, 2001)
	Risk/Peril	*			Resulted in strong dopamine or pleasure responses (Kohno et al., 2013; Wang & Tsien, 2011; Zaid et al., 2008)

Figure showing 14 patterns of biophilic architecture.

Source - 14 patterns of biophilic design improving health & well-being in the built environment. Terrapin Bright Green LLC.

**1.4 GREEN IN CONTEXT OF HIGH RISE AS PER CTBUH** – The “green wall” or “vegetated façade” is defined as a system in which plants grow on a vertical surface, such as a building façade, in a controlled fashion and with regular maintenance. (Source - CTBUH Technical Guide, GreenWalls in High-Rise Buildings (Wood, Bahrami, Safarik, 2014).). The green in high rise is divided into categories Façade supported green walls and façade integrated living system. The façade supported green wall is involves steel, wood and polythene with green externally supported by horizontal and vertical members. Metal mesh green wall, cable supported green wall. Living walls – The living wall system is not just a façade element but it is fully integrated in which plants are integrated in the vertical surface. Though there will be a layer of water proofing in between green living façade and the wall, the green wall surface is kept adistance from the wall so that the moisture content does not affect the wall.

## 1.5 POLICIES –

The National Forest Policy of India aims to ensure that a minimum of one-third of the total land area of the country remains under forest or tree cover. It encourages planting of trees alongside roads, railway lines, rivers, streams, and canals. Raising of “green belts” has been recommended in urban/industrial areas and in arid tracts (Ministry of Environment & Forests, India 1988). AMRUT scheme - Atal Mission for Rejuvenation and Urban transformation. The central government scheme aims at providing basic services to households and build amenities in cities to improve the quality of living for poor. One of the key points of the scheme is to develop green spaces like parks and well maintained open spaces.

Study of policy in Singapore – Singapore is one of fast growing global city and also is noted for its initiatives on maintaining urban greenery. Singapore has a mission of being City in a Garden. SGIS stands for SkyGreen Initiative Scheme is a scheme focusing on increasing the urban greenery levels. Singapore is having land limitations hence the focus is on the developing the green in the existing buildings and also the increase the urban green cover percentage. The goal the scheme along with other schemes is to achieve 8 sqm of the green space per person by 2030 and also to increase the greenery in High rise buildings by 50 ha.

The scheme has 2 categories 1. Rooftop Greenery which refers to having green spaces like sky gardens and community gardens at terraces of the high rise buildings. 2. Vertical Greenery – it is about incorporating green in the vertical surfaces. It includes plantations growing vertically.

The scheme is not only for residential buildings but also extends to the commercial, hospital and other land use buildings. The applicant has to submit the application of the proposed roof top garden) greenery or the vertical gardening to the authorities and after submitting the application the work need to be completed in 6 months. The reimbursement of 50% of amount will be provided for roof top gardens and vertical green garden by Nparks after inspection and ensuring 80% of work is implemented.

## 1.6 CASE STUDIES –

**1.6.1 The Interlace – Singapore.** Interlace is a high density residential building located in the area having well established connectivity. It apartment houses 1040 units ranging from compact units of 75 sqm to the pent houses with private gardens. The planning strategy is the key of the design. The entire building revolves around the 8 courtyard also being the community garden spaces. The green cover achieved after the entire built form is 112% which is more than the site area. The sky gardens along with the community gardens and the courtyards not only help in establishing visual connectivity through all units but also add to maintain better environmental quality there by encouraging community activities across various age groups. The aspects of biophilia like visual connection, non-visual connection, the texture and the material can be seen in the building.

Figure – 1.2

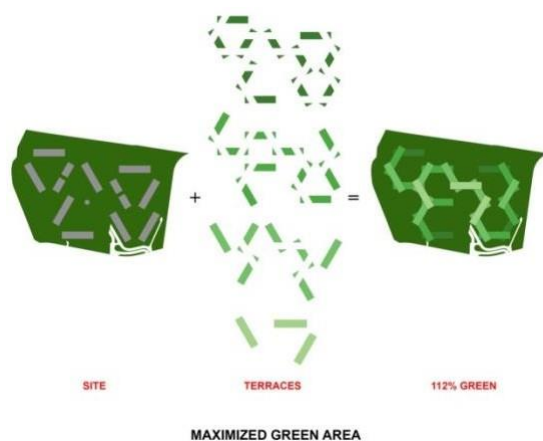


Figure – 1.3

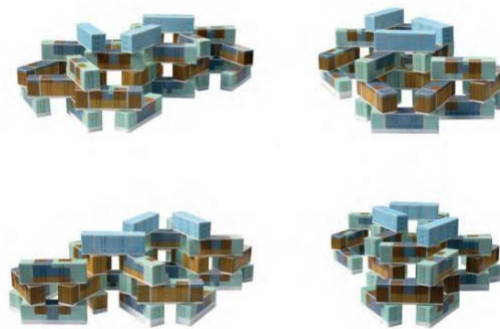


Figure – 1.2 showing green spaces spreading at all levels. Figure – 1.3 showing arrangement of blocks in Interlace. Source - The Interlace, Singapore © oma Ole Scheeren

The courtyards are having a modern interpretation creating a joyful feel of the village in the urban area. The staggering of the residential blocks establishes strong visual connections; the voids in the form make the visual connection more seamless. Though Interlace is in the well-connected area it is as affordable as the government housing projects. Interlace is one of the example of the planning strategy playing a vital role in establishing a strong connections with Nature and the built spaces. Though it is a high density housing project through the functioning of the courtyards in the site plan level and the staggering of the blocks the sense of connect with Nature is strongly established. The smaller units are visually connected to the green and the pent houses are having accessible private gardens. Terrace gardens also adds as additional green space having participatory nature to it. Because of the staggering of the blocks the columns in some blocks are affecting the interior layout of the units in some cases. Since most of the green spaces are either on the ground and the terraces of the intermediate floors.

**1.6.2 Bosco Verticale – Milan, Italy.** Situated at the heart of the city in Milan, Italy. Bosco verticale is a 2 tower residential building known for vertical forest. Milan has humid, subtropical climate. Bosco verticale is an ambitious attempt to connect green across vertically and establish a sense of being in ground for higher floors. The residential development houses around 400 units spread across 2 towers of 80M and 112M. The structural system consists of reinforced concrete structure. The highlight of the structural system is the large cantilevers (depth up to 3.3M and 14M width) which are designed to take the load of the green spaces with large planter boxes above the slab. The towers are having vertical core of staircase core lift, shafts core.

The wind tunnel test of scale model of 1:100 to understand the wind loads along with the vertical forest. All the greens balconies are well established network of PHE lines for irrigation.

The maintenance for the towers is done by the cables which are laid. The vertical forest is not just an aesthetical element but helps in maintaining the micro climate and keeps the residents well connected with the green garden space.

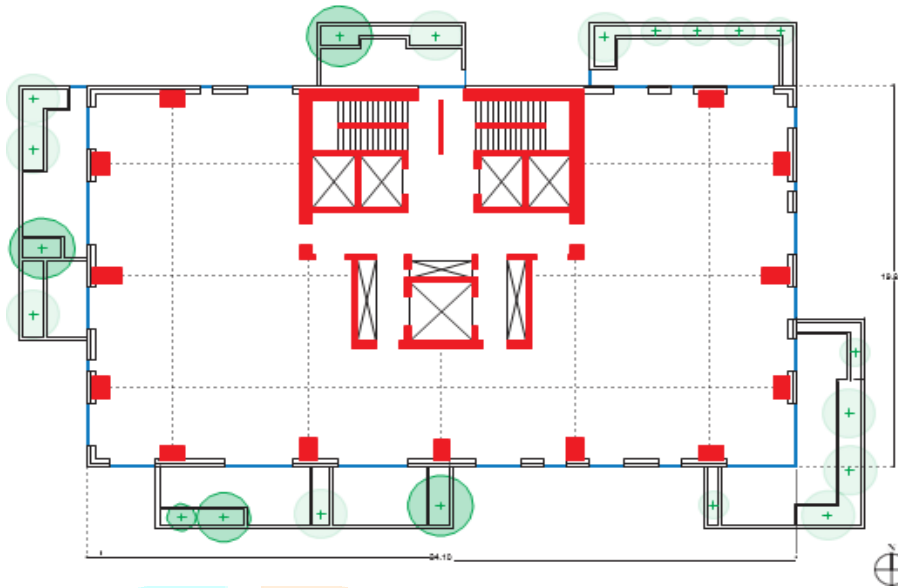


Figure – 1.4

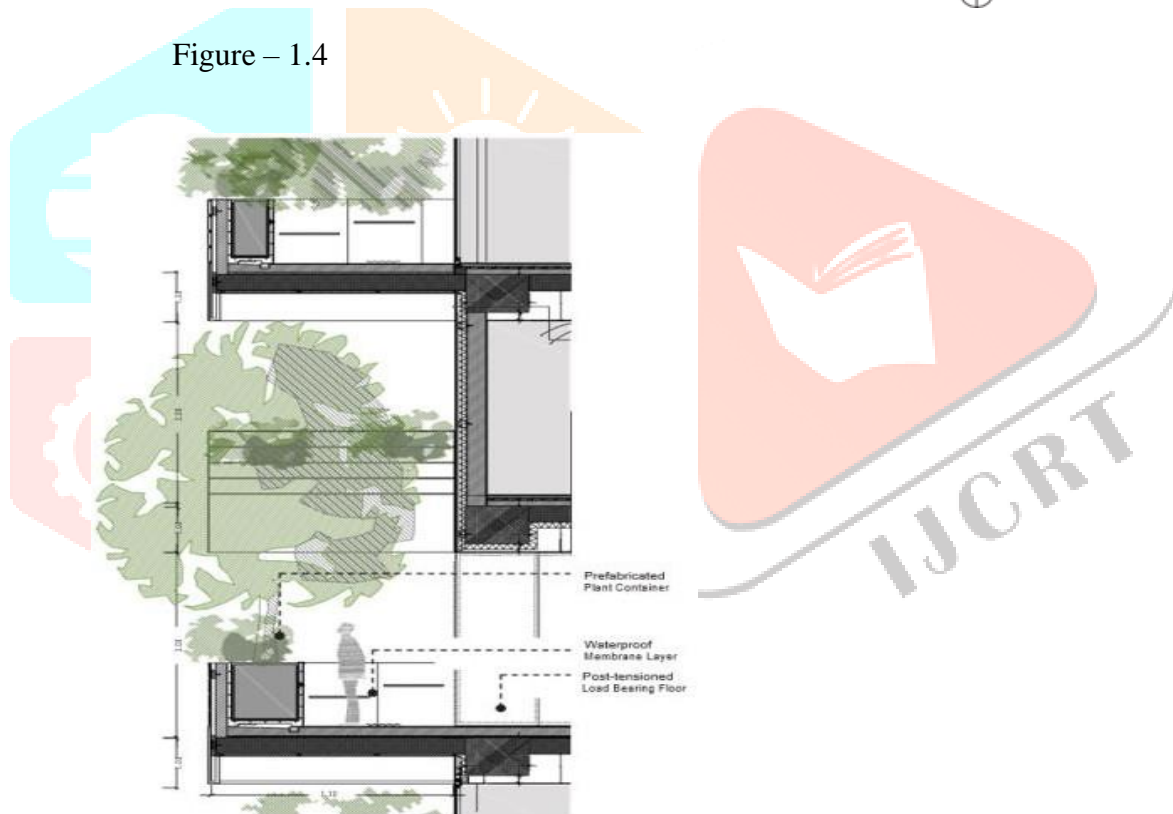


Figure – 1.5

Figure – 1.4 showing structural system of Bosco Verticale.

Figure – 1.5 showing sections of Planter container place on cantilever slab.

Source - Vertical Greenery Evaluating the High-Rise Vegetation of the Bosco Verticale, Milan Elena Giacomello & Massimo Valagussa – CTBUH Research Report.

**1.6.3 Malhar Terraces, Bangalore** – India. It is a residential development of low-rise apartment or home blocks in nature. Terraces will have low-rise blocks with homes ranging from 1 bedroom to 2 & 3 bedrooms inviting a more varied profile of residents. The unique part about the case study is that it addresses the affordable sector. The 1 bedroom units are having visual connection to the green and the 2 and the 3 bedroom units are having terraces of exclusive gardens with about 2 – 5%



of built-up area as landscape. Most of the living and dining areas in the homes are oriented to the terrace gardens. Some home have balconies instead of terrace gardens. A few others have no balcony or terrace garden but the views enjoyed from the elegant bay windows are of the beautiful grounds or a terrace garden below.

The Master plan of the housing revolves around the courtyards at larger levels. The visual connected for the smaller units is ensured since these units are not having accessible green.



Figure – 1.6 - Master plan of Malhar terraces.

Source - <https://goodearth.org.in/portfolio-items/terraces/>

The residential block consists of 63 units built across the plot area of 3 acres. The project is the demonstration that green is not a luxury which is affordable only by the high income group but is also a need for the affordable range of income. This kind of integrated planning which involves most of the services carried by having STP and there by using recycled water helps in maintaining the green with greater efficiency. The inclusion of biophilic patterns can be seen in the housing project in the urban scenario which will help the residents to reduce the mental stress levels because of the hectic work pressure and busy life style in urban setup.

### 1.7. FINDINGS –

Through the study it is evident that lack of total connect with green in a residential neighborhood results in dissatisfied living and hence does not offer better quality of living and achieving indoor thermal comfort. Urban open space like parks, play area well connected to residential living areas

contributes to better satisfaction physically, psychologically and economically. In some cases the lack of the green spaces impacts the residents to relocate. Compact and high density residential development should have reserved community green areas that facilitate participation of all age groups. Biophilic approach helps to reduce the stress levels and also the green inclusion ensures thermal comfort inside and to achieve better CO2 levels.

## 1.8 CONCLUSION –

In today's urban context with rising density of population and high land values it is vital to make compact development biophilic in nature by making private gardens since the vertical development is the only option due to scarcity of land in the urban areas. . The urbanisation needs to be supported by the nature, disconnect of residential dwellers with green and nature is affecting negatively at various levels (physical, emotional and psychological). This can be addressed by having integral approach of nature and architecture which is nothing but having biophilic approach to the design. Though the government is having schemes (like PMAY for first house purchase and AMRUT that support green parks and open spaces at urban level) that offer subsidies in housing sector more policies implementation from government are needed similar to Singapore policies that encourage the subsidies to support the cost of vertical gardens will attract the developers and the residents to make it possible.

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