STUDY ON GREEN BUILDINGS AND SUGGESTING EFFECTIVE DESIGN TO REDUCE ECOLOGICAL FOOT PRINTS

By,
S.preethi

A THESIS SUBMITTED TO THE AVINASHILINGAM DEEMED UNIVERSITY FOR WOMEN,COIMBATORE-641043

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN RESOURCE MANAGEMENT
APRIL 2012

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CERTIFIED AS BONAFIED RESEARCH WORK

Signature of the

Head of the Department

Signature of the Guide

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Gratitude is the most exquisite form of courtesy

-Jacques Maritan

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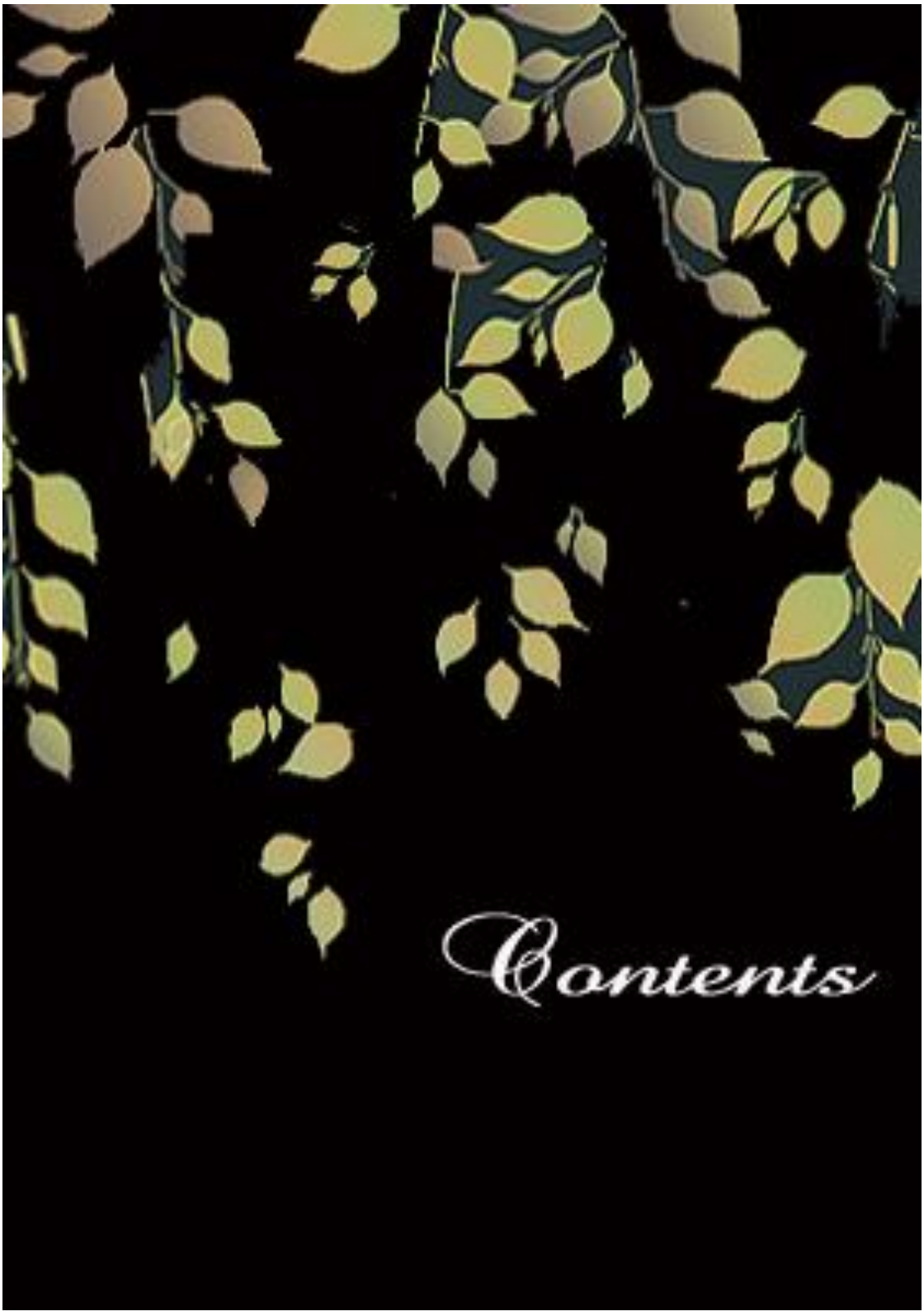
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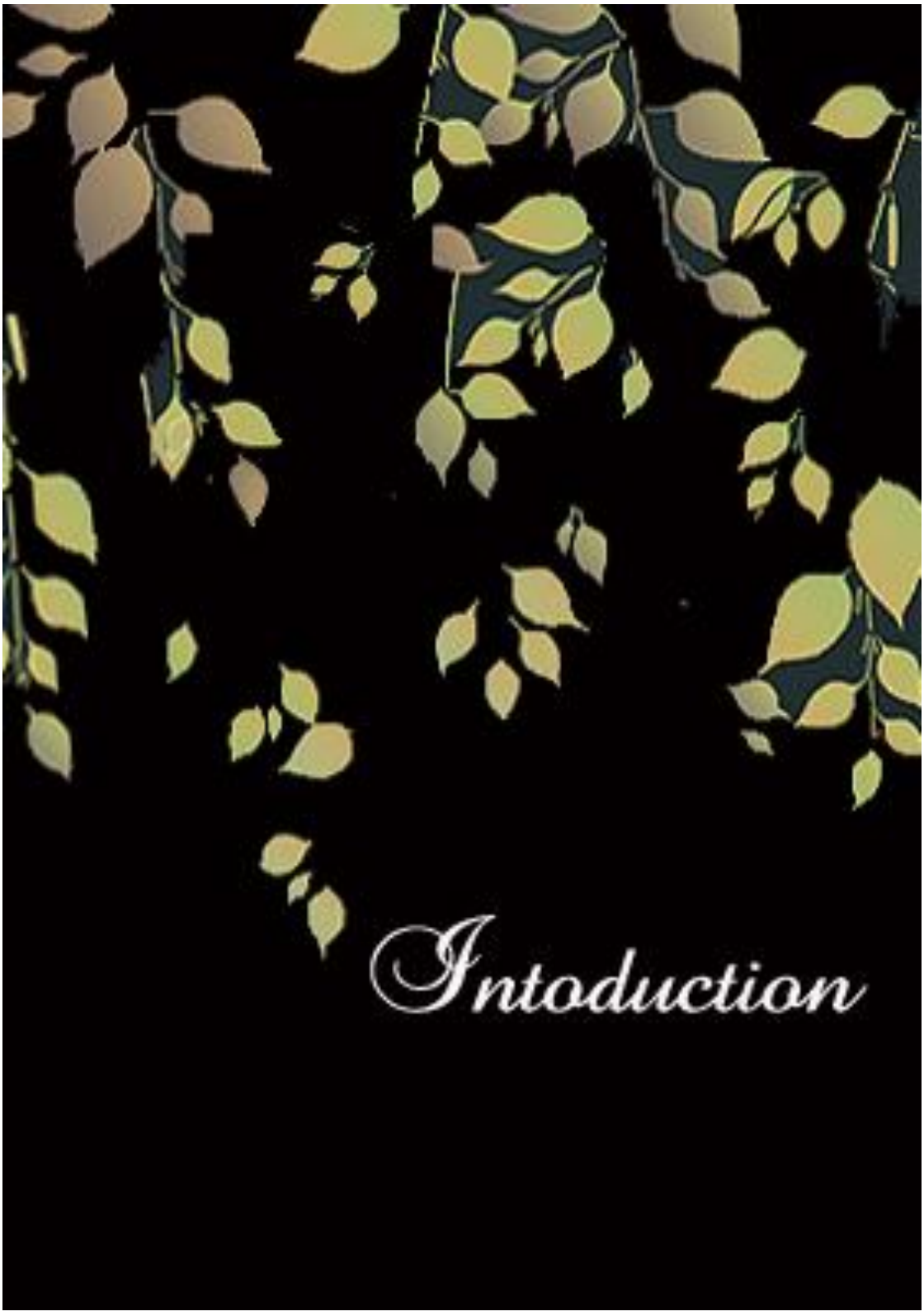


I. INTRODUCTION

"**Buildings are brick and mortar! Green home is a culture!!"**

- Theodore Roosevelt

The term house includes many kinds of dwellings ranging from rudimentary huts of nomadic tribes to complex structures composed of many systems (Walker, 1998). "House" refers to an object, possession, or measurable space, while "home," an "emotionally based and meaningful relationship between dwellers and their dwelling places." A house is transformed to home only when congenial people live, love each other, forgive each other, understand more each other, live in peace and avoid frictions at every count (Dovey, 2001).

A residence is an establishment where it was originally or currently being used by a host as their main place of dwelling or home. Architecturally, a residence is a home, mansion, cottage or even grand castle and palaces (Dodsworth, 2009). If the home is decorated it gives the illusion that our life is more interesting than it really is.

Interior design is also more than a profession which creates an interior environment for the pleasure of its inhabitants. Color choices, styles of furniture, space planning, textures and lighting are just a few of the intricate details involved in designing an interior (Neilson, 2010). It is a multi-faceted profession in which creative and technical solutions are applied within a structure to achieve a built interior environment that solves the customer's problems and links space to business strategies and goals. The design process, at its best, integrates the aspirations of art, science, and culture (Dunne, Et al., 2000).

Interior design include arranging the basic layout of spaces within a building as well as projects that require an understanding of technical issues such as Planning, acoustics, lighting, temperature, etc (Pile,2003 and Victor Papanek, 2008).It is the conscious effort to impose a meaningful order .

In view of Purohit, (2002) architecture is a visual art, and the buildings speak for themselves. Architecture is the art and science of design and erecting buildings and other physical structures. Architecture is a complex discipline that incorporates a variety of fields, including design, planning, building construction, landscaping, engineering, and social sciences.

Architects main responsibility is not to pick and choose the "best" solution but to incorporate all options that might generate workable solutions. There are no single formulae of what and how much to use. There is an urgent need of a new way of thinking and designing to reduce ecological foot prints (Ahewwalia , 2006). Architect should focus on using durable, low-maintenance, recyclable and economical materials and technologies which constrain breakdown, wear-and-tear, and replacement of materials and technologies will make building sustainable. Architect Frank Lloyd Wright developed organic architecture in which the form was defined by its environment and purpose, with an aim to promote harmony between human habitation and the natural world.

The twentieth century saw a tremendous development of a materialized civilization and rapid urbanization all over the world including India .These brought us a convenient and comfortable lifestyle, positioning human beings at the core of nature (Peter, et al, 1991) .As a result, unfortunately there has been the emergence of various global problems, such as global warming, the destruction of the earth's eco system, over use of natural resources, and accumulation of waste. They are now threatening the environment of the whole earth, the basic background for all our lives. And it is now obvious that our architectural activities play considerably important roles in such phenomena. In this regard, we now have to recognize the urgent need to realize a sustainable society, by preserving the global environment while maintaining the health and safety of the human beings at the same time. Architecture itself is not self-defining, and must be viewed within the context of its region as well as the global environment. Therefore, the basic

objectives for the 21st century must be the endeavor to create architecture that must be based on longevity, harmony between the social and natural environments, conservation of energy and resources, cyclicity and succession (Gabriele, et al, 1991).

Green buildings have existed in many world cultures for centuries. It is not a new approach. It has existed since people first selected south facing cave rather than one facing north to achieve comfort in a temperate climate. Building materials like adobe clay or green roofs in European towns are models for the modern green building movement, which began in the late 1980s. Architects responding to the energy crisis of the late 1970s began designing buildings that enhanced occupancy comfort while also actively conserving natural resources (Clark, 2010). What is new is the realization that a green approach to the built environments involves a holistic approach to design of building, that all the recourses that go into a building, be they material, fuels or the contribution of the users, need to be considered if a sustainable architecture is to be produced. Many buildings embody at least one of the various identifiable green characteristics. Green building is a multifaceted concept that lends itself to many interpretations. (Khartchenko,2004).

Green buildings compete in bottom-line terms as well as in aesthetics. They are relatively inexpensive to build, operate, and convert to their next use, as human needs inevitably evolve. Their mechanical systems to maintain comfort are small and well designed, or better still, eliminated by design (Gray, 2007).

Green building is the practice of increasing the efficiency with which buildings and their sites use and harvest energy, water, and materials; reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and the complete building life cycle (Jefferies ,Et al., 2010).Green building is the way of viewing the built environment

that has at its core a respect for people and the planet all along the process (Jodido, 2009) .That means healthy materials put together in a beautiful structure that minimizes waste and environmental impact and maximizes functionality and efficiency. It requires a holistic approach that combines the best of building performance science by looking critically at how every part of a building interacts with other parts and maximizes efficiency, durability ,natural building , choosing healthy, beautiful, locally produced materials (Sam,2001).

A green building is one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building"(http://www.igbc.in). The USGBC (U.S. Green Building Council), created in 1993, is the leading authority in green building initiatives with its LEED accreditation and certification program. According to USGBC and its Leadership in Energy and Environmental Design (LEED) program, green buildings reduce the negative impacts of buildings on occupants and the environment in five general categories: sustainable site planning, safeguarding water and water efficiency, energy efficiency and renewable energy, conservation of materials and resources, and indoor environmental quality (www.usgbc.org/).

The housing sector in India is growing at a rapid pace and contributing immensely to the growth of the economy. This augurs well for the country and now there is an imminent need to introduce green concepts and techniques in this sector, which can aid growth in a sustainable manner. Green concepts and techniques in the residential sector can help address national issues like handling of consumer waste, water efficiency, reduction in fossil fuel use in commuting, energy efficiency and conserving natural resources. Most importantly, these concepts can enhance occupant's health, happiness and wellbeing.

IGBC (Indian Green Building Council) Green Homes is the first rating programme developed in India, exclusively for the residential sector. It is based on

accepted energy and environmental principles and strikes a balance between known established practices and emerging concepts. The system is designed to be comprehensive in scope, yet simple in operation.IGBC has set up the Green Homes Core Committee to develop the rating programme. This committee comprised of key stakeholders including architects, developers, home owners, manufacturers, institutions and industry representatives. The committee, with a diverse background and knowledge has enriched the rating system both in its content and process.

In India, there are two distinct systems of rating that are popular. The first is the LEED rating system implemented by IGBC, managed by the CII Green Building Centre. The second is an indigenous rating system called GRIHA (Green Rating for Integrated Habitat Assessment) which has been developed and implemented by the organization called TERI. LEED is a "National-consensus based, market driven building rating system designed to accelerate the development and implementation of Green Building practices".

The LEED India rating system was formally launched by the IGBC in order to indigenize LEED US to suit Indian requirements. It adopts several Indian codes and standards such as the National Building Code, guidelines of the Environment and Forests Ministry, Central Pollution Control Board norms and the Energy Conservation Building Codes of the Bureau of Energy Efficiency. From January 2007 onwards LEED-India started registering projects under the Green Building New Construction (NC) system. In addition, LEED India Core & Shell rating system (CS) was launched by IGBC at the Green Building Congress, Chennai in September 2007.

The Energy Research Institute (TERI) based out of New Delhi is also actively popularizing the concept of Green Buildings in India. It has an indigenously developed Green Building rating system called GRIHA for various kinds of buildings including new, existing, commercial, institutional and residential. GRIHA has been developed taking into account both international

rating systems and based on Indian codes, standards and best practices (www.grihaindia.org).

The National Association for Home Builders (NABH) conceptualizes green building within its applicability to the construction process. Taking into account environmental considerations as well as building science and ease of implementation, this definition applies primarily to builders interested in sustainable practices (National Association for Home Builders, 2010).

According to Bradleynies (2008) Green Architecture is any form of design that minimizes environmentally destructive impacts by integrating itself with living processes. Green building uses construction practices and materials that are environmentally responsible and resource-efficient from the design phase through to maintenance and ideally to renovation and deconstruction as well. In the long term, economic sustainability depends on ecological sustainability.

"A green, renewable energy economy isn't some pie-in-the-sky, far-off future, it is now. It is providing cheap alternatives to $140-per-barrel oil. And it can create millions of additional jobs, an entire new industry, if we act now."

- Barack Obama

Green homes also ensure an effective contribution in the fight against global warming as it utilizes fewer natural resources and has a small carbon footprint. In the future we would have clusters of these new age, futuristic homes generating their own energy, reusing and recycling every drop of water they use, producing no waste at all and most importantly leaving a positive environmental foot print. (Times of India,4th July 2011).

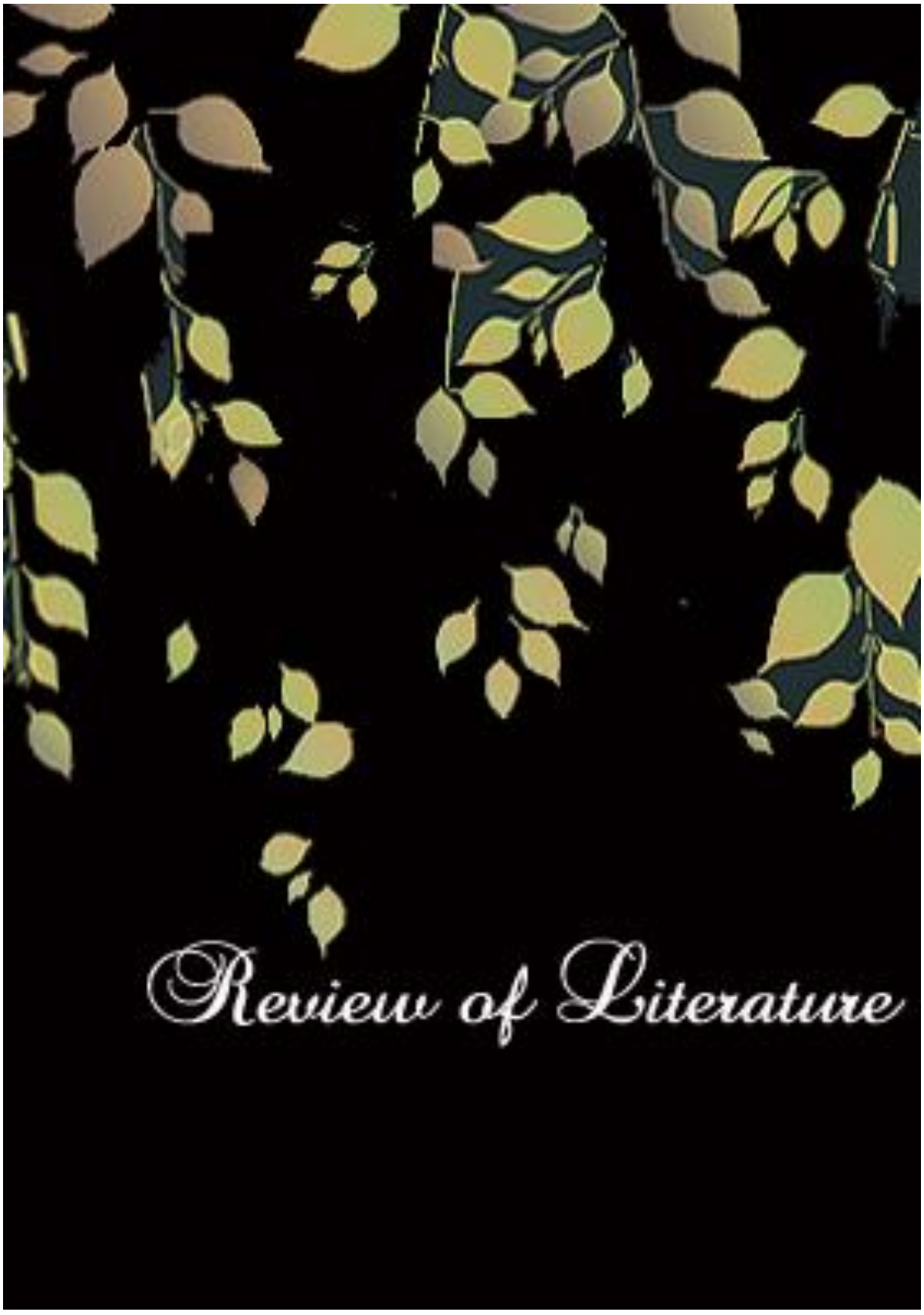
As there is paucity of research data available related to Green Buildings and its importance in making the residential spaces proficient and efficient, this triggered a keen interest of the investigator to take up this Study on Green Building and Suggesting Effective Design to Minimize Ecological Foot Prints to

investigate the depth in residential areas of this vast subject with the following objectives:

- Elicit Information from interior designers and architects on green buildings.
- Determine the views of the users about green building and its impact.
- Find out the materials available in the market.
- Study the existing residential green buildings.
- Create awareness among target groups.
- Develop green building design for its application.

"A great building must begin with the immeasurable, must go through measurable means when it is being designed and in the end must be immeasurable."

-Louis Kahn.


Review of Literature

II .REVIEW OF LITERATURE

The review of literature pertaining to the present study on "Green Buildings and Suggesting Effective Design to Reduce Ecological Foot Prints". is discussed under the following headings.

- History and Development of Green Buildings.
- Factors considered in green buildings.
- Principles of Green Building.
- Need for Green Building.
- Green Rating Systems.
- Green building: The Indian scenario.

➢ History and Development of Green Building

Sustainability, the guiding philosophy behind the Green Building movement, was an integral part of ancient civilizations world over as indeed in ancient India. Different solar passive techniques were adopted in the traditional/vernacular architecture of various places (Kahn, 2000),. Gradually as materials and techniques of construction developed, vernacular build firms evolved, through trial and error, to provide a harmonious balance between buildings, climate and people's lifestyle (Sinha, 2004).

Man's endeavor in finding a shelter for him probably begins with the cave. In the caves he found protection from the fury of nature as well as wild animals. The insulating and absorption properties of the earth mass provided warmth in winter and coolness and shade in hot summer. Sometimes the location of caves was governed by understanding of the suns movement in such a manner as the availability of sunlight during winter and shade during summer (Peter, et al., 1991). Another form of use of insulating capacity of the earth mass in extreme

heat and cold was found in the subterranean settlement of “Honan’s” in china. The dwelling in this settlement was dug into the ground (about 10-15m) with centre walls and staircases. This demonstrates the principle that the mass of earth below the surfaces retains temperature close to the yearly average, resulting in relative warm in winter and coolness in summer. This time proven principle has been adopted in contemporary versions of earth-cooled structures (Billots, et al., 1997).

In different parts of the world, man has found various solutions for protection against climatically unkind conditions through locally available materials. For example, in the hot and humid regions of Asia, Australia and Amazon, the roof was more important than walls for modifying the indoor condition, In fact the walls could be omitted all together. Hence light weight structures of timber skeleton, wooden frames, thatched roofs that woven lathe and venture walling were used in such regions. On the other hand, in the mountainous cold forest regions in the North West USA, Scandinavia and Himalayas, one found well insulated timber structure (Ahewalia, 2006).

In the case of early vernacular architecture, the roof played a determining role in the general form and appearance. Flat roof appeared in hot regions, vaulted roof in the hot and the dry regions and inclined roofs in temperate-dry climate, high-pitched roof used in the wet-temperature and cooler places .Both domes and vaults were popular in the hot-aired regions of the middle east and northern Africa, were low humidity leads to intense radiation exchange, and the variation between day and night temperatures is high. The logic here (probably reduces from centuries of experience) in that hemispherical vault as about three times the surface area of the base of a square roof so the solar radiation is diluted to the extent. Also, the cooling by radiation exchanges to the night sky is faster (Dash, 2001).

Chand (1913) pointed out that in the proto-historic period, community based collective house forms evolved. Bio-climatic aspects, orientation, house form, open spaces, etc.., were well intergrated in vernacular residential architecture. For example, the ancient Greeks gave their homes a southern orientation and thermal mass for heating purposes. Thick walls stored the heat and prevented undesired air infiltration. Later, the Romans improved on their techniques to incorporate clear window covering, green houses and radiant floor heating.

Natural lighting through clerestory and skylight has been used in many historical building such as temple of Amman at Karnak and pantheon at Rome. In the former case, the light was allowed through clerestories openings running along the centre aisle. Whereas, in the pantheon light was admitted through the eye of the dome. Medieval cathedrals all over Europe refined the early clerestory to a fine art. The Gothic style of construction exploited the benefits of diffused sunlight through large sustained glass windows. Palladio, the greatest renaissances architect, employed "thermal windows "to transmit the sun rays into the building interior for heating, as a key feature of his design. A group of six villas near Vicenza, Italy, built in the 16th century AD, incorporated a remarkable system of underground air conduits that provided air conditioning during the hot summer (Daniel, Et al., 2007).

India experiences diverse climatic conditions, which in turn have influenced the development of vernacular architecture in various regions. Control of micro climate around the building was always an important aspect of indigenous designs (Havel, 1913). The urban forms ensured that individual buildings were not exposed to the sun. While planning a town care was taken to orient the streets keeping the effects of sun and the wind in mind. For example, towns in Gujarat and Rajasthan that experience hot and dry climate, had row houses with common walls these were tightly packed along the streets and lanes to

minimize the exposure to direct sunlight and hot winds. The front façade were further shaded with well –articulated balconies called “jharokhas”. Air inlets were usually located on the front façade were the air was relatively cooler since the streets and lanes were well shaded. Each house had an open courtyard which acted as an exhaust for a warm air and provided enough natural light for the interior of the house. Another important factor in building was the willingness and the ability of the user to organize his daily activity in space and time so that not all spaces require to be maintained at comforts all the time. At any given time the active use of the building could be restricted to the area’s most comfortable at that time. In the cases of the larger complexes and building, landscaping and water bodies were often used around the buildings as exemplified in the Islamic architecture of Tajmahal, Fatehpur sikri and mandu (Callahan, 2008).

According to Day (2000) abundant use of sustainable design concepts such as orientation of building to effectively use sunlight, use of perforated screens for cooling ambient air, smart use of water bodies for evaporative cooling and recharging water tables have been established norms of ancient architecture. These principles were scaled up from building unit level and applied to entire cities and towns in the ancient civilizations. In the industrial era, as far back as the mid 19th century, the western world had already used passive systems to control air quality in the Crystal Palace in London. The more contemporary Green Building movement can be dated to 1990, when the Building Research Establishment Environmental Assessment Method (BREEAM) was instituted in the UK, the first formal international rating system for Green Buildings. In April 1993, the US Green Building Council was formed with a goal to develop industry standard design guidelines, policy positions, conferences and educational tools that support the adoption of sustainable Design and building practices (Peter, et al., 1991).

The turning point in the history of Green Building movement was the convention held in June 1993 “Architecture at the Crossroads: Designing a

Sustainable Future" at the World Congress of Architects in Chicago where the issue of sustainability in buildings was first recognized widely. The watershed was the formulation of Leadership in Energy and Environmental Design green rating system (LEED). The LEED Version 1.0 Pilot Program was launched at the USGBC (United States Green Building Council) Membership Summit in August 1998. 12 Projects completed the application process and were recognized as the first LEED Certified Pilot Projects in March 2000.The growth thereafter has been remarkable, both in terms of the spread of the Green Building movement worldwide as well the development of alternative systems for rating Green Buildings in various countries that embarked on this mission. Today many countries have adopted some form of a formal Green Building rating system or other (www.greeneconomics.net).

➢ Factors Considered In Green Buildings

Green building factors can be broadly classified into two types and they are:

I. Non Design Factors affecting Energy use in Buildings:

It should be emphasized as people use energy. The building itself does not use much energy. We cool or heat the people in the building, not the building. There are three broad aspects to consider and they are Indoor Environmental Quality, Climate, and Site Planning (David, Et al, 2004).

a) Indoor Environmental Quality

The amount of air conditioning load required and thus air conditioning energy used depends very much on the air temperature maintained in the building. Some office buildings and hotels maintain indoor temperatures as low as 18 to 20 degrees centigrade when the comfortable temperature is about 24 degrees centigrade (Agarwal, 2005). It is obvious the owners are not aware

of the cost implications of their actions. It should also be noted that the average outdoor air temperature in Malaysia is only about 4 degrees above the comfort range (Lee, 2009).

b) Climate

According to Rao (1998) climate affects the energy consumption in a building primarily by influencing the space cooling and heating requirements. The main climatic variables influencing the amount of energy needed for air conditioning are solar radiation, outside air temperature, wind and rain, night sky radiation. This would be useful for those planning large scale developments.

c) Site Planning

The following topographic factors have been found by Purohit (2002) to influence the microclimate around a building, and ultimately its cooling energy requirement.

- **Altitude :**

Temperature in the atmosphere decreases with increasing altitude by approximately 1 degree centigrade per 180 meters in the tropics and in the temperate regions and 1 degree centigrade per 220 meters in winter conditions (Thomson, 2004).

- **Terrain**

Cool air is heavier than warm air, and at night the outgoing radiation causes a cool air layer to form near the ground surface. The cool air behaves some what like water, flowing towards the lowest point. This “flow of cool air” causes “Cool Island” or “cool air puddles” to form in valleys. Accordingly, the flow of air effect

the distribution of nocturnal temperatures by dam action and concave terrain formations become cool-air lakes at night (Surendra, 2006).

The same phenomenon is involved, in valleys. The plateaus, valley walls and bottom surfaces cool off at night, a series of small circulations mix with the neighboring warm air, causing intermediate temperature conditions. Accordingly, the temperature at the plateaus will be cool, but the high sides of the slopes will remain warm. This area often indicated by the difference in vegetation, is referred to as the warm air slope (thermal belt) (Dhajeema, 2000).

- **Water Body**

Water having a higher specific heat than land, is normally warmer in winter and cooler in summer and usually cooler during the day and warmer at night, than land. The water moderates extreme temperature variations and lowers the peak temperatures in tropical climate. In the diurnal temperature variations, when the land is warmer than the water, low cool air moves over the land at day time to replace the updraft and the breeze may have a cooling effect of 5 degree centigrade. At night the direction is reversed. The effects depend on the size of the water body and are more effective along the lee side (Pandey, 2004).

- **Natural Cover**

The natural cover of the terrain tends to moderate temperatures and stabilize Conditions through the reflective qualities of various surfaces. The measurements taken by Professor Wong Nyuk Hien of the National University of Singapore shows the extent of the effect of plantings on the urban temperatures. Plants play an important role in reducing thermal heat gain due to their sun shading effects during daytime. For most plants, of plants is so good that they don’t just reduce heat from entering Buildings but actually resulting in heat loss from the building (Clark,2010).

Plants contribute in creating better outdoor thermal environment and mitigating the urban heat island effect. The 'cooling effect' of plants could be found from afternoon to sunrise next day. The maximum temperature difference was 4.2ºC, measured at 300mm height, around 18:00 hrs. This shows that plants on rooftop gardens can reduce ambient temperature as much as 4ºC. Foliage of plants affects temperature readings. Under dense shrubs, surface temperature remains stable, with less than 3 ºC daily variations. The maximum surface temperature was only 26.5 ºC (Williams, 2001).

- **Cities**

In views of Joshi (2002) Cities tend to be warmer than the surrounding countryside. That cities differ from the countryside not only in their temperatures but also in many other aspects of climate is widely recognized. Three basic influences set a city's climate. They are difference in surface materials, the rocklike materials of the city's buildings and streets can conduct heat about three times as fast than wet sandy soil. Structure have a greater variety of shapes and orientations and function like amaze of reflectors, absorbing some of the solar radiation and directing much of the rest to other absorbing surfaces, so that almost the entire surface of a city absorbs and stores heat. This shows the materials used in cities can absorb more heat in less time, so that at the end of a day the rock like material have stored more heat than an equal volume of soil.

Since air is heated almost entirely by contact with warmer surfaces rather than by direct radiation, a city is more efficient in using sunlight to heat large volumes of air. Thus, the city air has a heavy load of solid, liquid and gas contaminants, which reflect sunlight, reduce the amount of heat reaching the surfaces, but they also retard the outflow of heat resulting in higher peak temperatures (Meggyes, 2010).

II. Passive Design Factors affecting Energy use in Buildings

The building layout, planning, design, shape and construction cover a wide number of variables that affect building energy requirements. The building related factors influencing energy requirements are numerous and complex. They can be classified under the following headings (Demkin, 2008).

a. Size and Shape

According to Stein (2004) generally, a larger building will require more energy to cool than a smaller building because of the larger space to be cooled. Whether a building needs less energy per unit volume or floor area is still not completely resolved, many researchers take the view that larger buildings need less energy per unit size because of their smaller surface area per. Unit size and thus lower heat gain per unit size. Based on this theory they say "The larger a building, and the nearer to spherical in shape, the less are its energy needs because of the simple reduction in the ration of surface area to volume". They conclude that "The architectural fad for angular protrusions of buildings is an energy wasting form".

The Building Research Unit however found from field data that compact buildings cost more to erect and had higher energy running costs than sprawling ones. The maximum volume, minimum perimeter building will not be the most energy conservative and because of the mechanical systems required to provide interior comfort conditions at all times, may not even be the least expensive (Thomson, 2004).

b. Building Orientation

Building orientation affects the air conditioning /heating energy in two respects by its regulation of two distinct climatic factors: solar radiation and its heating effects on walls and rooms facing different directions, Ventilation effects

associated with the relation between the directions of the prevailing, winds and the orientation of the building. Of the two, solar influence on energy is the most significant and the Architect can do the following to reduce this solar heat gain. Orient the largest wall areas in the north-south direction. Areas such as staircases, store rooms and service ducts in the east-west External walls .Service rooms on the roof top to reduce the solar gain. Sky lights should not be used. If roof ventilation is required, use a jack up roof facing the north. Shade east-west facing walls with large roof overhangs or plant shading trees in front of them (Pat, et al, 2009).

c. Roof System

The typical house receives most of its solar heat gain from the roof, because the horizontal surface receives the highest solar radiation; from 50% to 85% of the total solar radiation. For sloping roofs if the following is implemented correctly can reduce inside temperatures by as much as 4 degrees centigrade (Manohar, 2000).

- Use lighter coloured roofing or better still slightly reflective type roofing.
- Apply aluminum foil insulation under the roof tile.
- Ventilate the loft area above the ceiling and below the roof tiles.
- Apply a layer of rock wool insulation immediately above the ceiling, Measurements taken in this loft area have been found to go as high as 45 deg.C for outside air temperature of 35 deg.C for not insulated roofs.

d. Planning and Layout

The planning and layout of spaces will have an air conditioning and lighting requirements. Some areas where the layout will influence are grouping of spaces, interaction of spaces, ceiling height, space volume and buffer zones(Demkin, 2008).

e. Thermo Physical Properties

The properties of materials which affect the rate of heat transfer in and out of a building, and consequently the air conditioning or heating energy requirements are thermal resistance, surface convective coefficient, absorbability, heat capacity reflectivity and emissivity (Trivedi, 2004).

➢ Principles of Green Building

- **Principle I: Conserving Energy**

A building should be constructed using green materials so as to minimize the need for fuels and resources. Past societies also accept the necessity of this principle. It is only with the recent proliferation of materials and technologies that such a basis for ordinary building has been lost. Recent buildings that have attempted to reduce use of fossil fuels have tended to stand along have separate experiments rather than cluster in patterns that respond to local climate. Consequently, such experiments must be viewed has half-way attempts of a green architecture (HUDCO, 2002).

- **Principle II: Working With Climate**

Buildings should be designed to work with climate and natural energy sources. It is how building form and the disposition of building elements can alter internal comfort conditions. The ancient Greeks and Romans were well aware of the benefits of solar design, and commonly arranged their houses to collect the rays of the winter sun. Green cities such as Priene, following its relocation to avoid flooding, were laid out on a grid plan with streets running east west to allow a southerly orientation of the buildings (Eblen, 2001).

The tradition of designing with climate to achieve comfort in buildings is not confined to the provision of warmth in many climates. The problem that faces

the architect is to cool spaces in order to achieve comfortable conditions. The conventional modern solution, the provision of air conditioning system, is no more effective than a crude process of opposing climate with energy (Simpson, 2008).

- **Principle III: Minimizing New Resources**

A building should be designed so as to minimize the use of the new resource and, at the end of its useful life, to form the resources for other architecture. Immense resources are already a part of the existing built environments, and that the rehabilitation and upgrading of the existing building stock for minimal environmental impact is important for the creation of a new green architecture (Attman, 2010).

Re-use can take the form of recycling materials or recycling spaces. The recycling of both buildings and building components is part of the history of architecture. The prefabrication methods of later medieval timber frame building, whereby the pieces were cut and fitted together in the carpenter's yard, marked, disassembled and moved to site, meant that portions or the whole structure has been moved find a new purpose (Dhamaja, 2000).The refurbishment of existing housing areas in cities and towns can also offer a considerable saving in resources over demolishing and rebuilding and avoid disruption of the community.

- **Principle – IV - Respect For Users**

Day, et al. (2000), states that greater respect for human need and labor can be evidenced in two separate ways. For the professional builder, it is essential that the materials and processes that form the building are as little polluting and dangerous to the individual worker or user. Architects have begun to realize the extent of the global or human poisons that may be found on building sites, and that it is no longer feasible to use insulating materials that contain CsCF , or to use methods of timber treatment that are carcinogenic(Aravind, 2006). Alternative

methods of protecting timber leads to the chemical approach. User participation: The requirement that a building shall remain relevant and functional for as long as possible is an important consideration for green architecture. One way to achieve longevity and avoid demolition is to design buildings that are capable of adapting to the users changing needs. Consultative design: All the dwellings were designed for their occupancy, but the very fact of such variety means present or future owners can adapt them without a determinant to the plant. User as a builder: A self-built house makes use of local materials. Here the architect David lea specified saplings cut during tree-thinning and specially grown straw as wall filling and for the roof. The owner and her friends constructed the small house almost entirely with their own labor.

- **Principle V- Respect For Site**

According to The Australian architect (Murcutt, 2001) A building will 'touch this earth lightly', preserve the existing site conditions that contributes the sustainable design principles, functions and aesthetic properties of the site. This could include for example wetlands, drainage areas or native plant community.

- **Principle VI-Holism**

All the green principles need to be embodied in a holistic approach to the building. It is not easy to find building that embodies all the principles of green architecture, for a green architecture is yet to be realized (Sharma, 1998).

➢ Need For Green Building

International Conference Management and Service Science, 2009 states that the green building movement in the U.S. originated from the need and desire for more energy efficient and environmentally friendly construction practices (Sinha, et al, 2004). There are a number of motives to building green, including

environmental, economic, and social benefits. However, modern sustainability initiatives call for an integrated and synergistic design to both new construction and in the retrofitting of an existing structure. Also known as sustainable design, this approach integrates the building life-cycle with each green practice employed with a design-purpose to create a synergy amongst the practices used (Mao, 2009).

Danial (2007) pointed out that Green building brings together a vast array of practices and techniques to reduce and ultimately eliminate the impacts of buildings on the environment and human health. It often emphasizes taking advantage of renewable resources, e.g., using sunlight through passive solar, active solar, and photovoltaic techniques and using plants and trees through green roofs, rain gardens, and reduction of rainwater run-off using packed gravel, permeable concrete instead of conventional concrete or asphalt to enhance replenishment of ground water.

The essence of green building is an optimization of one or more efficient Principles in structure design, energy efficiency, water efficiency, materials efficiency, indoor environmental quality, operations and maintenance optimization, and waste and toxics reduction (U.S. Environmental Protection Agency (October 28, 2009), with the proper synergistic design, individual green building technologies may work together to produce a greater cumulative effect. On the aesthetic side of green architecture is the philosophy of designing a building that is in harmony with the natural features and resources surrounding the site (Whole Building Design Guide (WBDG), Sustainable Committee ,August 18, 2009).

a. Energy efficiency

Green buildings often include measures to reduce energy required to extract, process, transport and install building materials and operating to provide services such as heating and power for equipment (Lovins,1992).

To reduce operating energy use, high-efficiency window placement (day lighting) can provide more natural light and lessen the need for electric lighting during the day, insulation in walls, ceilings, Solar water heating further reduces energy costs. Onsite generation of renewable energy through solar power, wind power, hydro power, or biomass can significantly reduce the environmental impact of the building. Power generation is generally the most expensive feature to add to a building (Kudesia, 2000).

The residential sector is a large consumer of electrical energy. IGBC Green Homes can reduce energy consumption through energy efficient lighting, air conditioning systems, motors, pumps etc., the rating system encourages green homes which select and use BEE (Bureau of Energy Efficiency)labeled equipment and appliances. The energy savings that can be realized by adopting this rating programme can be to the tune of 20 – 30% (Simpson, 2008).

b. Water efficiency

Reducing water consumption and protecting water quality are key objectives in sustainable building (Beatley,2004) .The protection and conservation of water throughout the life of a building may be accomplished by designing for dual plumbing that recycles water in toilet flushing. Waste-water may be minimized by utilizing water conserving fixtures such as ultra-low flush toilets and low-flow shower heads, use of toilet paper, reducing sewer traffic and increasing possibilities of re-using water on-site. Point of use water treatment and heating improves both water quality and energy efficiency while reducing the amount of water in circulation(Hawken, Etal.2000). The use of non-sewage and grey water for on-site use such as site-irrigation will minimize demands on the local aquifer (California Integrated Waste Management Board, January 23, 2008) and (http:// www.ciwmb.ca.gov).

c. Materials efficiency:

Building materials typically considered to be 'green' suggested by EPA (Environmental Protection Agency) include lumber from forests that have been certified to a third-party forest standard, rapidly renewable plant materials like bamboo and straw, insulating concrete forms, dimension stone, recycled stone, recycled metal, and other products that are non-toxic, reusable, renewable, and/or recyclable (e.g., Tress, Linoleum, sheep wool, panels made from paper flakes, compressed earth block, adobe, baked earth, rammed earth, clay, vermiculite, flax linen, sisal, sea grass, cork, expanded clay grains, coconut, wood fiber plates, calcium sand stone, concrete with high and ultra high performance, roman self-healing concrete (http://building ecology.com).

Building materials should be manufactured locally, whenever possible building elements manufactured off-site and delivered to site, to maximize benefits of off-site manufacture including minimizing waste, maximizing recycling (Mackley, 2002).

d. Indoor environmental quality enhancement

Indoor Air Quality seeks to reduce volatile organic compounds, moisture accumulation and other air impurities such as microbial contaminants. Buildings rely on a properly designed ventilation system (passively/naturally- or mechanically-powered) to provide adequate ventilation of cleaner air from outdoors or re circulated, filtered air as well as isolated operations (kitchens, dry cleaners, etc.) from other occupancies. During the design and construction process choosing construction materials and interior finish products with zero or low VOC emissions will improve IAQ (http://www.eurofins.com).

A well-insulated and tightly-sealed envelope will reduce moisture problems but adequate ventilation is also necessary to eliminate moisture from sources

indoors including human metabolic processes, cooking, bathing, cleaning, and other activities.

Personal temperature and airflow control over the HVAC system with a electrical light sources properly designed building envelope will aid in increasing a building's thermal quality, lighting quality and energy performance of a structure (Sorrell, 2001).

Solid wood products, particularly flooring, are often specified in environments where occupants are known to have allergies to dust or other particulates. The Asthma and Allergy Foundation of American recommends hardwood, vinyl, linoleum tile or slate flooring instead of carpet. The use of wood products can also improve air quality by absorbing or releasing moisture in the air to moderate humidity (Http://www .building / ecology.com).

e. Operations and maintenance optimization

No matter how sustainable a building may have been in its design and construction, it can only remain so if it is operated responsibly and maintained properly. Every aspect of green building is integrated into the O&M phase of a building's life(Bach,2010). The goal of waste reduction may be applied during the design, construction and demolition phases of a building's life-cycle; it is in the O&M phase that green practices such as recycling and air quality enhancement take place (WBDG Sustainable Committee, August 18, 2009).

f. Waste reduction

Green architecture also seeks to reduce waste of energy, water and materials used during construction. The site includes a variety of resources for regulators, municipalities, developers, contractors, owner/operators and individuals/homeowners looking for information on wood recycling. For e.g., in California nearly 60% of the state's waste comes from commercial buildings (Kats,

2003) during the construction phase, one goal should be to reduce the amount of material going to landfills. Well-designed buildings reduce the amount of waste generated by the occupants, by providing on-site solutions such as compost bins to reduce matter going to landfills (Gawtham,2009).

When buildings reach the end, they are demolished and hauled to landfills. Deconstruction is a method of harvesting what is commonly considered "waste" and reclaiming it into useful building material (Jeffrey, 2003)Extending the life of a structure reduces waste of building materials .Centralized wastewater treatment systems can be costly and use a lot of energy. An alternative to this process is by converting waste and wastewater by running a semi-centralized biogas plant which can produce fertilizer. This concept was demonstrated by a settlement in Lubbock Germany in the late 1990s. It provide soil with organic nutrients and create carbon sinks that remove carbon dioxide from the atmosphere, offsetting greenhouse gas emission. Producing artificial fertilizer is costlier than the above process (Lange, Et al.,1998).

g. Cost and payoff

The most criticized issue about constructing environmentally friendly buildings is the price. Photo-voltaic, new appliances and modern technologies tend to cost more. Most green buildings cost a premium of <2%, but yield 10 times as much over the entire life of the building (Mulvaney, Et al., 2011). The stigma is between the knowledge of up-front cost vs., life-cycle cost. The savings in money come from more efficient use of utilities which result in decreased energy bills (Fedrizzi, 2009).

Studies have shown over a 20 year life period, some green buildings have yielded $53 to $71 per square foot back on investment (Langdon, Davis, 2007) .Confirming the rent ability of green building investments, further studies of the commercial real estate market have found that LEED and Energy Star certified

buildings achieve significantly higher rents, sale prices and occupancy rates as well as lower capitalization rates potentially reflecting lower investment risk (Fuerst, Et al, 2009).

➢ Green Rating Systems

- **LEED (Leadership in Energy and Environmental Design) India.**

The LEED system for New Construction (NC), globally and in India, promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health and assigning points according to the following criterion: sustainable site development, water efficiency, energy and atmosphere, material and resources, indoor environmental quality, innovation and design Process (en.wikipedia.org). Each of these mentioned attributes are accorded certain amount of credit points and are further detailed into sub parameters. These parameters are essentially what any building aspiring to go Green should satisfy. For projects that go through the certification process through LEED accredited professionals there are additional points that can be attained. The total number of credit points that are accorded for all the mentioned parameters for Green Buildings is 69 for New Construction projects. Based on how much a building can achieve compliance to the main and subsidiary parameters outlined, becomes the basis for the number of points it can earn out of the total of 69 credit points. The certification level accorded by LEED is thus based on the following rating scale: The steps involved in the LEED rating process include: registration of the project through IGBC. The steps involved in the LEED rating process include: registration of the project through IGBC. Once a project is registered, the building project team begins to prepare documentation and calculations to satisfy the prerequisite

and credit point requirements. LEED certification levels in India is shown in Table II.

TABLE-I

LEED INDIA-CERTIFICATION LEVELS

Certification Levels	Points Required
LEED Certified	26-32 points or >37% of max.
LEED Certified Silver	Level 33-38 points or >47% of max.
LEED Certified Gold	Level 39-51 points or >56% of max.
LEED Certified Platinum	Level 52-69 points or >75% of max

. Then the credit interpretations are done in which IGBC has established a review process for registered project inquiries, called Credit Interpretation Requests (CIRs), to ensure that rulings are consistent and available to other projects. Then the certification and documentation is done. To earn LEED India NC certification, the applicant project must satisfy all of the prerequisites and a Minimum number of points as per the rating level applied for. The IGBC charges a designated fee for project registration and upon successful certification of the registered buildings; the IGBC further charges a certification fee which depends upon the size of the building (www.usgbc.org).

- **GRIHA(Green Rating for Integrated Habitat Assessment) Rating:**

The steps involved in GRIHA rating process include: online registration of projects through the TERI website. After that documentation is submitted by the building project team, the buildings are evaluated and rated in a three-tier process. The preliminary evaluation

Points	Rating
50-60	One star
61-70	Two star
71-80	Three star
81-90	Four star
91-100	Five star

is done by team of professionals and experts from TERI, by reviewing the mandatory criteria. The TERI team then evaluates the optional criteria and estimates the total number of achievable points. The evaluation summary report is sent to members of the evaluation committee, which independently review the documents for the award of points(Http:// Www.Epa.Gov). The GRIHA rating is valid for a period of five years from the date of commissioning of the building and the schedule of fees for registration and certification are mentioned in the TERI website (www.rsrdc.com).

- **IGBC (Indian Green Building Council) INDIA**

Indian Green Building Council (IGBC) has launched 'IGBC Green Homes Rating System' to address the national priorities. By applying IGBC Green Homes criteria, homes which are sustainable over the life cycle of the building can be constructed. This rating programme is a tool which enables the designer to apply green concepts and criteria, so as to reduce the environmental impacts, which are measurable. The programme methodologies cover diverse climatic zones and changing lifestyles (IGBC, Reference guide, 2011).

Indian Green Building Council

a. Benefits of Green Homes

The Green Homes Rating System addresses the most important National priorities which include water conservation, handling of waste, energy conservation, conservation of resources like wood and lesser dependence on usage of virgin materials (www.igbc.com).

- **Water Efficiency:** Most of the Asian countries are water stressed and in countries like India the water table has reduced drastically over the last decade.

Green Homes encourages use of water in a self sustainable manner through reducing, recycling and reusing strategies. By adopting this rating programme green homes can save potable water to an extent of 30 – 50%.

- **Handling of Home Waste:** Handling of waste in residential buildings is extremely difficult as most of the waste generated is not segregated at source and has a high probability of going to landfills. This continues to be a challenge to the municipalities which needs to be addressed. IGBC intends to address this by encouraging green homes to segregate the house hold waste.

- **Reduced Use of Fossil Fuels:** Fossil fuel is a slowly depleting resource, world over. The use of fossil fuel for transportation has been a major source of pollution. The rating system encourages the use of alternate fuels for transportation and captive power generation.

- **Reduced Dependency on Virgin Materials:** The rating system encourages projects to use recycled & reused material and discourages the use of virgin wood, other virgin materials thereby addressing environmental impacts associated with extraction and processing of virgin materials. Reduced usage of virgin wood is also encouraged.

- **Health and Well-being of Occupants:** Health and well-being of occupants is the most important aspect of Green Homes. IGBC Green Homes Rating System ensures minimum performance of day lighting and ventilation aspects which are critical in a home. The rating system recognizes measures to minimize the indoor air pollutants (IGBC, Reference guide, 2011.

b. Features of IGBC Green Homes

IGBC Green Homes Rating System is a voluntary and consensus based programme. The rating system has been developed based on materials and

technologies that are presently available. The objective of IGBC Green Homes is to facilitate the creation of energy efficient, water efficient, healthy, comfortable and environmentally friendly houses (Appendix-III).

Rating system evaluates certain credit points using a prescriptive approach and other credits on a performance based approach. The rating system is evolved so as to be comprehensive and at the same time user-friendly. The programme is fundamentally designed to address national priorities and quality of life for occupants. The rating programme uses well accepted national standards and wherever local or national standards are not available, appropriate international benchmarks have been considered.

c. Scope of IGBC Green Homes

IGBC Green Homes Rating System is a measurement system designed for rating new residential buildings which broadly include two construction types:

1. Dwellings where interiors are part of the project.

2. Dwellings where interiors are not part of the project

Interiors include but not limited to refrigerators, internal lighting, furniture, Carpets, etc.Based on the scope of work, projects can choose any of the above options. The following categories of dwelling can apply for rating: Individual homes, Gated communities, High rise residential apartments, Existing residential buildings, and Residential buildings with major renovation, Hostels, Service apartments, Resorts, Motels and Guest houses.

In general all dwelling spaces which can meet the mandatory requirements and minimum points can apply. Various levels of green building certification are awarded based on the total points earned (IGBC, Reference guide, 2011.

d. The Future of IGBC Green Homes

Many new green building materials, equipment and technologies are being introduced in the market. With continuous up-gradation and introduction of new green technologies and products, it is important that the rating programme also keeps pace with current standards and technologies. Therefore, the rating programme will also undergo periodic revisions to incorporate the latest advances and changes. It is important to note that project teams applying for IGBC Green Homes should register their projects with the latest version of the rating system. During the course of implementation, projects have an option to transit to the latest version of the rating system.IGBC will highlight new developments on its website on a continuous basis at www.igbc.in.

e. IGBC Green Homes Process

The guidelines detailed under each credit enable the design and construction of green homes of all sizes and types. Different levels of green building certification are awarded based on the total credits earned. However, every Green Home should meet certain mandatory requirements, which are non-negotiable.

- **When to use IGBC Green Homes**

IGBC Green Homes is designed primarily for new residential buildings. However, it is also applicable for existing buildings redesigned in accordance with the IGBC Green Homes criteria. The project team can evaluate all the possible points to apply under the rating system using a suitable checklist. The project can apply for IGBC Green Homes certification if it can meet all mandatory requirements and achieve the minimum required points (IGBC,v1.0).

- **IGBC Green Homes Registration**

Projects can be registered on IGBC website (www.igbc.in) under 'IGBC Green Homes'. The website includes information on registration fee for IGBC member companies as well as non-members. Registration is the initial step which helps establish contact with IGBC and provides access to the required documents, templates, important communications and other necessary information. Consult the web site for important details about IGBC Green Homes application as well as the certification review process, schedule and fee.

- **IGBC Green Homes Certification Levels**

The rating system caters to projects like individual houses, apartments, motels, resorts, hostels, etc., projects are broadly classified as interiors are part of scope of work and where interiors are not part of the scope of work. Interiors include but not limited to materials like interior finishes and furniture and appliances like refrigerators, fans, lights etc., As a general guideline, individual owners can use the checklist 'Projects with Interiors' ,developers and builders can use the checklist titled 'Projects without Interiors'.

TABLE-II

VARIOUS RATING LEVELS (IGBC)

Certification Level	Points for projects with interiors	Points for projects without interiors
Certified	32 – 39	30 – 36
Silver	40 – 47	37 – 44
Gold	48 – 59	45 – 55
Platinum	60 – 80	56 – 75

- **Documentation**

The project team is expected to provide supporting documents such as, specifications, drawings (in native format only), cut sheets, manufacturer's literature, purchase invoices and other documents, at each stage of submission for all the mandatory requirements and the credits attempted (IGBC,v1.0).These details are mentioned in this guide, under each credit / mandatory requirement. Documentation is submitted in two phases – design submittals and construction submittals: After the design submission, review is done by third party assessors and review comments would be provided within 40 working days, after which the rating is awarded. The next phase involves submission of clarifications to design queries and construction document submittal. The construction document is submitted on completion of the project. IGBC will recognize homes that achieve one of the rating levels with a formal letter of certification and a mountable plaque.

- **Precertification**

The documentation submitted for precertification must detail the project design features which will be implemented. The rating awarded under precertification is based on the project's intention to conform to the requirements of Green Homes Rating system. A certificate and a letter are provided to projects on precertification.

- **Credit Interpretation Ruling**

In some instances the design team can face certain challenges in applying or interpreting a mandatory requirement or a credit. To resolve this IGBC uses the process of 'Credit Interpretation Ruling' (CIR) to ensure that rulings are consistent and applicable to other projects as well. The steps to be followed in case the project team faces a problem are to Consult the reference Guide for description of the credit goal, compliance options and calculations, review the goal of the credit or mandatory requirement and self-evaluate whether the project satisfies the goal,

review the tredit Interpretation web page for previous CIR on the relevant credit or mandatory requirement, All projects registered under IGBC Green Homes will have access to this page, If a similar CIR has not been addressed or does not answer the question sufficiently, submit a credit interpretation request. Only registered projects are eligible to post CIRs, Two CIRs are answered without levying any fee and for any CIR beyond the first two CIRs, a fee is levied (IGBC, Reference guide, 2011).

- **Appeal**

Generally credits get denied due to misinterpretation of the goal. On receipt of the final review, the project team has the option to appeal to IGBC for reassessment of denied credits or mandatory requirements. The documentation for the mandatory requirements or credits seeking appeal may be resubmitted to IGBC along with necessary fee. IGBC will take 40 working days to review such documentation (IGBC,v1.0).These submissions would be reviewed by an assessor not involved in the earlier assessments. Documentation for appeals should include the following: i. Documentation submitted for design submission, ii Documentation submitted for construction submission, iii. Clarifications along with necessary drawings and calculations.

f. Updates and Addenda

This is the first version of IGBC Green Homes Abridged Reference Guide. As the rating system continues to improve and evolve, updates and addenda to the reference guide will be made available through the website. These additions will be incorporated in the next version of the rating system.

➢ Green Buildings: The India Scenario

There is no doubt that the formal Green Building rating system is being earnestly adopted by the Indian construction and building industry.

Within India, if one considers all the buildings that have been certified Green till now (Sep 07) under LEED, and analyze them by Regional distribution, of the total 4.13 million square feet that these buildings cover, it is apparent that Chennai leads the share in total volume of certified Green Building space and also in number. A noteworthy fact is that in spite of having only one certified Green Building, Kolkata is second only to Chennai with 15.7% share of the total Green Building space, as of now. Delhi NCR comes third in the ranking with an 8.7% share in the total area, while Mumbai clocks a 2.9% share followed closely by Hyderabad (http://www.igbc.in/site). The scenario of LEED certified and registered Green Buildings across the world, as available at the time of compilation of this document is shown in Table-III. (Source: CII GBC,IGBC)

TABLE-III

LEED CERTIFIED GREEN BUILDINGS IN INDIA

No.	Project Name	City	LEED (Rating)	Project Type	Area (Sq ft)
1	Gurgaon Development Centre, Wipro Ltd.	Gurgaon	Platinum	IT Park	175,000
2	Olympia Technology Park	Chennai	Gold	IT Park	12,00,000
3	3 ETL BPO Park	Chennai	Gold	IT Park	12,00,000
4	Technopolis	Kolkata	Gold	Office	650,000
5	Grundfos Pumps India, Pvt Ltd.	Chennai	Gold	Office	50,000
6	World Bank Building	Chennai	Silver	Office	136,000
7	Vestas India Pvt. Ltd.	Chennai	Gold	Office	20,000
8	CII Godrej Green, Business Centre	Hyderabad	Platinum	Office	20,000
9	ITC Green Centre	Gurgaon	Platinum	Office	170,000
10	IGP OFFICE COMPLEX	Gulbarga	Gold	Office	29,000
11	ABN Amor Central Enterprise	Chennai	Gold	Office	80,000
12	L& T EDRC 1	Chennai	silver	Office	81,000
13	Hiranandani BG Building	Mumbai		Office	120,000
14	Hyderabad Institute of Technology	Hyderabad	Silver	Educationa l institute	70,000
15	Spectral Services Consultants	Naiad	Platinum	Office	16,000
16	Wipro SDB 1	Kochi	Gold	Office	100,000
17	Rane Institute of Employee Dev.& Management (HITAM),Hyderabad	Chennai	Silver	institute	16,500
TOTAL					41,33,500

- **Regional Distribution of LEED Certified Green Buildings Area –**

From an analysis of LEED certified Green Buildings, it is evident that just around 97% of the total area of these buildings comprises of self occupied corporate offices and IT parks, clearly indicating that companies and developers have taken the first lead in getting their buildings green rated(www.Hrguide.Com) . In terms of ownership, 95% of the area under LEED certified Green Buildings is attributable to profit making corporations, 3.77% is under nonprofit making organizations and 0.7% is under a public service organization. The entire data set available as of September 2007 comprises of 70 projects that are registered under LEED and TERI comprising a total area of around 32.22 million square feet.

An analysis on the basis of the regional distribution reveals that Mumbai tops the list with 17.58% of the total cumulative area under registered buildings, followed by Hyderabad (at 16.27%) and Chennai, which today, leads in terms of certified buildings. Notably, also the regional distribution suggests the emergence of a far wider spread of the Green Building phenomenon in terms of geographic spread within the country, as compared to the existing scenario of the certified Green Buildings (http: //www.igbc.in).

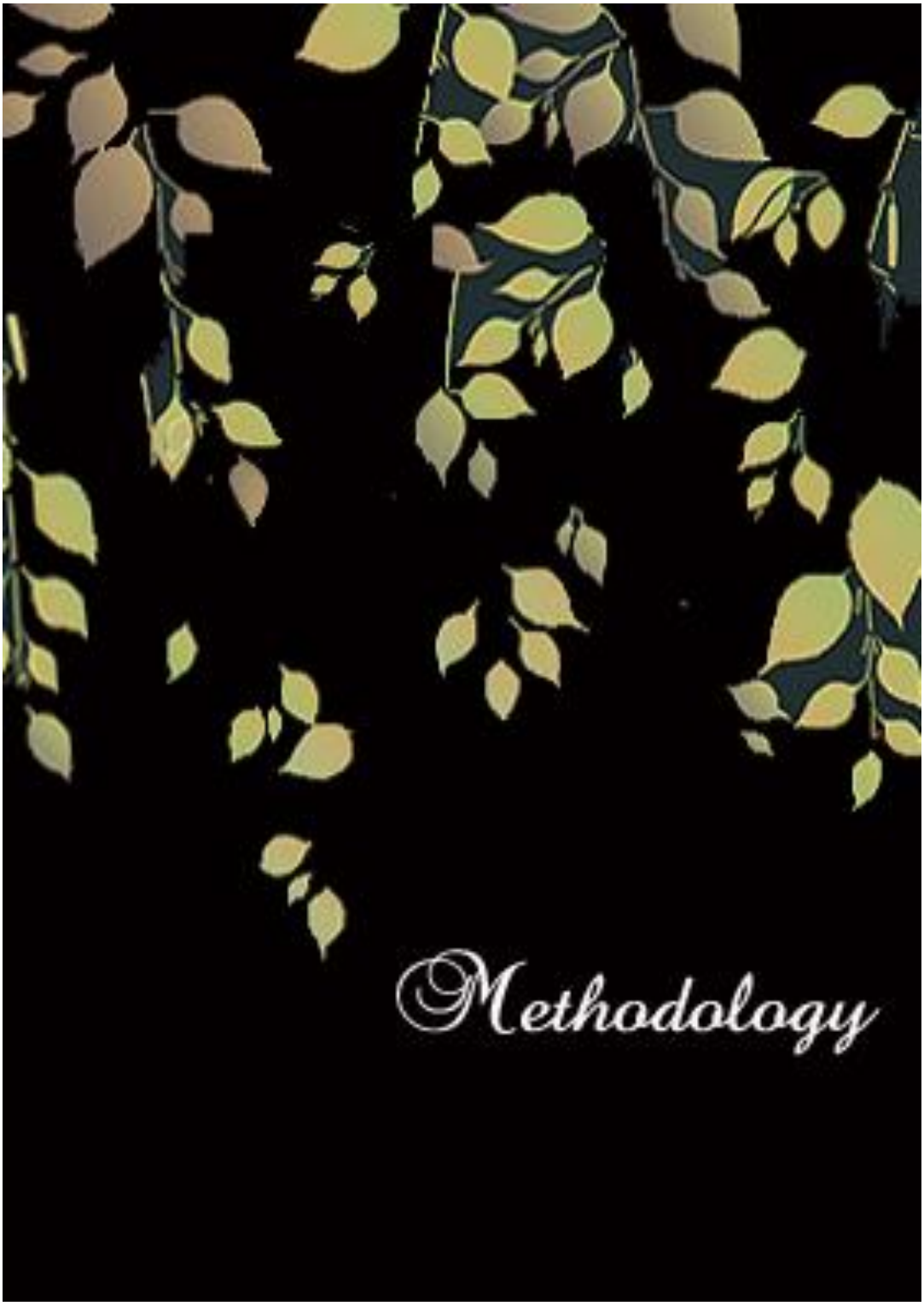
- **Distribution of Registered Buildings for Green Certification (Geography)**

While the existing certified buildings under LEED are present mostly in large metropolitan cities in India like Chennai, Kolkata, Mumbai, Hyderabad and Delhi NCR, the only smaller towns in the group are Kochi & Gulbarga. Apart from all the major metropolitan cities of the country, the projects registered for Green Building certification are spread far and wide across the country in around 12 smaller cities and (Http://Www.Nrdc.Org).On further analysis of the registered buildings in the pipeline as per the data available as of September 2007, under both the LEED and the TERI rating systems, it is clear that in terms of typology, the trend evident from the certified building data set is likely to continue. IT parks

and corporate offices would dominate the future Green Building scenario, comprising of over 71 % of the total area under registered projects for Green certification (Www.Gree economics.Net). Significantly there is also the possibility of addition of several new asset types such as residences, hospitals and hotels into the Green Building basket in coming years, as such projects have already started getting registered either under LEED or GRIHA (http://www.igbc.in/site/igb).The diversity of the kind of projects getting registered for Green Building certification is certainly heartening. Apart from residential, health care, hospitality projects joining the bandwagon, there are a first few examples of large infrastructure and township development projects also going Green. The Hyderabad International Airport Passenger Terminal has been registered under LEED and an integrated township in Asansol has been registered under GRIHA (Http://Earthand economy.Com).

- **Distribution of Registered Buildings for Green Certification (Typology)**

Apart from the wide variety of projects which are driving the Green Building movement in India through certification with formal rating agencies such as IGBC and TERI, Bangalore based developer called Biodiversity Conservation [India] Limited (BCIL), which has developed several sustainable environmentally friendly residential projects. (CIIGBC & TERI) One of these, called T-Zed Homes, has been developed in Whitefield, Bangalore and is spread over 1.5 million square feet of land .According to the developer, this project has secured Carbon Emission Reduction certification for up to 24,000 tones, for the saving of Carbon Emission during the construction of this project, the benefits of which are passed onto each home owner through Carbon Financial Credits every year. The 95 homes in the project have been constructed using compressed stabilized earth blocks and do not rely on external water supply (Http://Www.Smartplanet.Com).


Methodology

III .METHODOLOGY

"One touch of nature makes the whole world kin." -Shakespeare

Green building uses construction practices and materials that are environmentally responsible and resource-efficient from the design phase through to maintenance and ideally to renovation and deconstruction as well.

The procedure pertaining to the "Study on Green Building and Suggesting Effective Design to Minimize Ecological Foot Prints", is presented under the following headings:

A. Conduction of Survey.

B. Creating Awareness on Green Buildings.

C. Presentation of Case Study.

D. Designing with Green Building Concept.

A. Conduction of Survey

a. Among Interior Designers And Architects

A survey is a systematic method for gathering information from a sample of entries for the purpose of constructing qualitative descriptors of the attributes of large population. In order to obtain the required information, survey was found essential by the investigator. A survey was conducted to gather information among the interior designers about the functioning of their firm, details of the project undertaken and conflicts faced if any.

The survey included the following aspects:

1. Selection of the study area.
2. Selection of sample.
3. Formulation of the research tool.

4. Collection of data.
5. Consolidation of the collected data.

1. Selection of the study area:

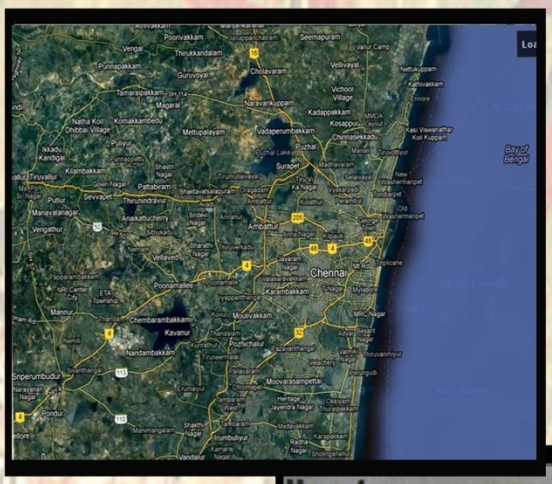
Chennai formerly known as Madras or Madarasapatinam, the capital city of the Indian state of Tamil Nadu, located on the Coromandel Coast of the Bay of Bengal was selected for the study (www.wikipedia.com). The investigator is more familiar with this area as Chennai is her native place. It is the fourth most populous metropolitan area and the sixth most populous city in India (Rina Kamath, 2000).

Chennai leads in India in terms of the number as well as the total volume of certified green building space. Out of the 17 Leadership in Energy and Environmental Design (LEED), a green building rating system developed by the US Green Building Council" certified buildings in the country; Chennai alone is the home to eight of them. This account for 67.3 per cent of the total green building space in India (Hindustan Times February 19, 2008).

Chennai's economy has a broad industrial base in the automobile, computer, technology, hardware manufacturing and healthcare industries. The city is India's second largest exporter of software, information technology (IT) and information-technology-enabled services (ITES) (The Hindu, 15 October 2011). The city is also called as 'Gateway to South India', due to its importance as a port city and its major role in South India's development (Times of India, 15 September 2011).

2. Selection of sample:

A sample is any group of measurement selected from a population for analysis (Gupta, 2003) .A sample is group from which measurements will be sort. In many cases, the sample will be only a very small fraction of sampling frame



Chennai Map

How to Go Green (Time of India)


How to go green

Flowering

GREEN MATTERS


THE METROPLUS

Chennai . Fashion . Food COIMBATORE-WEDNESDAY, DECEMBER 21, 2011 Music . People . Youth

Green with pride

OFFBEAT A whiff of change is blowing across Tirupur, known for its industries and industriousness. Many are learning to give back to Nature. Eco-friendly buildings, sustainable practices and plastic-free zones have become a reality. SUBHA J RAO profiles two institutions that are green, plastic-free zones

Green with pride (Hindu)

PLATE I

Article on green building in Chennai

and therefore, of sampling population (Groves , Et al., 2009). According to Gupta (2002) purposive sampling is a technique in which a desired number of sample unit is selected deliberately or enquiry. Hence 25 Interior designers and Architects were selected, who formed the sampling unit for the study.

Various green building designers and architects are coming up in Chennai city. As interior designing is in trend now among the affluent societies, this business has now spread its tentacles in designing both residential and commercial building of Chennai. The investigator identified the green building designers and architects with the help of family members, friends, just dial and yellow pages.

3. Selection of research method:

Interview method was selected for collection of data pertaining to study. Devadas and kulandaivel (1989) states that interview method is face-to-face contact with the persons from whom the data are to be collected. (Blaxter, Et al., 20001) points out survey research as the method of collecting data by asking a set of preformatted questions in a predetermined sequence, using a structured questionnaire to sample of individuals drawn, so as to be representative of defined population.Interview method was chosen to propose the oral version of questionnaire or schedule in which the subject supplies the needed information through a face-to-face relation. Thus the investigator followed interview as the research method in order to get the relevant details required for the research study.

4. Formulation of research tools:

The tool selected was an interview schedule, which refers to a set of statements or questions to be answered by the respondents in a Face to face Interview (Ghose,1995).The investigator prepared the interview schedule to obtain the data on general information of the firm, their investment ,economic details and the conflicts faced with clients if any.

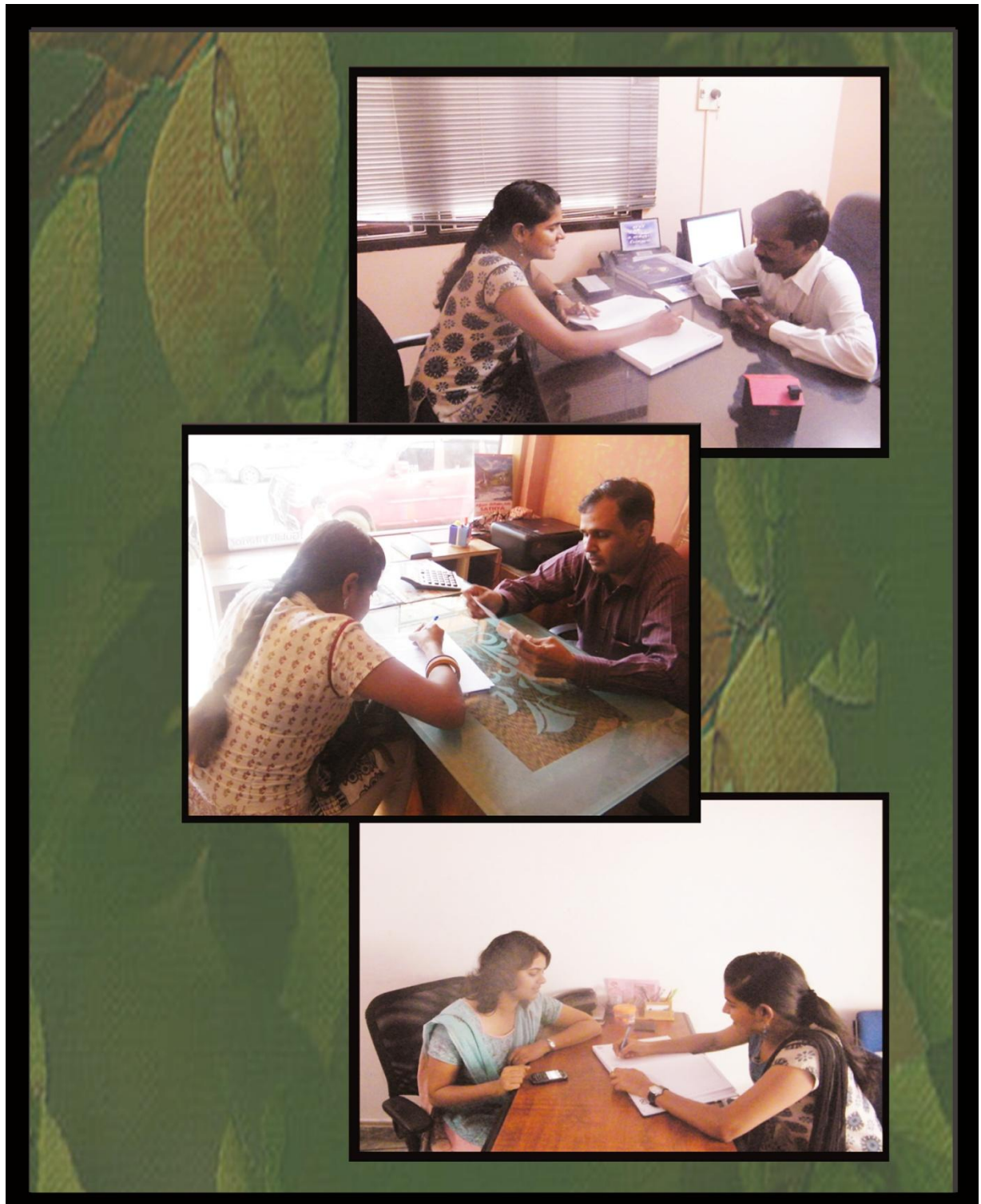


PLATE I

Surveying Interior designers and Architects

The pilot study was considered which helps in checking the adequacy of the tool and possibility of conducting the survey (Kothari, 2000). Schedule was pretested among five green interior designers. The pilot study indicated the need for adding certain items based on the response from the green interior designers, necessary modifications were made and schedule was finalized, which is presented in Appendix-I

5. **Collection of data**

To approach the interior designers and architects was a difficult task to amist their busy schedule. Hence the investigator fixed an appointment with Interior designers and Architects before approaching them .She contacted them and explained about the purpose of the study. A good rapport was established between the interviewer and interviewee .The investigator went from firm to firm and interviewed the individual personally and administered the question one by one, and filled up the schedule on the basis of the information supplied by the individual. Thus, questions were asked informally and necessary informations were gathered for the study as shown in Plate II.

6. Consolidation of collected data:

The analysis of data involves number of closely related operation that are performed with the purpose of summarizing the collected data and organizing them in such a manner that will yield answer to the research question (Mohan,2007). According to krishnaswami (1999) after the transcription of data is over, the data should be summarized and arranged in compact form for further analysis. This process is called tabulation.

This phase involves the orderly and systematic presentation of numerical data in forms designed to elucidate the problem under consideration (Devi, 1998).Thus the tabulation is the process of summarizing raw data and displaying

them on compact tables for further analysis and interpretation, the collected data were consolidated and tabulated.

b. Among the Clients:

Survey was conducted among the clients who have adopted green concept by engaging interior designers. In order to obtain required information for the study on their economic background and their experience with interior designers in different stages of their project, a survey was found essential. The procedure adopted is based on the following steps:

1. Area Adopted for survey.
2. Selection of sample.
3. Research method applied.
4. Formulation of the schedule.
5. Data collection and Interpretation.

1. Area Adopted For Survey:

Residential areas such as T-Nagar, Anna nagar, Puraisaivakkam, M, R.Nagar, choolai and sowcarpet, were identified by the investigator due to convenience, easy accessibility for obtaining the desired information and co-operation extended by the clients in disseminating the required information. Chennai leads with 29 green buildings among cities awarded Leadership in Energy and Environmental Design (LEED) certification by IGBC (Times of India, 13 February 2012).

2. Selection of Sample:

Fifty clients belonging to high and upper middle income families residing in Chennai city who have implemented green building techniques were selected for the study based on the purposive sampling technique. As she felt that these

groups of people only could afford to know the latest trend of interior designing. Besides they will have better ideas to bring eco friendly environment and also will be ready to spend money for the purpose without any hesitation. An element of randomness was introduced into this kind of sampling by using random numbers to pick up the unit. It is easier and economical method of sampling (Bowles, 2003). This sampling technique allowed the researcher to select the sample for the study for the particular purpose.

3. Research Method Applied:

Personal interview method was applied by the investigator for this study. Face to face interview between an interviewer and respondent is referred to as personal interview (www.learnmarketing.net/primaryresearch) as shown in plate III. The investigator selected the interview method in order to obtain supplementary information and in-depth awareness (www.Learnmarketin.net) . The sincerity, frankness, truthfulness and insight of the interviewer can be better judged through cross questioning. Visual stimuli to which the informant may react can be identified (Patnaik, 2001).

4. Formulation of the Schedule

Schedule is generally filled out by researcher or the enumerator who can interpret the question (Reddy, 2004). The schedule framed for the study consisted of general information of the residents-ownership, their interest towards decorating the interiors, budget allocated and problem faced if any with the Interior designer and Architects. As a general rule, a questionnaire should not be used without adequate pretesting, Malhotra (2008). The prepared schedule was pretested in five residences for its ambiguity and the schedule was modified, which is presented in Appendix-II.

6. **Collection and Interpretation of Data**

According to Paneerselvam (2004) data are the basic input in any decision making process. The processing of data gives statistics of the study. The needed data were collected from the selected clients. The investigator created a right type of friendly atmosphere with the selected house owners, which is very conductive for obtaining desired data. The respondents were to reveal information.

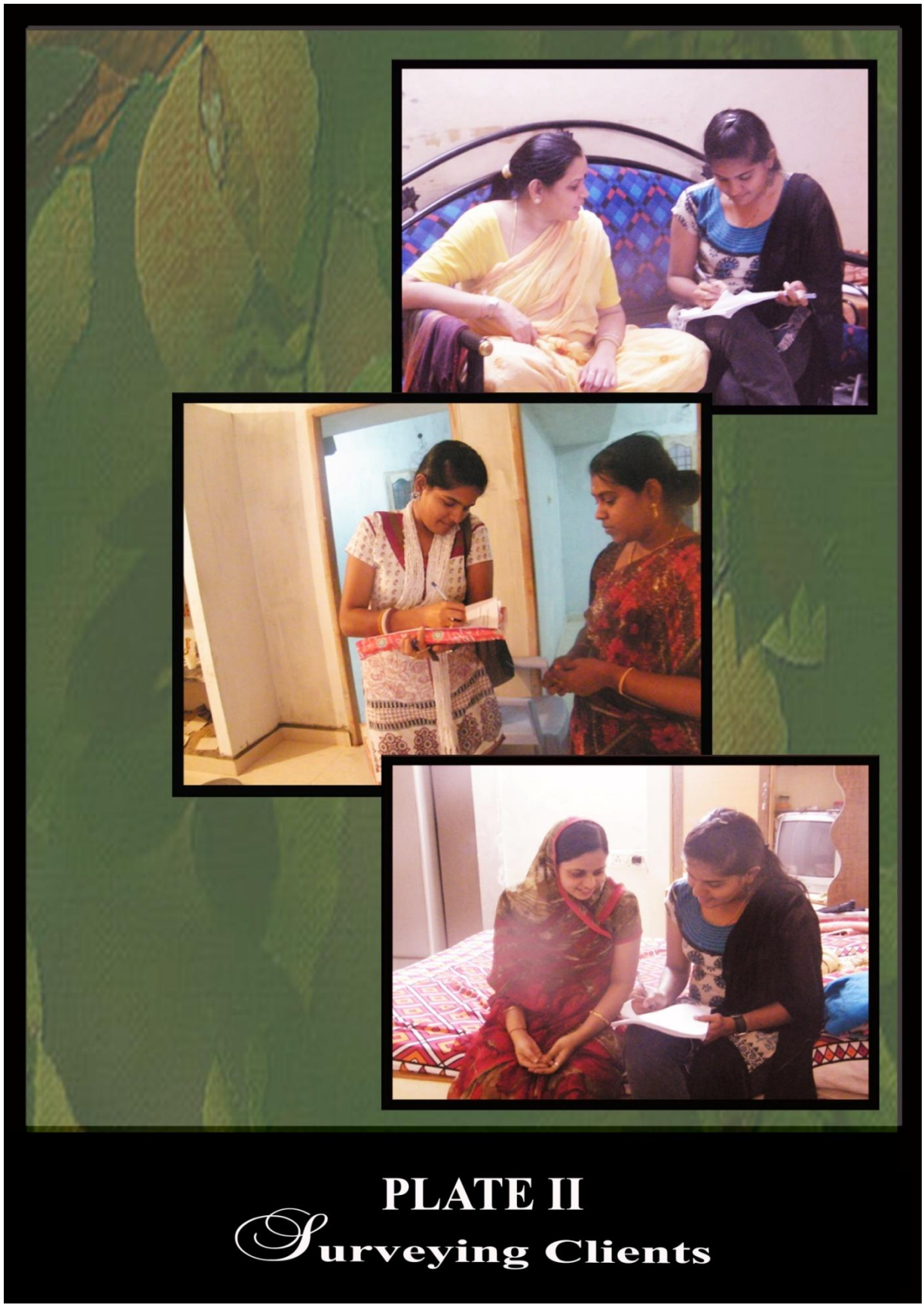


PLATE II

Surveying Clients

Interpretation is not only necessary but unavoidable as research is concerned. In fact, it is an important step in so far as conclusion of research study (Reddy, 2004).The data thus collected were consolidated and tabulated (Jain, 2000). The purpose of the table is to simplify the presentation and to facilitate comparison. Thus the tabulated data were analyzed, discussed and presented in chapter IV result and discussion.

B. Awareness Creation On Green Building

Creating awareness on green buildings among the people was essential as many of them have the belief that green building is expensive and the materials used may not be strong, durable and attractive. People have to rely on builders, engineers and designers for choosing material and technical guidance. Hence to make them clear about the concept, awareness was created on the importance of green architecture, benefits of Green architecture, green materials, cost effective green technologies and need to avoid hazards to themselves and environment at Thyagaraya nagar social club, Chennai.

Fifty members from Thyagaraya nagar social club was selected to create an awareness based on the framed course content as given in Table IV and plate III. The programme aimed to educate the middle and upper middle income people. Their interest to accept the concept of green architecture and the willingness to implement were the reasons for selecting the specific samples for education programme. It was scheduled for two days based on the convenience of the club members.

TABLE IV

DEVELOPMENT OF COURSE CONTENT

S. no	Topic	Course Content	Method used
1	Environmental sanitation	• Types of pollution: air ,water, soil and noise • Sources :Building construction ,demolition, building materials, mechanical devises	Slide shows, lecture
2	Green buildings and its benefits	• Green building- An Introduction • Importance of green building • Sustainability as an element • Energy efficiency, Water Conservation, grey water utilization, enhanced air quality, excellent day lighting, health and safety benefits of people, and conservation of scarce national resources.	Lecture , Slide show and group discussion
4	Other Informations	• Existing green buildings. • Future green building projects. • Various Green building consultant and builders.	Photographs lecture, slide showing

The success of the programme depends on how well it is carried out. Creating awareness and sensitizing the selected samples are important aspect to be considered in the implementation of sustainable education programme. The selected samples were requested to assemble in the seminar hall of Thyagaraya nagar social club. Chief member of the club was invited to inaugurate the programme. The programme was interactive as all members actively participated and discussed on the above mentioned topics. Slide show inspired people, attracted attention and eye catchy which urged them to take immediate action (Reddy, 2008).

Thyagaraya nagar social club

Slide Show and lecturing

Members participated in the programme

PLATE III

Creating awareness on Green building

C. **Presentation of Case Study**

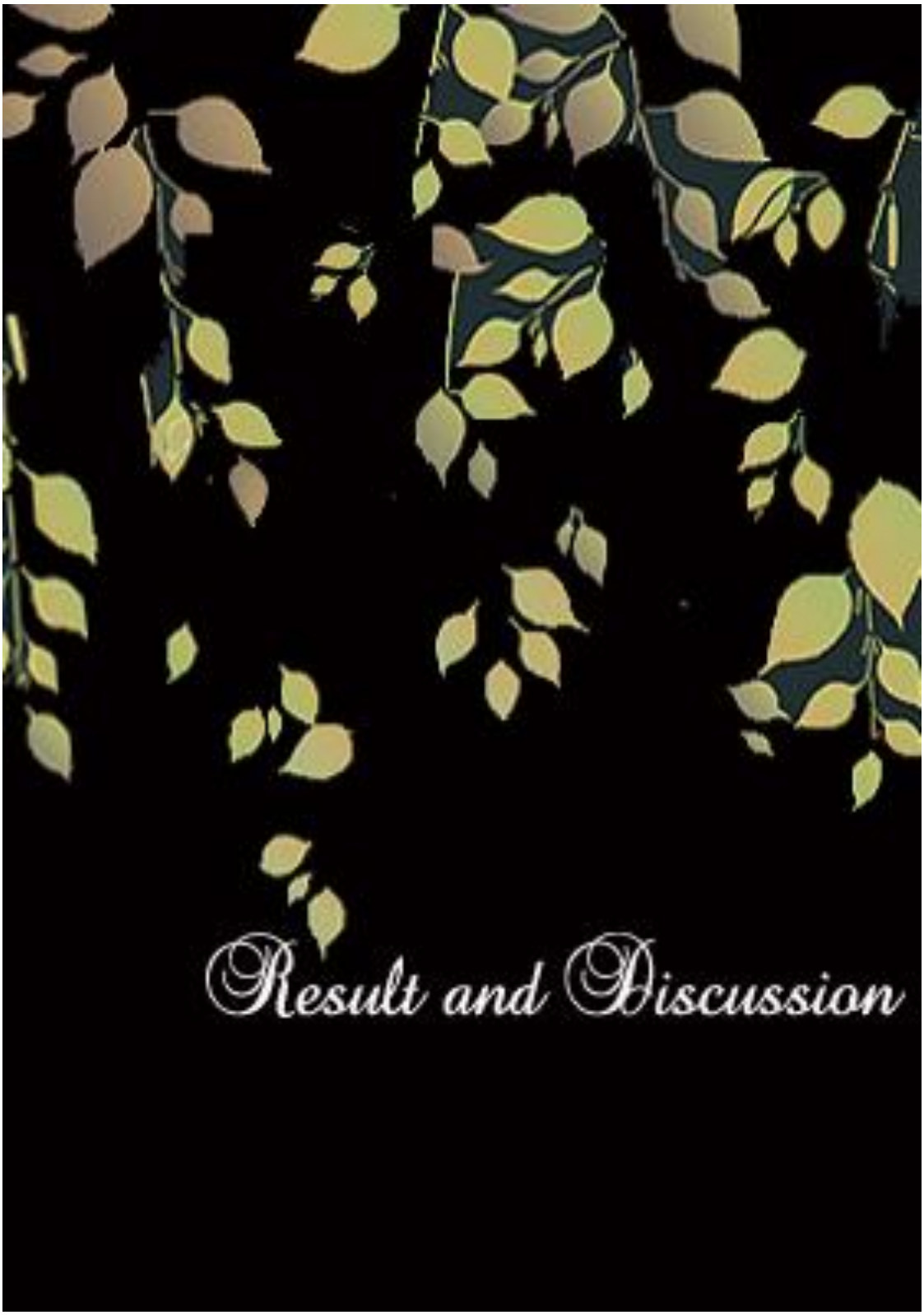
The investigator with the help of experienced Green Architects of EN3 sustainability solutions.pvt.ltd and Isha homes, Pvt, ltd, received all necessary advise, assistance and guidance. She collected informations on different techniques and materials used. The projects selected for the case study were upto the satisfaction of the clients and Government standards, the below case study were done:

Case study I - Viswa Syamalam

Case study II - Isha Mia Villas

D. Designing With Green Building Concept

The investigator attempted to design a Green Building. Hence she approached the Interior designer Miss. S.Malini, Falcon Decors (interior design firm), who gave all necessary advice, assistance and guidance to develop the plan using different materials and techniques. Modification and necessary alterations were made in the plan, so that the final outcome of the project will be upto the satisfaction of the clients. The investigator involved herself in designing a green building plan, were she was assisted by the designer in every step from developing the rough plan to the rendering of the plan. The project named "Healthy Family" was finalized and plans are shown in chapter IV-Result and discussion.


Result and Discussion

IV.RESULT AND DISCUSSION

The finding of the study on "Green buildings and suggesting effective design to reduce ecological foot prints" are discussed under the following headings:

E. Information Obtained On Green Building

c) Architects and Interior designers.

d) Clients.

F. Creating Awareness

G. Presentation of Case Study

c) Viswa syamalam.

d) Isha mia.

H. Designing with Green Building concept

A) Information Obtained on Green Building

a) Architects and Interior designers.

This phase of finding present the data received from the selected 25 Interior designers and Architects, which include:

1. General information about the Green builders (Architects and Interior designers).
2. General information of the firm.
3. Economic details of the firm.
4. Specific information of the firm.

1. General information about the green builders(Architects and Interior designers)

As green building is an area which is gaining popularization, investigator showed interest to gather information from the Interior Designers and Architects. Table V gives the general information on the selected interior designers and architects.

TABLE V

GENERAL INFORMATION ABOUT GREEN BUILDERS

Details	Per centage (n=25)
Sex	
• Male	90
• Female	10
Age	
• 25-35	15
• 35-45	33
• Above 45	52
Educational status	
• B.sc. ID	8
• Dip.ID	13
• B.E.Civil	32
• M.E.Civil	9
• B.Arch	30
• M.Arch	7
• Others	1
Years of experience	
• 1-5	15
• 5-10	48
• 10-15	30
• Above 15	7

From the table it was found that majority, 90 per cent of the selected Interior designers and Architects were men but 10 per cent of women designers were supported by their fathers, husband and brothers in the same field. Fifty two per cent of them were above the age of 45 and remaining were within 25-45 years. The basic qualification was B.E., Civil Engineering (32 per cent), B.Arch (30 per cent) and Dip.ID (13 per cent).Only 9, 8 and 7 per cent were M.E.Civil, B.sc. ID

and M.Arch. It could be inferred that along with the qualification, interest, in the field and creative thinking helped the selected interior designers and architects to survive and withstand in the field.

The surveyed Interior designers and Architects revealed that 48 per cent had an experience of 5-10 years in the field followed by 30 per cent between 10-15 years and 15 per cent had only up to five years of experience.

2. General Information of the Firm

Table VI indicates the information on location and type of building, builtup area and ownership.

TABLE VI

GENERAL INFORMATION OF THE FIRM

Details	Per centage (N=25)
Location	
• Heart of the city	100
Type of building	
• Rented apart	15
• Rented house	40
• Owned apart	35
• owned house	10
Year of establishment	
• 1995-2000	14
• 2000-2005	48
• 2005-2011	38
Buildup area	
• Below 500sqft	12
• 500-750sqft	73
• 750-1000sqft	9
• Above 1000sqft	6
Ownership	
Sole proprietorship	14
partnership	86

Cent per cent of selected Interior designers and Architects firm were located in heart of the city as it would be easy for clients to approach. Forty per cent of

them had their firm in rented houses, while 15 per cent of them on rented apartments. Thirty five per cent of selected samples had established their firm in their owned apartmenst and 10 per cent of them had setup their firm in owned houses.

All selected Interior designers and Architects had registered and insured their firm. Regarding the year of establishment, nearly 50 per cent of them started their business between 2000-2005.

A majority of them were running only small firms. The built up area for 73 per cent of the firm was between 500-750sqft for 12 per cent and 9 per cent was below 500 and between 500-1000 sq.ft and only 6 per cent of the firm was above 1000 sq.ft. Eighty six per cent of them were running the firm under partnership with their friends and colleagues and only 14 per cent were sole proprietors of the firm. Among them majority (83 per cent) were drafting their plans of their projects using only Auto cad and rest of them were doing it either manually or using AutoCAD, 3ds Max, Archie Cad, Rivet etc. whichever is preferred by the clients.

The selected Interior designers and Architects took up the projects locally as well as nearby cities such as chengalpet (22 per cent), Salem (16 per cent) and Madurai (10 per cent).Sometimes popular Interior designers and Architects took projects even from faraway places like Bangalore (36 per cent), Coimbatore (32 per cent), and Mumbai (32 per cent). Similarly, based on the nature of the project they had to visit the site either locally or outstation. Hence it was also revealed that they could not exactly mention the number of days they will be out of station per month. 87 per cent of them indicated that, at least once a week they had to go out of station in relation with their profession.

Place of purchase of material for green construction depends on the quality, quantity and the cost. Most of the materials were purchased locally, where as materials like accessories, lighting fixtures, fashionable rugs were all imported or brought from Delhi, Bangalore and Mumbai. Meager 13per cent of them and 6 per cent imported items within India and other countries.

Progress in business mainly depended on how popular the firm is and how long the firm exists. To make their firm popular, advertisements, previous client's successful projects and recommendations of the satisfied clients play an important role. All Interior designers and Architects took much effort to complete the project successfully as this could fetch good name and more clients in future.

Among them 93per cent of them were taking up both residential and commercial projects for 62 % of interior designers and architects previous project was commercial and the rest were residential.

3. Economic Details of the Firm

The initial investment of the firm, its present value, approximate yearly turnover and their profit are shown in detail under the Table VII.

TABLE VII

ECONOMIC DETAILS OF THE FIRM

Particulars	Per centage (N=25)
Initial Amount Invested (`)	
0-1lakh	15
1-5 lakh	28
5-10 lakh	47
Above 10lakh	11
Present Value (`)	
1-15 lakhs	12
15-30 lakhs	23
30-45 lakhs	56
Above 45 lakhs	9
Yearly Turn Over(Approximately) (`)	
1-10 lakhs	2
10-20 lakhs	3
20-30 lakhs	9
30-40 lakhs	18
40-50 lakhs	42

Above 50 lakhs	26
Profit Per centage	
10-20 %	13
20-30 %	32
30-40%	32
Above 40%	23

For any firm, investment plays an important role for its achievement. Majority of them, (47 per cent) had initially invested up to 10 lakhs, followed by 28 per cent who had invested 1-5 lakhs and 15 per cent had contributed within 1 lakh, while remaining 11 per cent spent more than 10 lakhs.

As firms of all the Interior designers and Architects were running successfully, the present value of the firm had also increased considerably in recent years. As per the table present value of firm, is 30-45 lakhs for 56 per cent where 23 per cent have 15-30 lakhs, while 12 per cent of the value of their firm to be 1-15 lakhs ,9 per cent of them revealed that their value of the firm was above 45 lakhs.

Based on the value of the project undertaken, the turnover also differs. The selected interior designers and architects expressed that they could not specifically mention about the number of projects undertaken and their turn over, but the approximate turnover of their firm was 40-50 lakhs with the maximum of 42 per cent. Twenty six per cent of well established firms turnover was above 50 lakhs a year.

Well established Interior designers and Architects were able to keepup their profit above 40 per cent .which was mainly due to their goodwill and years of experience.

4. **Specific information of the firm**

Table VIII and Figure I, II, III present the details about the employees, expected qualities and other such information about green building materials, special features of the firm.

TABLE VIII

SPECIFIC INFORMATION OF THE FIRM

Details	Per centage (N=25)
Number of employees	
2-5	31
5-10	36
10-15	22
Above 15	11
Qualities expected from employees(*)	
Good skill	100
Software skill	99
Practical knowledge	28
Tackling problems	38
Source of information about green building materials(*)	
Exhibition	100
Magazine	100
Dealers/market/ Representatives	100
Seminar And Conference	100
Friends/Relatives	89
Special feature(*)	
Job perfection	100
Innovative ideas	92
Client satisfaction	86

- Multiple responses, * marketing tools

From the above table it is clear that nearly 67 per cent of the firm appointed 2-10 employees, Twenty two per cent had about 10-15 employees and 11 per cent employed more than 15. While selecting employees 99 per cent of the proprietors considered their software skills like auto Cad, 3ds Max, Archie Cad, Rivet etc.,28 per cent expected them to have practical knowledge and 42 per cent capacity to tackle problems.

To visit exhibitions, read civil magazines, meet dealers and representatives, attend seminar and conferences were the sources of information to update the knowledge on innovative green materials and techniques of construction.

According to selected Interior Designers and Architects, the special features of their firm were job satisfaction, innovative ideas and of client satisfaction .Other than this they also expressed on selection of materials, quality of the product, cost efficiency, aesthetic appeal, client's preference and availability and its efficiency. Table IX and Figure IV depicts the marketing tools used for advertising the firms.

TABLE IX

MARKETING TOOLS USED BY FIRMS

Marketing Tools*	**Per centage (N=25)**
Yellow Pages	100
News Paper	30
Magazines	5
Television	4
Radio	14
Just Dial	30
Web Services	85

Effective marketing was followed so that they can expand their firm and also meet the competitions in the industry. yellow pages were used by cent per

cent and web services by 85 per cent of the firm. Thirty per cent in newspapers and just dial were the other marketing tools. Fee structure of the firm is discussed in Table X and Figure V.

TABLE X

FEE STRUCTURE OF THE FIRM

Details	Per centage (N=25)
Total contract	46
Number of visits	11
Consultant fee	26
Per centage of total cost/labor cost	17

Among the selected respondents, for 46 per cent of the fee structure was on total contract, followed by 26 per cent by consulting fee, 17 per cent by per cent of total cost/labour and 11 per cent according to the number of visits. Ninety five per cent of selected Interior designers and Architects signed an agreement with the client before starting their project to avoid issues at later stages. They also expressed that they will stick on the contract at the maximum, sometimes might be changed according to the necessity.

About 45 per cent of Interior designers and Architects prepare their plans according to vastu and feng shui. 35 five per cent of them who design according to vastu and feng shui also mentioned that they design only on the demand of client, others revealed that they don’t believe such superstitions.

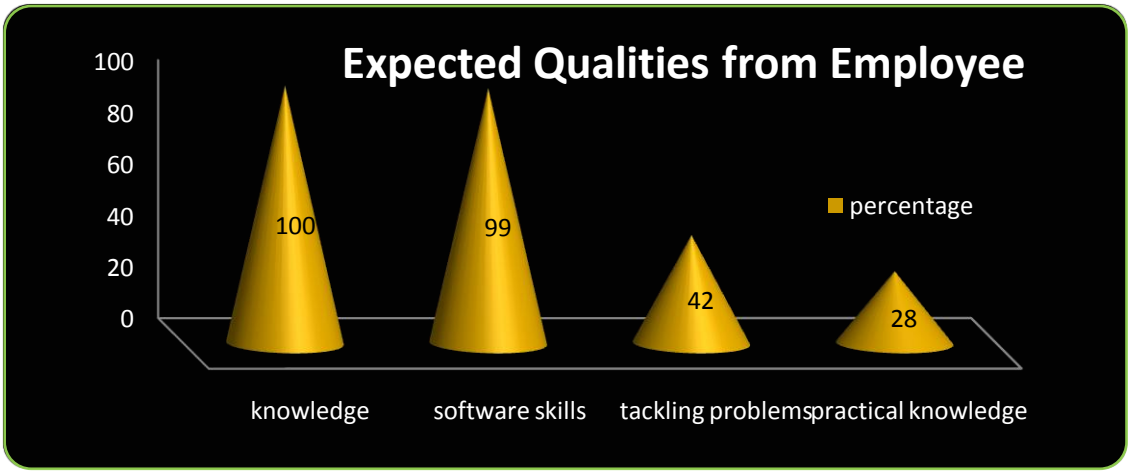


FIGURE I

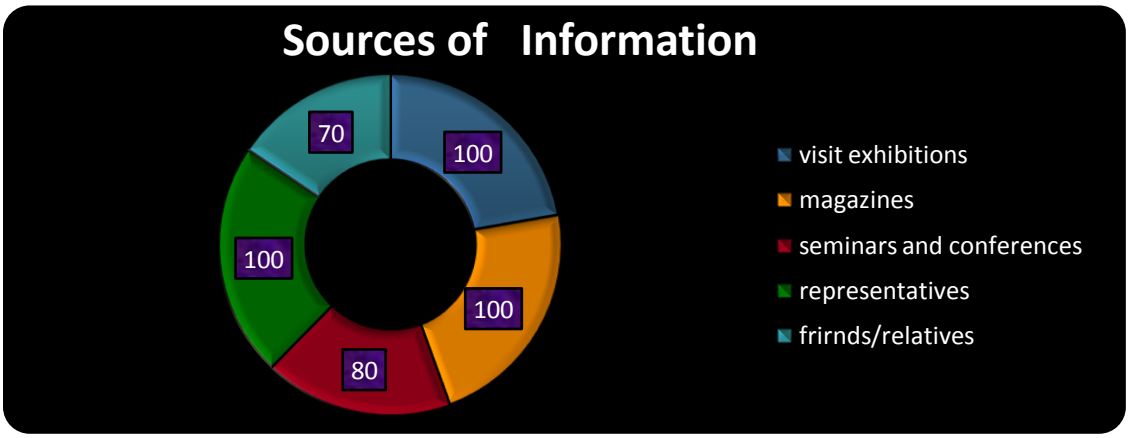


FIGURE II

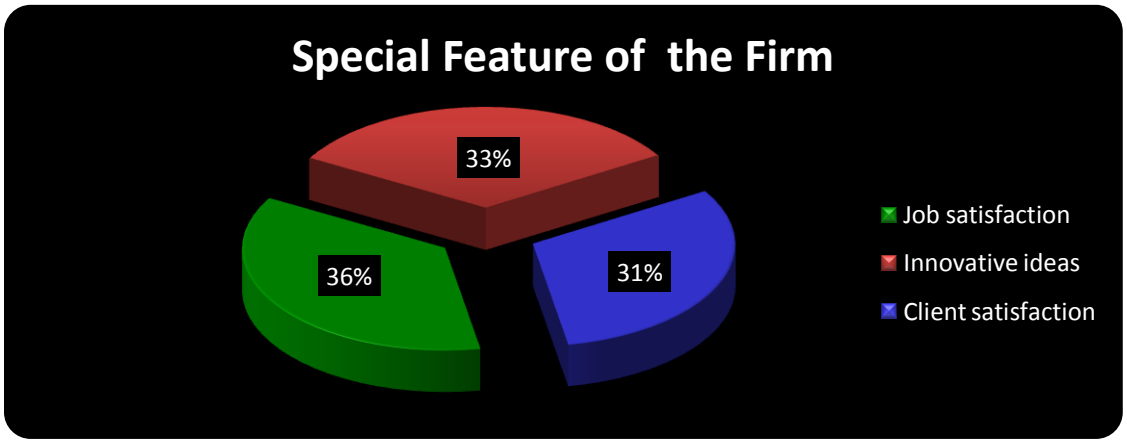


FIGURE III

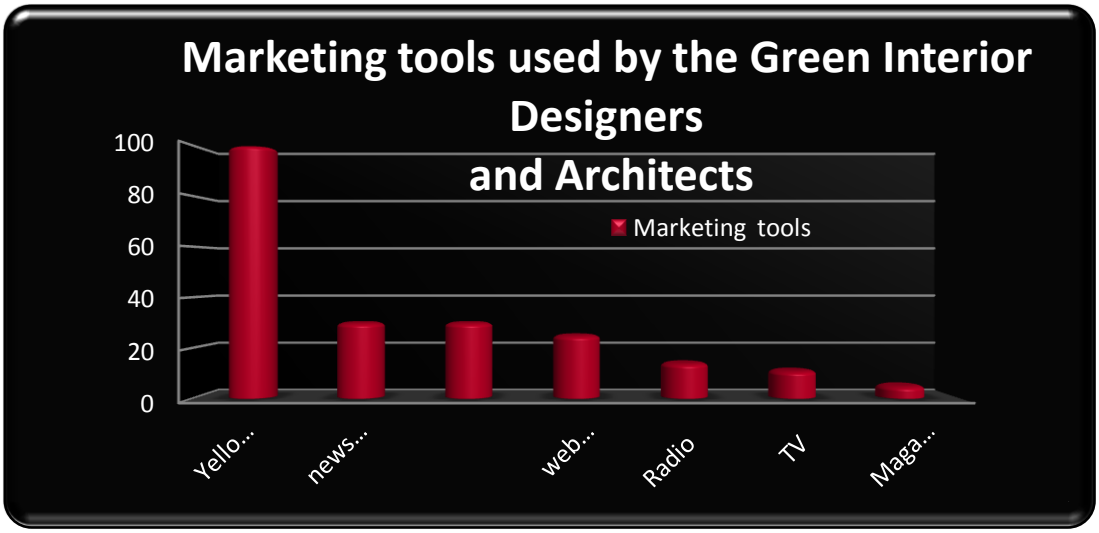


FIGURE IV

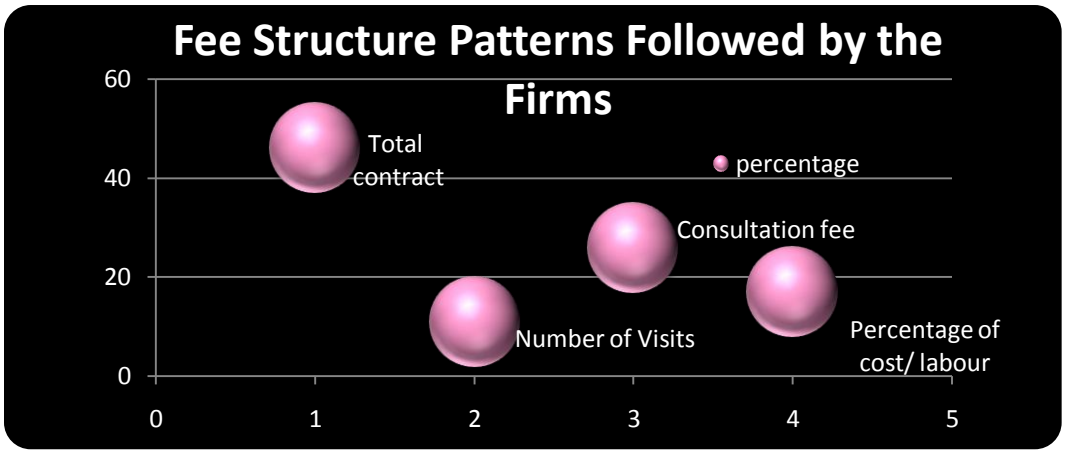


FIGURE V

B) Clients

This part of the study gives information about the association of the client with their Interior designers. The results are discussed under the following headings:

1. Family background.
2. Building details.
3. Economic details of the selected clients.

1. Family Background

The family background of 50 selected clients included details such as family type, educational status and employment status. These details are discussed under the table XI

TABLE XI

FAMILY BACKGROUND OF CLIENTS

Details	Per centage (N=50)
Family type	
Joint family	14
Nuclear family	86
Educational status	
School	
College	10
Professionals	32
Doctorates	38
	20
Employment status	
Doctors	8
Engineers	46
Business	32
Professors	10
Other	4

The selected clients highly favored nuclear families (86 per cent) and only 14 per cent belong to joint family system. This shows the change in family system.

The selected clients belonged to high and upper middle income groups. Among them, 54 per cent were professionals like doctors and engineers, 32 per cent were engaged in business and 10 per cent were working in educational institutions. Regarding educational status of the heads of families, 32 per cent had

at college level, 38 per cent and professionals and 20 per cent had their doctorial degree.

2. Building Details

Table XII includes the type of building, year of construction and total area utilized for the construction of their residence.

TABLE XII

BUILDING DETAILS OF CLIENTS

Details	Per centage (N=50)
Type of building	
Individual house	52
Apartment	48
Year of construction	
Before 2000	12
2000-2005	24
2005-2010	34
After 2010	30
Total Area	
Below 500sqft	0
500-1000sqft	6
1000-1500sqft	18
1500-2000sqft	30
2000-2500sqft	42
Above 2500sqft	4

Among the selected clients 48 per cent were residing in apartments, the rest in individual houses .Thirty six per cent of houses were built during 2000-2005, 2005-2010 by 34 per cent and after 2010 by 30 per cent.

Number of rooms in the selected residence

Table XIII depicts the number of rooms in the selected residence.

TABLE XIII

NUMBER OF ROOMS IN SELECTED RESIDENCE

Details		Per centage (N=50)
Rooms	**Number**	
Living room	One two	96 4
Bed room	One Two Three	20 46 34
Guest room	None One two	74 14 12
Study room /kids room	None one	90 10
Dining room	One Two	94 6
Kitchen	One Two	98 2
Store room	Attached with kitchen Separate	84 6
Bathroom	1-3 Above three	88 12
Pooja room	one	100
Library	One None	98 2
Office room	One None	82 8

Majority of 96 per cent and 20 per cent of the selected households had single living room and bedroom. Separate guest room and kids study room was not considered in 74 per cent of families. Only 10 per cent of houses had separate kids/study room, 90 per cent of houses do not have such types. Majority of 94 per

cent and 98 per cent had single dinning and kitchen. In eighty four per cent Store Rooms were combined with the kitchen for comfort and easy access.

It was encouraging to note that cent per cent of the clients have opted for green techniques such as maximum natural light and ventilation, rain water harvesting, utilization of grey water, use of energy efficient equipments, and lamps.

While planning their houses (Figure VI) the clients had given due considerations of a cent per cent user preference, life style ,space requirements, environmental factors, economic factors, codes and restrictions(98 per cent), functions performed (84 per cent),mechanical consideration(76 per cent). Four per cent expressed that certain design modifications have been made for the elderly at home. The design principles like emphasis, scale, proportion, harmony and balance were considered by cent per cent. The resource from which colours chosen are given in Table XIV.

TABLE XIV

SOURCES OF COLUR SELECTION

Details	Per centage (N=50)
Catalog	46
Interior designers and Architects	32
Magazines	12
friends/relatives	10

The above Table XIV depicts the sources of colour selection by the clients. Colour was given utmost importance by all the selected clients. Majority of 46 per cent of inmates had choose colour from catalog, 32 per cent by consultation with interior designers and architects, others by magazines and through friends and relatives.

Source of Information about Interior Designers

In order to have technical guidance and other information about green buildings from green designers, the clients choose their Friends/Relatives(38 per cent), 20 per cent of them obtained information from news papers, yellow pages , TV and Radio , Just dial and by visiting Exhibitions. This is illustrated in Figure VIII

Reason for choosing Interior designers and Architects

While selecting interior designers, the reasons expressed by clients are maximum preference for economy, job Perfection, quality of work, appearance, per cent on basis of efficiency, Client preference and Prompt service. The clients preference for selecting interior designers and for their construction project are shown in Figure IX

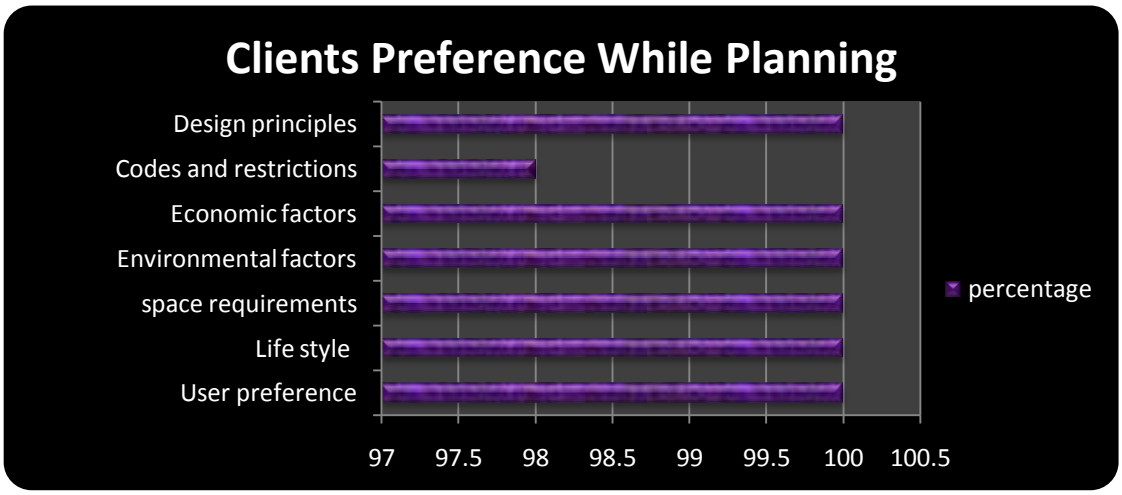


FIGURE VI

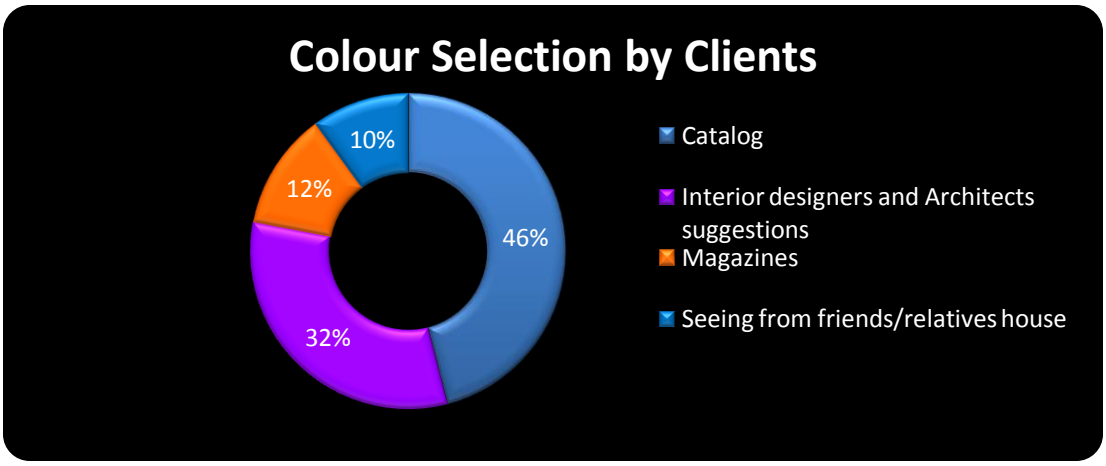


FIGURE VII

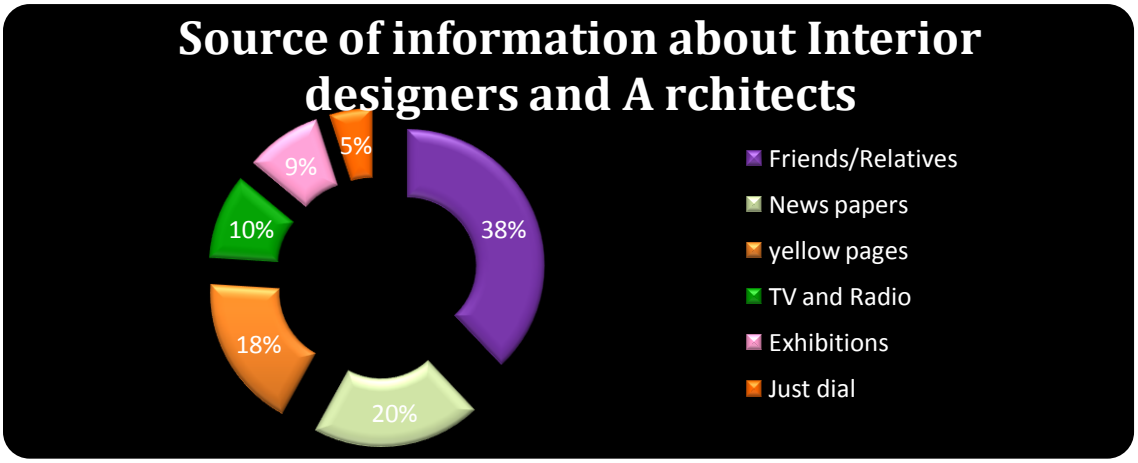


FIGURE VIII

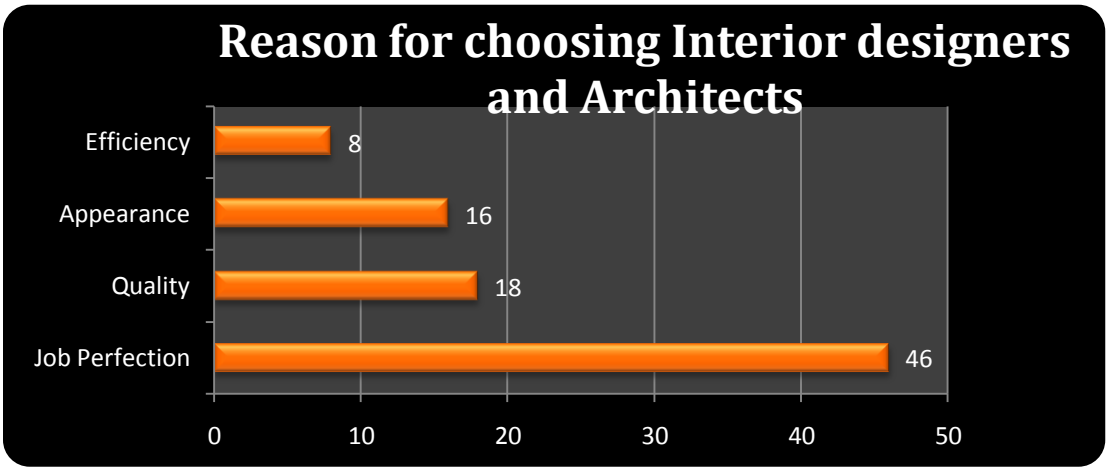


FIGURE XI

Materials Used For Construction

Table XV includes information on materials used for constructions by the selected clients.

TABLE XV

MATERIALS USED FOR CONSTRUCTION

Details*	Per centage (N=50)
• Water installations without PVC	68
• Materials with environmental certification	92
• Foam materials (CFC and HCFC)are completely avoided or minimized	86
• Gravel replacement in the form of crushed concrete	100
• flooring materials -wood ,natural stone or ceramic tiles	100
• Recycled bricks and tiles.	98
• Insulation materials of recycled organic origin	89
• Low “not renewable” energy consumption materials	78
• Special care to the local weather conditions	96
• Use of glass and windows.	100
• natural and cross ventilation	100
• Thermal mass as a basis for storage of solar gains	98
• Avoidance of air condition/cooling systems.	98
• Designed with natural or hybrid ventilation.	94

***multiple response**

Among the selected clients cent per cent of them used wood, natural stone as flooring materials, glass windows for maximum utilization of daylight and cross ventilation, replaced gravel in the form of crushed concrete, had given special care to local weather conditions and planned to natural and cross ventilation, 98 per cent used recycled bricks for construction, minimized air conditioning/cooling

systems and the buildings were completed with a documented level of thermal mass as a basis for storage of solar gains.

Ninety four per cent of homes were designed with a high amount of "free heat" gains are designed for natural or hybrid ventilation, 92 per cent used materials with environmental certification, 88 per cent used recycled organic Insulation materials, Surfaces are treated with materials that are indoor-climate certified, 86 per cent avoided using of Foam materials of CFC and HCFC and 78 per cent followed low "not renewable" energy consumption material and 68 per cent of them had Water installations without PVC.

Recreation Facilities Provided

Table XVI represents the recreation facilities provided in selected houses

TABLE XVI

RECREATION FACILITIES PROVIDED IN CLIENTS HOUSE

Facilities	Per centage (N=50)
Recreation facilities	
Indoor game	42
Bar	34
Home theater	36
Meditation hall	18
Outdoor game	8
Safety facilities	
Fire exit stairs	36
Fire alarm	48
Automatic power cut management in lifts.	98
Fire extinguisher	86

Sixty five per cent of the houses had recreation facilities, whereas 35 per cent had no such provision. Forty two per cent had indoor Game facilities, Home

theaters, 34 per cent had Bar facilities, 18 per cent had Meditation hall and 8 per cent with outdoor Game facilities were planned. Regarding safety 98 per cent had automatic power cut management in lifts and 86 per cent had fire extinguishers.

Specifications

This phase consists of information on water, rainwater, indoor air climate, energy utilization, waste disposal as shown below in Table XVII.

TABLE XVII

SPECIFICATIONS OF THE BUILDING

Details	Per centage (N=50)
Water ,Rainwater	
Rainwater harvesting facilities	100
Use age of Rainwater (gardening &toilets)	90
Individual water meter	66
Utilization of Grey Water	54
Indoor Air Climate	
Balanced ventilation	100
Cross ventilation	100
Indoor material with climate certification	96
Noise insulation (below 25db)	84
Energy Utilization	
Natural energy utilized	100
Installed Individual consumption displays	82
Useage of solar water heaters	98
Hot water taps -limited and centrally placed	92
Low-energy consumption lighting	100
User-activated specific lighting.	100
Waste Disposal(solid and waste)	
Proper provision for waste disposal.	100
Treatment before disposal.	84

Among the selected clients, cent per cent of them had installed rainwater harvesting and 90 per cent of rainwater was used for gardening and toilets. sixty

six per cent installed Individual water meter and 54 per cent used grey water. Cent per cent of the selected clients implemented balanced ventilation and cross ventilation, 96 per cent used materials with indoor climate certification and 84 per cent maintained noise level below 25db.

cent per cent utilized natural energy and installed Low-energy basic lighting and User-activated specific lighting. Eighty two per cent installed Individual consumption displays, 98 per cent used solar water heaters , 92 per cent limited hot water taps .There were Cent per cent proper provision for the disposal of waste and 84 per cent treated the waste before disposal.

Cent per cent of the surveyed clients realized the environmental impact of waste on air, water, soil and revealed that the Government, NGO'S and other organizations must focus their attention towards protection of the environment.

3. Economic Details of the Building:

This Table XVIII below depicts the information on the amount spent for interiors, expected budget and actual budget.

TABLE XVIII

ECONOMIC DETAILS OF THE BUILDING

Details	Percentage (N=50)
Amount spent for interiors	
Below 1 lakh	18
1-5 lakhs	56
5-10 lakhs	14
Above 10 lakhs	12
Expected budget	
Below 5 lakhs	74
5-10 lakhs	14
Above 10 lakhs	12
Actual budget	
Lesser	14
Exact	42
More than	44

Among the selected clients, more than 56 per cent have spent 5-6 lakhs for interior decoration, whereas 14 per cent have spent 5-10 lakhs and 18 per cent below one lakh and onlym12 per cent above ten lakhs. Expected budget for 74 per cent were below 5 lakhs, for 14 per cent it was 5-10 lakhs and for 12 per cent the amount expected was above 10 lakhs.

B. Creating Awareness

After creating awareness all the respondents were aware of green building concept and they showed their willingness to implement for their house construction as specified in Table XIX and Figure X.

TABLE XIX

IMPACT OF THE AWARENESS PROGRAMME

Details	Per centage (N=50)
Realized the need for sustainable architecture.	92
Gained knowledge on green concept	100
Cost effective green techniques in green buildings	100
Realized that green techniques are economical and not expensive.	100
Green buildings are essential for the future world	100
Realized-Healthy housing ensures healthy family living.	93
Reduces ecological foot prints and protect the environment	98
Green techniques must be mandatory in approval of the building plan	72

Most of them (92 per cent) realized the need for sustainable architecture in future. Cent per cent of them gained knowledge about green concept, its necessity for future world and also cost effective green techniques. green building are essential for future world Everyone realizes that healthy housing ensures healthy family living.

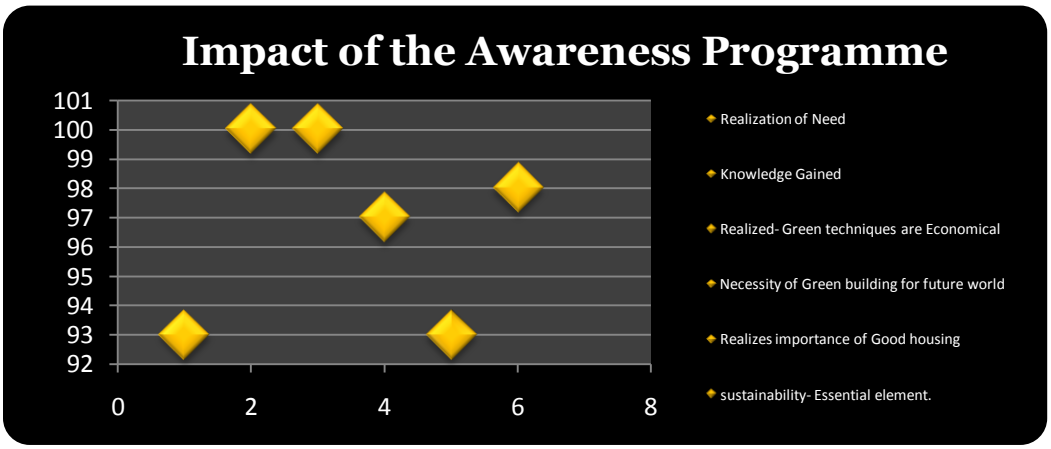


FIGURE X

Around 72 per cent of them considered green techniques must be mandatory in approval of the building plan.

C. Presentation of Case Study

The investigator with the help of experienced green architects of EN3 sustainability solutions.pvt.ltd and Isha homes, Pvt, ltd, who gave all necessary advise, assistance and guidance. They also explained the different techniques and materials used so that the final outcome of the project will be upto the satisfaction of the clients and Government standards. The details of two case studies carried out were discussed below:

a) Viswa Syamalam

'Viswa Syamalam', Chennai, is amongst the first Green Homes, rated highest 'Platinum' by the Indian Green Building Council (IGBC). IGBC encourages eco-friendly sustainable practices for homes that cover a wide gamut starting from Site Selection and Planning, Structure Design, Water and Energy Efficiency, Materials and Indoor Environment Quality. Innovation, Design Process and Operations and Maintenance optimization, Waste and Toxics Reduction are also included as a part of typical overall green building evaluation. For example, with rain water harvesting, recycling and adopting conservation methods and practices, Viswa Syamalam is a water positive home with least carbon foot print.

Table XX highlight project details on Viswa Syamalam, India's first Green home rated highest platinum by IGBC which has been exceedingly complied with all the above prerequisites of making a world class Green Home.

TABLE XX

CASE STUDY 1-VISWA SYAMALAM

Project Details	
Building Use	Residential
Location	Chennai
Size	3,790 Sq. Ft.
Certification Level	Platinum
Owner Family	Mr. U V Krishna Mohan Rao & Dr. (Mrs.) Uma Devi Rao and daughter Dr. U V Nivedita
Architects & Structural Consultants	P. Ravi Architects Private Limited & Ms. Vidhi Gupta, Chennai
Electrical, Plumbing, HVAC, Landscape, Horticulture, Consultants	UV Krishna Mohan Rao Associates, Chennai
Contractor	MJ Babu, Chennai
Green Consultant	Dr. U V Nivedita
LEED Facilitator	En3 Sustainability Solutions Pvt Ltd., Chennai

It's in the Family

National Award Winner as a Best Energy Auditor from Petroleum Conservation Research Association, Government of India, UVK Rao mentioned that he has always been a firm believer that conservation starts from one's home and lifestyle. So does Nivedita, a LEED Green Associate, perhaps the first medical professional in India to have passed the US Green Building Certification Institute Exam. To prove the ideology and that Green do not necessarily mean cost, the family built 'Viswa Syamalam' with passion and zeal for large scale replication in an era of accelerated building construction activity all-over.

The Green Agenda

Taking advantage of natural, renewable resources, recycling and reuse are emphatic at Viswa Syamalam for which the Architects had given the following key agenda for designing:

- Least carbon foot print and lowest energy loads and consumption
- Utilization of renewable energy
- Lowest operating and maintenance cost with positive life-cycle benefits
- 100 % self-sufficiency in water and to be a water positive home
- "No electric light" during daytime
- Excellent ventilation for round-the clock freshness in the entire premises and to ensure that whenever ambient is less than 28°C there is no need to turn on air-conditioners
- 100% re-utilization of any refuse, waste material during construction and consider only eco-friendly materials and practices. To operate as a "zero waste" home
- At least for three features, to be the best in the country, if not as a world model

Sustainable Site and Practices

In line with Green Buildings' requirement, soil preservation was given utmost importance – top soil was preserved and used back for horticulture purposes, steps taken to prevent soil and water runoff. Construction debris and refuse was used back in the premises.

For local transport bicycles are used and for family commuting hybrid car being used and predominantly electric trains and public transport are relied upon. Materials with high solar reflectance and thermal emittance on the roof to meet Green Buildings' minimum requirement of 50% have been used in this building.

Efficient Design on a Life-Cycle Benefit Basis

Considering green integration at the concept and design stages on a life-cycle benefit basis laid the foundation for Viswa Syamalam's highest rating. The "respect for energy, water, resources and environment in totality at concept stage itself" is a key element in a home building project life cycle, as it has the largest

impact on cost and performance. Viswa Syamalam minimizes the total environmental impact associated with all life-cycle stages of the building project.

Minimal Energy Load for Viswa Syamalam

As a fundamental issue, the load is critically reviewed and finally took power connection for barest minimum with practically no redundant sockets and power loads. Heat ingress into the building is minimized by a variety of means such as constructing the peripheral walls with an air gap, using insulating material in roofs, reflective coating on terrace, using energy efficient glass; providing shades. Cross ventilation is provided to ensure freshness in every nook and corner of the home. The windows and openings are provided in such a fashion that light is brought in and not the heat. The property is designed to harvest day lighting with the result 100% of the entire living space of the home is day lit without the necessity of turning on electric lamp during sunrise to sunset.

Efficiency of the building envelop was enhanced with high-efficiency glass, insulation in walls and ceilings. Care is taken in effective orientation of windows, walls, awnings, porches for good ventilation and light. Plants and creeper shading in a cozy manner provide and aid heat and dust ingress and aid good ventilation.

Every electrical appliance – fans, refrigerator, air conditioners, water pump are most energy- efficient rated and the best available in the country, if not the World. The 100% of the indoor and outdoor lighting of the two storied building is with least energy consuming and long lasting, mercury free lamps , namely, LED lighting. Simple controls such as automatic sensors for lights, fans and air conditioners are used. Auto sensors are also used for security purposes. There are no voltage stabilizers in the house and no “remotes” and therefore there is no standby power loss.

Solar water heating further reduces energy loads. Tapping solar energy for water heating completely eliminated need for electric geysers. In the washing

machine and even in the solar heating system, stand-by electric heater element which normally is supplied by default has been avoided at the first instance.

Water Positive Home with No Municipal Water Connection

Viswa Syamalam depends entirely on rain water collected in its 60'x40' gross site area. Water that is collected in a clean manner is purified with necessary filtration and reused on-site. The protection and conservation of water throughout the building life is to a great extent accomplished by designing for dual plumbing that recycles water for toilet flushing and horticulture. This non-sewage and grey water utilization minimizes the demand on the local aquifer. Waste-water is minimized by utilizing water conserving fixtures such as ultra-low flush toilets and low-flow tap and shower heads fitted with aerators.

Need for artificial water treatment plant is eliminated in this home. Recycling of water is practiced: separate pipelines are laid for toilet flush and the grey water from the kitchen, hand wash and bathing is treated using Root Zone filtration system, without using any power and relying on nature's own biological army (bacteria and plants) to treat the water.

There is no municipal water connection for the home. The only water source of rain water is managed for yearlong usage by supplementing with adequate storage capacity of 50,000 liters. During heavy monsoon days, the surplus water over and above the storage capacity is harvested to charge the bore well and surrounding aquifer.

Thus the 3,790 sq.ft "Viswa Syamalam" consuming 50% less water than other typical urban dwellings is a water positive Green Home with rain water harvesting, water-efficient fixtures, controls, recycling and conservation of water. Says UVK Rao, "we not only respect water as sacred but also assign value to it greater than one would do with expensive eye-drops". Every drop of air-

conditioner condensed water is captured and reused, and not a rain drop that falls on site is let-off without harvesting.

100% Smart Lighting

This eco friendly home uses natural day light with the result from sunrise to sunset not a single electric lamp is required to be used in any part of the home – be it kitchen, living, study, pooja, rest rooms – every nook and corner takes advantage of natural light adding immense natural life to the home ambience. For practical demonstration effect, a rest room and an interior clinic room (Dr. Uma Devi's) in the ground floor utilize sun pipes providing brilliant yet cool natural light. In fact, it is 100% electrical light energy saving during day time! After sunset, entire Viswa Syamalam is lit only with LED - both interior and exterior – perhaps the first of its kind in this part of the world light to use 100% LED lighting. These are custom-designed, aesthetic lamps, giving task and need-based light with apt color temperatures.

Most of the building is painted white and balance minimal spaces in light colors thus accentuating lighting naturally.

Extra care for Material Efficiency and 0% Waste in Viswa Syamalam

During construction, extra care was taken to use standardization to minimize waste, and whatever remnant materials were reused. For example, the broken tiles were used for terrace cladding; wooden scaffolding poles reused for gardening and paint cans as pails and flower pots.

Viswa Syamalam

Water Positive technique

PLATE IV

Case Study I- Viswa Syamalam

Nearly 90% of all the material sourced for Viswa Syamalam is locally manufactured and thus ensuring that even during the construction the use of fossil fuels is minimized. This property also used recycled and reused material to ensure additional resources need not be squandered. For example, packaging wood is re-used for compound wall gate and making furniture. Terrace cladding is done with broken tiles which not only conserves material but also reduces the heat ingress into the building.

Eco-friendly building materials like fly-ash based cement and blocks, recycled steel, reclaimed wood, bamboo screens and flooring were done. The family opines that "waste is actually misplaced wealth". There is no material that is wasted. For example, kitchen and garden refuse is converted into manure and entirely used in the home garden which grows flowers, fruits, vegetables, herbs, shade-giving and water treatment plants and creepers.

Green materials including used wood or rapidly renewable plant materials, recycled metal, and UPVC windows are used. In the entire building no teak and no imported material was used.

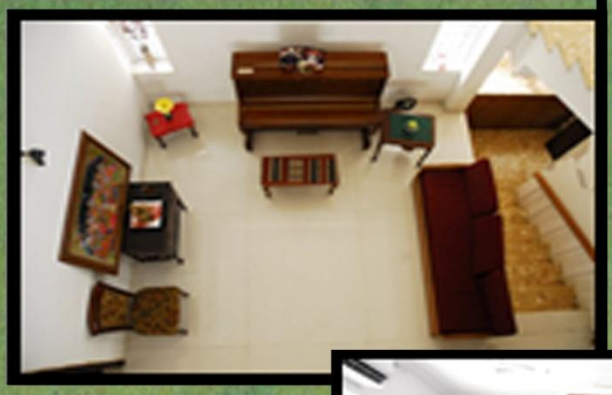
Indoor Environmental Quality Enhancement

State of the art air conditioners with inverter based control and highest energy -efficiency are installed in the few rooms that are air-conditioned. .During

the design and construction process construction materials and interior finish products were carefully chosen with zero or low emissions.

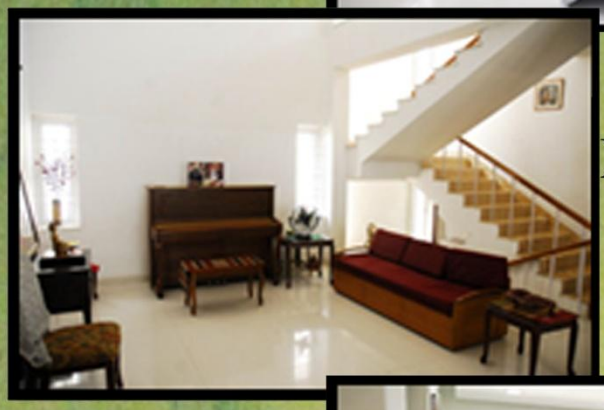
Home that respects renewable energy

Solar water heater is provided for not only bathrooms but also to the kitchen for preheating and utensils and clothes washing that aids in reduction of water and detergent consumption. Foot pedal lamp cum battery charger, solar



100%
smart lighting

IEQ
Enhancement



Minimal Energy
utilization

Efficient
Design

PLATE V

Case Study I- Viswa Syamalam Features

lantern and emergency lamps, sun pipes, solar cookers are other examples of supporting non-conventional energy.

Viswa Syamalam project which commenced during 2008 and completed in 2009 is a symbol of the future, the future where builders, architects and buyers would shape the design, costing and construction methods that would ensure that Green Homes are not just a societal statement but change agents ensuring efficient and responsible use of earth's resources.

Incorporating the various sustainable features meant an additional initial cost of about 18 % and additional time of about 6 months for scouting various materials and competent professionals in the case. However, Viswa Syamalam owner family is are clear that it is a positive home in all respects and therefore on a lifecycle benefit-basis there is no extra cost for greening the home.

a) Isha Mia Villas

Isha Mia Villas is an eco-friendly gated community, which consists of 106 independent villas, set in over ten acres of lush greenery. Ensuring residents with an effortless sustainable lifestyle, Isha Mia Villas is crafted to blend nature with living spaces. Implementing a variety of green features, combined with state-of-the-art amenities and smart designs that best suit today's contemporary lifestyles and help live the dream life, naturally. Architectural elements such as walls, flooring, carpentry, painting, electrical materials used are given in table XXI.

TABLE XXII

ARCHITECTURAL ELEMENTS AND MATERIALS USED

ARCHITECTURAL ELEMENTS	SPECIFICATIONS
CIVIL WORKS	
Walls	Fly ash solid blocks/Fly ash bricks
Structure	R.C.C. framed structure
Kitchen Platform	Black granite
Staircase steps	Black granite Raiser, Treads, and for skirting also. Handrail with SS 304 grade material.
FLOOR CLADDING	
Toilet floor, balcony& terrace.	12” x 12” branded Antiskid ceramic tiles
Entire floor area	2’0” x 2’0” branded Vitrified flooring tiles
Bathroom walls	12” x 18” Up to 7’0” height branded ceramic wall tiles
kitchen counter	Branded ceramic tiles doing up to 2’0”
CARPENTRY	
Main doors	Forest Certified teakwood frame with paneled shutters
Bedroom doors	Forest Certified teakwood frame with hardcore flush doors
Toilets & Balcony doors	Forest Certified teakwood frame with both sides waterproof/film coated/PU coated flush doors
Windows	Eco-friendly UPVC operable windows with single glazing low heat transferring glass with wall mounted M.S. Grill
PAINTING	
Ceilings	Putty finish.
External wall	Low VOC exterior weather shield paint
Toilet doors	Low VOC enamel paint for bedrooms
Main doors	M.S. Grills. Melamine finish
PLUMBING	
CPVC pipes	All concealed ¾” & 1” pipe lines
Concealed cistern & wash basin	All ceramic fittings Dura it/equivalent brand wall mounted EWC
All CP fittings	Groh/equivalent with diverter
Branded kitchen	stainless steel sink single bowl with drain board.
ELECTRICAL	
Switches/equivalent	MK Brand Modular
Wires	Polycot PVC FRLS

PLATE VI

Case Study II - Isha Mia Villas

- **Solar power:**

Effectively utilizing sun's renewable energy to provide a cost-effective home; every home is equipped with solar panels that are capable of powering a home during the day with sunlight and four hours without. But that's not all. Solar water heaters on every roof ensure a copious supply of hot water at all times.

- **Windmills:**

Windmills placed in the campus ensure optimum usage of wind power, which contributes significantly to the minimization of carbon dioxide, apart from cost saving. The harnessed wind energy is used to power the streetlights, the clubhouse and the commercial complex.

- **Water management:**

Providing the community with adequate water supply, Isha Mia Villas puts in place rainwater harvesting techniques along with a hydro-pneumatic water distribution system and a sewage treatment plant. This ensures an independent water supply during water restrictions, while also effectively preserving and recycling water for multiple uses.

- **Herb & Kitchen garden :**

Stay healthy by consuming home grown produce that ensures freshness, nutrition and taste, while keeping away from food preservatives, additives and the recent bout of genetically altered crops. The community devotes half an acre of land for a herb and kitchen garden, which provides the community with culinary and medicinal herbs as well as fresh produce.

- **Power for eco vehicles :**

Isha Mia Villas offers battery charging stations for electric vehicles with every home, encouraging residents to reduce pollution and cut costs on fuel with electric

PLATE VII

Case Study II- Isha Mia(Recreation facilities)

vehicles. Producing zero emissions at the point of use, electric vehicles not only have a small carbon footprint but are also more efficient than internal combustion engines found in normal vehicles.

- **Bicycle :**

Providing a bicycle with every home, Isha Mia Villas encourages residents to opt for an eco-friendly mode of commute within the community, while contributing to their green lifestyle.

Additional Green Features:

- Solar fencing
- Heat resistant roofs and windows
- Low VOC paint
- Forest Certified Teakwood
- Rain water harvesting with 0% discharge
- Solid waste management
- Indoor plants that enhance air quality

Specification:

Harmonizing ultra-modern architecture with green building principles, Isha Mia Villas is an eco-friendly masterpiece, designed to visibly express a small carbon footprint. With luxurious homes constructed using eco-friendly building materials, every aspect of home helps to maximize savings and minimize costs, giving you the perfect opportunity to experience a sustainable lifestyle, effortlessly.

- **Amenities**

Isha mia villas is designed to address all our needs, Isha Mia Villas houses

world class amenities that include healthcare, shopping and entertainment all in one campus. can experience everything you need in life at your own pace.: Landscaping , gymnasium, guard room, outdoor games,Park,CCTV / intercom, commercial complex, party lawn with gazebos, multi-purpose hall, indoor games, jogging track, children play area, power backup for common area, servant/drivers toilet, shuttle court, skating rink.

Apart from our excellent customer service, we at Isha Homes have been well recognized as pioneers in the Villa segment..With Isha's Signature Villas, we revolutionized Chennai's real estate market by bringing in the innovative concept of gated communities. In the years to come, we will be launching few more Villa projects featuring a lot more luxurious amenities in the suburbs of the city.

Any eco-friendly home gives you the opportunity to conserve the environment within its confines. At Isha Mia Villas, we take it a step beyond the community's walls. With its close proximity to the SIPCOT zone - Asia's largest tech park, leading schools and shopping centers, you can now conserve fuel when you commute to work, school or shopping.

- **Fostering Sustainability**

Embracing a greener lifestyle means making healthy. Earth-friendly choices that are good for the environment, as well as health. But going green doesn't require you to give up the things you love. Designed to deliver a socially conscious lifestyle, these resource efficient villas ensure an effortless sustainable lifestyle without compromising on exclusivity, amenities or luxury.

- **Green Construction**

Construction using eco-friendly building materials, every home will implements energy efficient designs, materials and appliances to provide a tighter, more energy saving home. This only means that residents can enjoy a healthy and

more comfortable life, Green homes also ensure your contribution is effective in the fight against global warming as it utilizes fewer natural resources and has a small carbon footprint.

D. Designing with Green Building Concept

Creating a Green home design is an art itself. A plan that serves all the necessary requirements of the home owners is a challenge to most architects. A good Green home design plan always creates a balance between the functions, energy efficiency, uniqueness, aesthetics and economics of the home building.

The investigator approached an experienced Interior Designer, Miss .S.Malini, Falcon Decors (interior design firm) who gave all necessary advice, assistance and guidance. She suggested different techniques, modified her plans and made necessary alterations, so that the final outcome of the project will be upto the satisfaction of the clients. The investigator involved herself in designing a green building plan were she was assisted with suggestions from every step by the designer from developing a rough plan to the rendering of the plan.

Stages Involved In Developing a Plan

While developing a building plan, the understanding of the client's lifestyle, design criteria, and financial limits are to be considered. However the investigator due to limitation of time and experience she could not implement the plan to reality. But the steps involved in developing the plan by her with the assistance of the Interior decorator are:

Stage I: Developing a Rough plan

This stage begins with the building and zoning department that govern the site, investigation of the site, and discussions with any board of review that may be required. Once this initial research has been done, preliminary design studies can be started with Bubble diagram.

Bubble drawings are freehand sketches used to determine room locations and relationships. In this stage of the preliminary design, consideration is given to the site and energy efficiency of the home.

Stage II: Changes in the Concept

Once satisfactory layout has been sketched, these shapes are transformed into scaled sketches. Figure XII. Shows a preliminary floor plan developed by the Investigator. Several sets of sketches were developed by the investigator. Among these, the Interior designer selected the plan that suited their requirement.

Stage III: Developing Stage

This stage includes floor plan and an elevation. Investigator made changes and revisions this time according to the utility of rooms throughout the design process. Furniture outline were planned to determine the amount of space in the room. Architectural standards were followed. Once the plan was approved by Interior decorator, the drawings were ready to be converted to technical design drawings.

Stage IV: Technical and Material specification Stage

The Investigator laidout the technical drawing, which include the site, foundation, roof, electrical, cabinet and framing planes, size of the beam and other structural members, but exact size are usually not determined until project is carried out.

Stage V: Completion of Drawing

Complexity of the residence will determine which drawings are required. Most building departments required a site plan, a floor plan, foundation plan, elevation, and on cross section as the minimum drawing to get a building permit. The completed plans developed by the Investigator include the Floor plans

(Appendix V), electrical plan (Appendix VI), details of roof(Appendix VII) and sections and elevations(Appendix VIII).

HEALTHY FAMILY

Healthy family house have exceedingly complied with all the above prerequisites of making a world class Green Home. For example, with rain water harvesting, recycling and adopting conservation methods and practices, it is a water positive home with least carbon foot print. The investigator developed the Healthy family project for which their specifications are shown in Appendix IV with the following features are also considered.

The project is planned with three bedrooms, two bath of 2,395Sq. Ft. The project is planned using Structural Insulated Panels (SIPs) for the exterior wall systems. The panels provide a very rigid structure with continuous R-16 insulation unbroken by studs and panels provide an envelope with less air infiltration. The exterior cladding is planned as it can hold paint for a longer time and which is resistant to pests and rot. This reduces cost of maintenance and repairs.

The exterior and interior walls were planned with insulated metal studs. Roofings were installed with a ridge off it galvalume venting system, gas combo or hydronic heating system and a porch with west orientation. The non load bearing walls are made of Stramit Enviropanels of 2¼ inches thick which are made of compressed wheat straw and covered with drywall paper. These reduce labor by eliminating framing, insulating, easy to install and allow more interior space and reduce the use of dimensional lumber, thereby reducing the need to harvest mature trees.

To avoid heat buildup in the attic, galvanized metal roofing combined with rigid and-soffit venting system are planned to reduce the temperature by 20-30 degrees on hot summer days. These roofs will last 30-40 years with little or no

maintenance as R-30, 10 inch blown cellulose made of recycled newsprints is

PLATE IX

Green project- Healthy Family

87

planned for ceiling insulation. Considering floors in the public rooms, stained concrete and in bedrooms recycled tiles and carpet were used. Linoleum counter tops were planned for kitchen. The project is planned to use paints, adhesives and vinyl flooring with low Volatile Organic Compound (VOC), having less than 150 grams per liter and hundred per cent recycled carpets for further reduce off-gassing.

In addition to the thermal benefits that reduce the operating costs of the project, mostly recycled material were used for construction. Thus use of virgin raw materials in the construction is reduced. To complete the thermal package, installation of high efficiency 14 SEER air conditioning, ceiling fans in all major rooms .It is planned in such a way that there are windows on two walls for cross ventilation, comfortable living space , energy efficiency and Community-building. Porch in the front provide shade for the walls and windows adds to living space , where the families can get to know their neighbors and keep track of neighborhood activities. To provide the best indoor air quality use of formaldehyde free Medium Density Fiberboard (MDF) were planned for cabinet construction. All landscaping were done according to xeriscape principles.

IEQ (Indoor Environment Quality) & Materials:

PVC excluded from all interiors, roofing (EPDM & metal) and piping, Flooring: Linoleum, Stratica, reusable carpet and tiles, Wall covering: Sisal and Low toxic paints and finishes and certified wood.

Site

A storm water retention system, captures the first three-quarter inch of rainfall from each storm, allows it to drain through filtered catch-basins from the rooftop into the cisterns and then moves it into the building's water recycling system, Light-colored roofing, with shading provided by plants and overhangs, keeps temperatures down in and around the building, In the courtyards, porous paving made from 100 per cent post-consumer or post-industrial plastic resins allows

storm water to percolate into the ground instead of running down storm drains and Old trees are preserved.

Water

Dual-flush toilets and a high-efficiency dishwasher help keep water use low and Water recycling system stores, filters and disinfects water reclaimed from rainfall, showers and sinks for use in flushing toilets and irrigating landscaping, Drought-resistant landscaping and outdoor potted plants, including many native to plants, minimize irrigation needs and A drip irrigation system emits measured amounts of water through small tubes to each plant's root ball, limiting water loss due to evaporation.

Energy

14 SEER central air conditioner for Continuous ridge and soffit venting, Large covered porch with 2 foot overhangs sized to provide shade, Cross ventilation with Operable windows in every occupied space, Galvalurne and Reflective metal cool roof, Designed day lighting with photocell sensor lighting control and Energy-efficient, low-mercury fluorescent lamps minimize mercury disposal in the waste stream, Structural Insulated Panel (SIP) exterior wall systems and Double paned windows /solar screens and Light wells, clerestories and architectural glass provide natural day lighting throughout the building to reduce the need of electric lighting.

Renewable Energy

A 7.5 kW grid-connected solar electric array produces approximately 37.5 kWh of electricity per day, enough for about 20 per cent of the building's electricity demand.

Materials and Resources

Sixty per cent of all new wood of Forest certified, sustainable forests, Floor mats and tiles are made from recycled rubber, countertops mats and tiles are made

mats and tiles are made from recycled rubber, countertops are made from recycled glass and veneer panels are formaldehyde free.

Carpeting

Stramit compressed straw panels, Paint primer, Deck porch decking and Cellulose insulation (100% recycled lumber and newsprints),High fly ash content concrete, Recycled-content materials and furniture in the building include glass tile, mineral fiber ceiling tiles, workspace and conference room furniture, detergent bottle toilet partitions and gypsum drywall and Some furniture and light fixtures were planned to reuse from old ones.

Indoor Environmental Quality

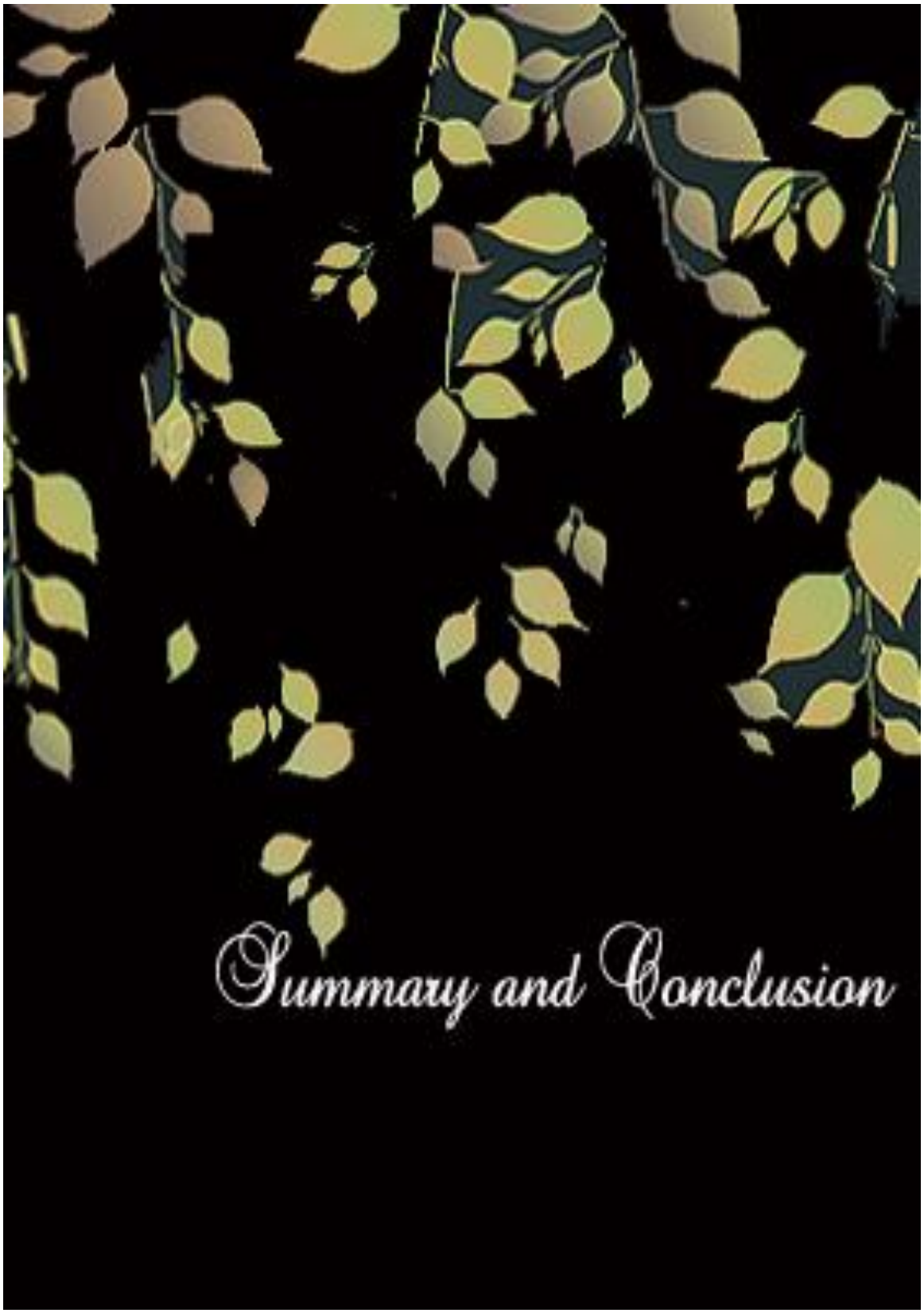
Medite formaldehyde-free MDF cabinets, Pleated media HVAC filters,Paints, adhesives with low VOC components ((less than 150 grams per liter).The building is free of added urea formaldehyde and nearly free of vinyl. chlorinated solvents, and vacuums that are equipped with filters to prevent the release of particulate matter into the air.

Projected Utility Use and Costs (regulated uses only)(www.greenecono.net)

- Electricity: 38,150 kWh.
- Natural Gas: 2,360 Therms.(A unit of heat equal to one lakh British thermal units)
- Water: 35,500 gallons.

Pollution Reductions

- CO2 (carbon-di-oxide): 54 tons/yr.
- NOx (Nitrogen oxide): 450 pounds/yr.
- Sox (sulfur oxide): 500 pounds/yr.


Summary and Conclusion

V. SUMMARY AND CONCLUSION

Green building brings together a vast array of practices and techniques to reduce and ultimately eliminate the impacts of buildings on the environment and human health. It often emphasizes taking advantage of renewable resources.

Green homes also ensure an effective contribution in the fight against global warming as it utilizes fewer natural resources and has a small carbon footprint. In the future we would have clusters of these new age, futuristic homes generating their own energy, reusing and recycling every drop of water they use, producing no waste at all and most importantly leaving a positive environmental foot print.

Hence the investigator focused the research "Study on Green Buildings and Suggesting Effective Design to Reduce Ecological Foot Prints". The findings of the study are summarized below:

Chennai, leads in terms of number as well as the total volume of the certified Green building space was the locale of the study. The investigator has selected 25 Interior designers and Architects (15 Architects and 10 Interior designers.) who formed the sampling unit were identified with the help of family members, friends, just dial and yellow pages. Purposive sampling was the basis for selection of samples.

Fifty clients belonging to the higher and upper middle income families residing in Chennai city, who have implemented Green building techniques were selected , as they were ready to spend money and aware of the latest trends in Interior design.

An awareness was also created on green building to 50 members at Thyagaraya nagar social club. To make them clear about the concept on the

importance, benefits, materials, and cost effectiveness of Green buildings .

Case studies on viswa syamalam and Isha mia villas was presented in this study with the help of experienced Green Architects of EN3 sustainability solutions.pvt.ltd and Isha homes, Pvt, ltd, received all necessary advise, assistance and guidance.

The investigator designed green building project named “Healthy family” with the help of Interior designer Miss. S.Malini, Falcon Decors (interior design firm), who gave all necessary advice, assistance and guidance to develop the plan using different materials and techniques.

A) **Information Obtained on Green Building**

a) Architects and Interior designers

All the Interior designers and Architects belong to the age group of 24-45 and above 45(48 and 52 per cent). With reference to their education status 32 per cent and 30 per cent were B.E., Civil Engineering and B.Arch and remaining have completed Dip.ID , M.E.Civil, B.sc. ID and M.Arch. Nearly 50 per cent of them had 5-10 years of experience.

Regarding the general information, every selected interior designers and architects firm were located in heart of the city. Among these , 55 percent were on rented basis and the remaining had in their own buildings. They initiated their business between the year 2000 and 2005 (48 per cent). Utmost 81percent of the selected interior designers and architects were running the firm under partnership by takingup both residential and commercial projects.

Majority, 83 percent of selected interior designers and architects drafted the plans using Auto cad, 3ds Max, Archie Cad, Rivet etc. They took up projects locally, nearby cities and faraway places also. Place of purchase of green material

depends on quality, quantity and the cost. Most of the materials were purchased by them locally , where as rare materials, accessories, lighting fixtures, fashionable rugs were all imported. Cent percent of them aspire to complete the project successfully, which could fetch good will and more clients in future .Seventy two percent of them obtained clients through advertisement.

Forty seven percent of interior designers and architects had initially invested upto 10 lakhs. The present values of 56 percent of the firms were 30-45 lakhs. Forty two percent of them revealed that their approximate turnover is 40-50 lakhs and well established firms turnover was above 50 lakhs per year. The profit earned for 64 percent after completion of the project was 20-40 per cent and it was above 40% for well established firms.

Concerning the specific information of the firm, nearly 67 percent of selected interior designers and architects have appointed 2-10 employees and 99 percent of them were expected to have software skills(auto Cad, 3ds Max, Archie Cad, Rivet etc.) .Other than this practical knowledge in the field and tactfulness was also importantly considered.

Special features of the firm as expressed by Interior designers and Architects were, job satisfaction (100 percent), innovative ideas (92 percent)and client satisfaction (86 percent). cent percent maintain good marketing. Advertising in yellow pages was the major media followed to attract clients. Maximum of 46 percent of them, the fee structure was on total contract. They also expressed that they will stick on to the contract at the maximum, sometimes might be changed according to the necessity.

b) **client**

The selected clients from high and upper middle income groups were well settled and had a good educational profile. Majority of 52 percent lived in

individual houses and 85 percent in nuclear families. Forty one percent of their houses were constructed with the total area of 2000-2500sqft. Thirty three percent were constructed during the year 2006-2010.

Cent percent of them used wood, natural stone as flooring materials, glass windows for maximum utilization of daylight and cross ventilation, replaced gravel in the form of crushed concrete, had given special care to local weather conditions and planned natural and cross ventilation. Ninety eight percent used recycled bricks for construction, avoided air conditioning/cooling systems and the buildings were completed with a documented level of thermal mass as a basis for storage of solar gains. Free heat gains, natural or hybrid ventilation, materials with environmental certification, avoidance of foam, use of recycled organic Insulation and indoor-climate certified materials, low "not renewable" energy consumption material and water installations without PVC were the specific green materials utilized in construction .

B. Creating Awareness

The awareness on green building was given to make the selected respondent (T-nagar) accept the concept of green architecture and the willingness to implement. The awareness programme was scheduled for two days based on the convenience of the club members. The framed course content included environmental sanitation, green buildings and its benefits and other Informations future green buildings projects and green building consultant and builders.

After the awareness cent percent of them expressed that they gained knowledge on green concept, cost effective green technique in green buildings, realized that green techniques are economical and not expensive, green building are essential for future world, healthy housing ensures healthy family living.

Around 72 per cent of them stressed that green techniques must be mandatory in a approval of the building plan.

C. Presentation of Case Study

The investigator with the help of experienced green architects took up two case studies (residential green buildings). 'Viswa Syamalam' a residential building of 3,790 Sq Ft in Chennai, is amongst the first Green Homes, rated highest 'Platinum' by the Indian Green Building Council (IGBC).

The salient features of Viswa Syamalam which follows green trends starting from site selection, planning, structure design, water and energy efficiency, materials and indoor environment quality. Innovation, design process and operations and maintenance optimization, waste and toxics reduction are also included as a part of typical overall green building evaluation. For example, with rain water harvesting, recycling and adopting conservation methods and practices, Viswa Syamalam is a water positive home with least carbon foot print.

The second case study on Isha Mia Villas, is an eco-friendly gated community, which consists of 106 independent villas, set in over ten acres of lush greenery. Green materials used were forest certified wood for doors, R.C.C. framed structure, fly ash solid blocks, Low VOC paint for interior and external wall, eco-friendly UPVC operable windows with single glazing low heat transferring glass with wall mounted M.S. Grill. Solar power, windmills, herb and kitchen garden, power for eco vehicles, bicycles, solar fencing, heat resistant roofs and windows, solar waste management are the other green elements and technologies implemented in Isha Mia Villas.

D. Designing with Green Building Concept

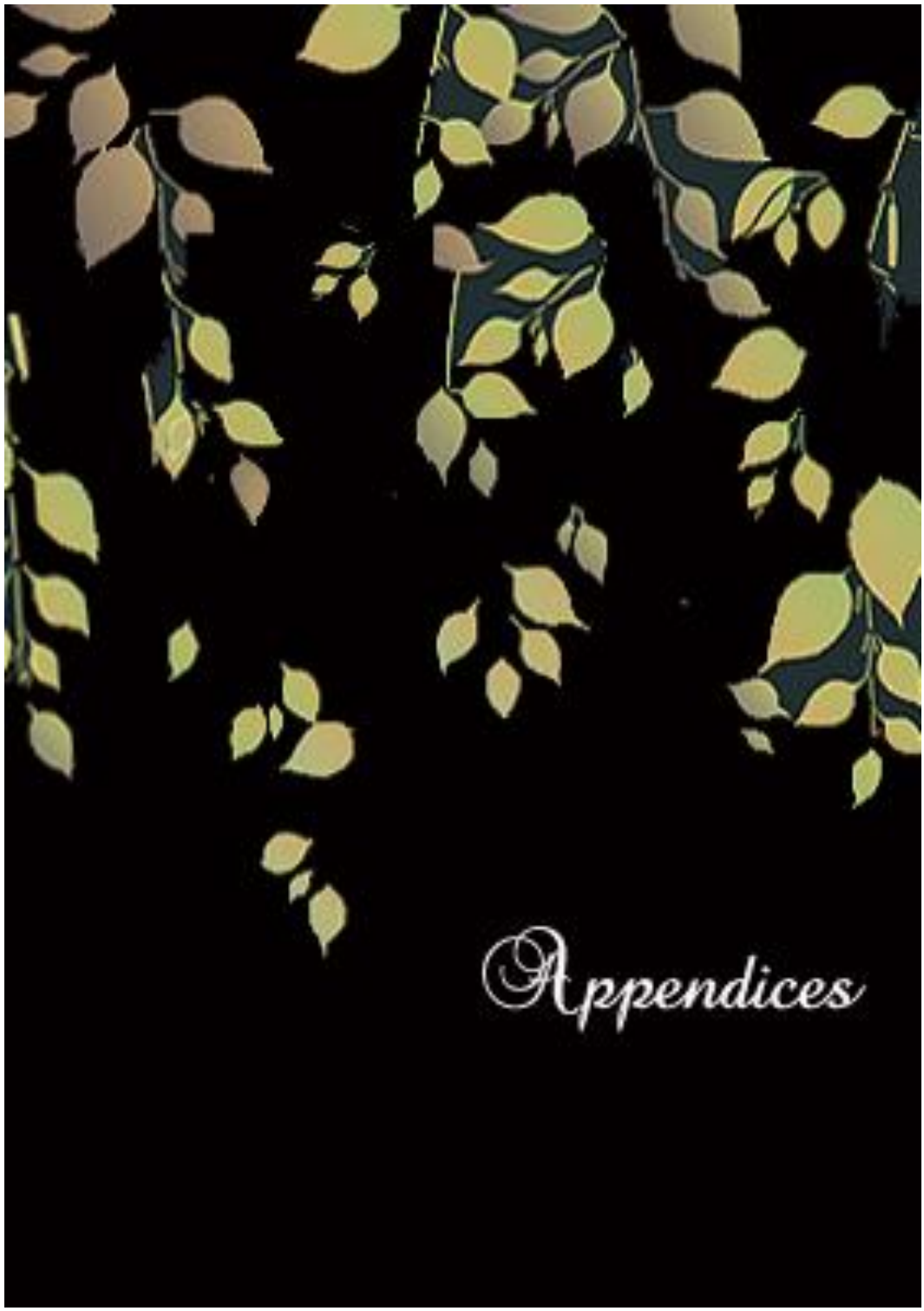
In the first stage of designing a green home (Healthy family house) a rough plan was developed using a bubble diagram. Once satisfactory layout has been

sketched, these shapes were transformed into scaled sketches in the second stage. Third stage includes floor plan and an elevation. Investigator made changes and revisions according to the utility of rooms throughout the design. In the fourth stage the technical drawing, which include the site, foundation, roof, electrical, cabinet and framing planes, size of the beam and other structural members were laidout. In the fifth stage, the completed plans incorporates the Floor plans, electrical plan, sections, elevations and details of roof and porch.

Investigator has incorporated the green concepts from case studies while developed the project "Healthy family" have exceedingly complied with all the above prerequisites of making a world class Green Home for 2,395Sq. Ft. Green materials used were forest certified wood for doors, R.C.C. framed structure, Fly ash solid blocks/Fly ash bricks, low VOC paint for Interior and External wall, Eco-friendly UPVC operable windows with single glazing low heat transferring glass with wall mounted M.S. Grill. Green techniques in regard with site, water carpeting, materials and resources, renewable energy, energy, indoor environmental quality were given most importance. On regulated use of the above materials and techniques healthy family project reduces energy consumption by 38,150 kWh of Electricity, 2,360 Therms. Of Natural Gas and 35,500 gallons of water per year. It reduces pollution by carbon-di-oxide (54 tons/yr), Nitrogen oxide (450 pounds/yr), sulfur oxide (500 pounds/yr).

"**We are seeing a new perspective of the world, where ecology and economy are two sides of the same coin.**"

-**Tahanie**


Appendices

APPENDIX-I

INTERVIEW SCHEDULE TO ELECIT INFORMATION FROM INTERIOR DESIGNERS AND ARCHITECTS ON GREEN BUILDINGS.

Identification Details:

1. Date of interview:
2. Name of interviewer:
3. Designation of interviewer:
4. Name of the firm:
5. Address of the firm:
6. E-mail id of the firm:
7. Contact number of the firm:

About the Interior Designer

1. Age:
2. Sex:
3. Marital status:
4. Educational status:

   ☐ B.sc.ID ☐ M.sc.ID ☐ Dip.ID

   ☐ B.E.Civil ☐ M.E.Civil ☐ B.Arch

   ☐ M.Arch. ☐ Any other ……..
5. years of working experience:
6. Age of entry into the field:

About the Firm:

1. Location :

   ☐ Heart of the city ☐ Urban sub

   ☐ Urban ☐ Any other
2. Building type :

   ☐ Apartment ☐ Owned

   ☐ Rented

☐ On lease

☐ Individual ☐ Owned

☐ Rented

☐ On lease

3. Year of establishment:
4. Built up area :
5. Ownership :
   - ☐ Sole proprietorship
   - ☐ Partnership
   - ☐ Corporate
   - ☐ Government representatives
   - ☐ Any other ……
6. Nature of job:
   - ☐ Designing - manually
   - ☐ Designing CAD
7. Type of consultancy:
   - ☐ Part time
   - ☐ Full time
8. Nature of purchasing eco-friendly materials :
   - ☐ Local
     - ☐ Name of the dealer:
   - ☐ Out station
     - ☐ Name of the dealer:
9. obtaining clients for green designing through:

   ☐ Advertisement ☐ Previous projects

   ☐ Previous clients ☐ Any other ……
10. Recent project undertaken:

    ☐ Residential ☐ commercial
11. green technique implemented:

    ☐ Residential ☐ Interior

    ☐ Exterior

☐ Commercial ☐ Interior

☐ Exterior

About The Client

12. Location of clients:

☐ Local ☐ out station

13. Economical status preferred:

☐ High income ☐ Upper middle income

☐ Middle income ☐ Any other ……

14. Source of motivation for taking up the job:

☐ Friends ☐ Relatives

☐ Advertisement ☐ Job security

☐ Indoor work ☐ Work spot nearby

☐ Any other……..

Financial Details Of The Firm:

1. Initial investment for the firm:
2. Value of the firm (at present):
3. Yearly turnover of the firm:
4. Percentage of profit:

Other Details Of The Firm:

1. Number of employee working in the firm:
2. Expected qualities of the employees:

☐ Good skill ☐ Practical knowledge

☐ software skill ☐ Tackling problems.

3. Sources of information about latest green materials for interiors:

☐ Magazines ☐ Friends

☐ Dealers ☐ Representatives

☐ Advertisement ☐ Any other ……

4. How is your firm special from other firms in green building construction

- ☐ Perfection of job ☐ client satisfaction
- ☐ Innovative ideas ☐ Any other ……..

5. What is your preference while selecting materials:
   - ☐ Quality ☐ Efficiency of the material
   - ☐ Appearance ☐ Economical
   - ☐ Client preference ☐ Market availability
   - ☐ Any other …….
6. What are your marketing tools:
   - ☐ Magazines ☐ Media - Radio , TV
   - ☐ Exhibitions ☐ Dust dial
   - ☐ Yellow pages ☐ Any other ……
7. How do you charge for the project:
   - ☐ Total contract ☐ Number of visits
   - ☐ Consultant fee ☐ %of total cost/labor cost
8. Do you sign any agreement or contract before the project is started:
   - ☐ Yes ☐ No
9. Do u stick on to the information as per the contact
   - ☐ Yes ☐ No
10. If, no mention the reason:
11. Do you design according to:
    - ☐ Vastu ☐ Feng shui ☐ Any other ……
12. problem faced while working on a project:
    - ☐ Payment delays from client ☐ Co-operation of client
    - ☐ Delay in material transportation ☐ Government sanctions
    - ☐ Non -availability of technicians /labors ☐ Any other……
13. Any other special information about your firm:

……
……

APPENDICS-II

AN INTERVIEW SHEDULE TO ELICIT INFFORATION ON GREEN BUILDING IN CHENNAI.

A. General Information

1. Name of the interviewer:
2. Name of the interviewee:
3. Name of the head of the family:
4. Address of the interviewee:
5. Family background:

S.No	Name	Age	Sex	Relationship to the head of the family	Education	occupation	Income/Month

6. Type of family:
   - ☐ Nuclear joint

B. Building Details

1. Type of Building:
   - ☐ Individual house
   - ☐ Apartment
2. Year of construction:
3. Total site area(sq.ft):
4. Built area (sq.ft):
5. Orientation of the house:
   - ☐ North ☐ East
   - ☐ South ☐ West
6. Space around the building:
   - ☐ Individual house Front

☐ Apartment

Rear
Side
Front
Rear
side

7. Name of the builder:
8. Cost of the building/apartment:
9. Is it green building:

☐ Yes ☐ No

10. If yes ,which agency certified:
11. Number of rooms present in your house:

ROOMS	NO.OF ROOMS	SIZE	DESIGN INFO
Veranda			
Living Room			
Kitchen			
Store Room			
Dining Room			
Bed Room			
Guest Room			
Pooja Room			
Meditation Room			
Office Room			
Study Room			
Bath Room			
Bar			
Gym			

12. Your source of information about your interior designer:

☐ Media - radio , TV ☐ Magazines
☐ Exhibitions ☐ Friends/relatives
☐ Just dial ☐ Yellow pages
☐ Any other ……

12. Reason for choosing your interior designer:

☐ Quality ☐ Efficiency
☐ Appearance ☐ EcoNomical

☐ Client preference ☐ Perfection

☐ Any other ……..

13. Are you satisfied with the work completion and materials used by them?

☐ Highly satisfied

☐ Partially satisfied

☐ No

14. If No, specify the reason:

15. What was the time line taken to design:

☐ Within 3 months

☐ 3-6 months

☐ others……..

16. Did they design by considering vastu/ feng shui:

☐ Yes ☐ No

C. Economic Details of The Building

1. Amount spent for interior designing:
2. What was your expected budget? :

D. Materials Used For Construction

1. Water installations without PVC is applied:

☐ Yes ☐No

2. Materials with environmental certification are
   a. applied (please specify) .

☐ Yes ☐ No

3. Foam materials using CFC and HCFC is totally avoided .

☐ Yes ☐ No

4. Gravel replacement in the form of crushes concrete is applied.

☐ Yes ☐ No

5. As flooring materials are only applied wood ,natural stone or ceramic tiles.

☐ Yes ☐ No

6. Recycled bricks and tiles are used .

☐ Yes ☐ No

7. Insulation materials of recycled organic origin are applied (for example flax and paper granules)

☐ Yes ☐ No

8. Surfaces are treated with materials that are indoor-climate certified.

☐ Yes ☐ No

9. Low "Not renewable" energy consumption materials, 200 MJ/m² or less.

☐ Yes ☐ No

10. Special care so constructions are protected against the local weather conditions, e.g. using extended eaves.

☐ Yes ☐ No

11. Use of glass and windows to obtain maximum utilization of daylight.

☐ Yes ☐ No

12. The building is designed to utilize natural and cross ventilation in the summer.

☐ Yes ☐ No

13. The building is made with a documented level of thermal mass as basis of storage of solar gains.

☐ Yes ☐ No

14. A building design is used which avoids the need for air condition/cooling systems.

☐ Yes ☐ No

15. Areas with a high amount of "free heat" gains are designed for natural or hybrid ventilation.

☐ Yes ☐ No

E. Facilities In The Establishment

1. Type of Recreation facilities provided:

Recreation	facilities provided
Super market	

Clubs	
Game courts	
Theater	
Others	

2. Type of Medical facilities

Medical	**facilities provided**
Hospital/dispensary	
Doctors available 24hrs	

3. Type of Safety measures

Safety	**facilities provided**
Fire exit stairs	
Fire alarm	
Fire extinguisher in each floor.	
Automatic power cut management in lifts.	

F. Specifications of The Building

1. water ,rainwater

I. Rainwater harvesting installed:

☐ Yes ☐ No

II. Rainwater used for gardening &toilet use

☐ Yes ☐ No

III. Individual water meter installed?

☐ Yes ☐ No

IV. Do you use grey Water?

☐ Yes ☐ No

i. If yes, specify:

2. Indoor Air Climate

I. Is balanced ventilation maintained?

☐ Yes ☐ No

II. Is cross ventilation used?

☐ Yes ☐ No

III. indoor material with indoor climate certification is applied

☐ Yes ☐ No

IV. Noise insulation is kept below 25db

☐ Yes ☐ No

G. Energy Utilisation

1. Is natural energy utilized

   ☐ Solar ☐Wind ☐Tidal
2. Individual consumption displays are installed

   ☐ Yes ☐ No
3. Is solar water heaters installed.

   ☐Yes ☐ No
4. The number of hot water taps are limited and are placed centrally with short and small diameter tubing.

   ☐Yes ☐ No
5. Low-energy basic lighting is installed. Supplied with user-activated specific lighting.

   ☐Yes ☐ No

H. Waste Disposal

1. Is there any kind of provision for waste disposal

   ☐ Solid ☐ Liquid
2. Is there any kind of treatment is given before disposal?

   ☐ Yes ☐No
3. If, yes specify:…….
4. Do you feel any environment impact of waste on air, water &soil?

   ☐ Yes ☐ No
5. If yes, specify the reason?
6. Do you need help for protection of your environment ?

   ☐ Yes ☐ No
7. If yes, your source of help

   ☐ Government ☐ Voluntary organizations ☐ Others

8. What kind of improvement do you want to make in your establishment safer?

   ……
   ……..
   …….

9. Your opinion about green building

   ……
   …….
   ……

10. Advantage of green building

    ……
    ….

APPENDIX III

FEATURES OF IGBC GREEN HOMES

CERTIFICATION LEVEL		Points Available	
		Projects with Interior	Projects without Interior
SITE SELECTION AND PLANNING			
Mandatory Requirement 1	Local Regulations	Required	Required
Mandatory Requirement 2	Soil Erosion Required	Required	Required
Site Credit 1.0	Basic Amenities	1	1
Site Credit 2.0	Topography/Landscape : 15%, 25%	2	2
Site Credit 3.0	Heat Island Effect-- Roof : 50%, 75%	2	2
Site Credit 4.0	Parking Facilities for Visitors	1	1
Site Credit 5.0	Electric charging Facility for Vehicle	1	1
Site Credit 6.0	Design for Differently Abled	1	1
Site Credit 7.0	Green Home Guidelines - Design & Post Occupancy	8	9
WATER EFFICIENCY			
Mandatory Requirement 1	Rainwater Harvesting, 50%	Required	Required
Mandatory Requirement 2	Water Efficient Fixtures	Required	Required
Water Credit 1.0	Turf Design : 20%, 40%	2	2
Water Credit 2.0	Drought Tolerant Species : 25%	1	1
Water Credit 3.0	Management of Irrigation Systems	2	2
Water Credit 4.0	Rainwater Harvesting : 75%,95%	2	2
Water Credit 5.0	Water Treatment : 50%, 75%, 95%	3	3
Water Credit 6.0	Treated Greywater-Landscaping : 50%, 75%, 95%	3	3
Water Credit 7.0	Treated Grey Water for Flushing : 50%, 75%, 95%	3	3
Water Credit 8.0	Water Efficient Fixtures: 20%, 30%	3	3

Water Credit 9.0	Water Metering	1	1
ENERGY EFFICIENCY			
Mandatory Requirement 1	CFC Free Equipment	Required	Required
Mandatory Requirement 2	Minimum Energy Performance	Required	Required
Energy Credit 1.0	Energy Performance	10	10
Energy Credit 2.0	Energy Metering	1	1
Energy Credit 3.0	Refrigerators	1	NA
Energy Credit 4.0	Solar Water Heating Systems : 50%, 75%, 95%	3	3
Energy Credit 5.0	Captive Power Generation	1	1
Energy Credit 6.0	On-site Renewable Energy2.5%, 5.0%, 7.5%, 10%	4	4
Energy Credit 7.0	Efficient luminaries & Lighting power density : 20	1	1
Energy Credit 8.0	Energy Saving Measures in Appliances &Equipment	1	1
MATERIAL			
Mandatory Requirement 1	Separation of Waste	Required	Required
Material Credit 1.0	Waste Reduction During Construction : 75%	1	1
Material Credit 2.0	Waste Management, Post Occupancy :50%, 95%	2	2
Material Credit 3.0	with Recycled Content : 10%, 20%	2	2
Material Credit 4.0	Rapidly Renewable Materials : 2.5%, 5%	2	1
Material Credit 5.0	Local Materials : 50%, 75%	2	2
Material Credit 6.0	Reuse of Salvaged Materials : 2.5%, 5%	2	2
MaterialCredit 7.0	Certified Wood Materials &Furniture :50%, 75%	2	2
INDOOR ENVIROINMENTAL QUALITY			

Mandatory Requirement 1	Tobacco Smoke Control	Required	Required
Mandatory Requirement 2	Day lighting : 50%	Required	Required
Mandatory Requirement 3	Fresh Air Ventilation	Required	Required
IEQ Credit 1.0	Exhaust Systems	2	NA
IEQ Credit 2.0	Enhanced Fresh Air Ventilation : 30%	2	2
IEQ Credit 3.0	Low VOC Materials	2	2
IEQ Credit 4.0	Carpets : 5%	1	NA
IEQ Credit 5.0	Building Flush Out	1	NA
IEQ Credit 6.0	Day lighting : 75%, 85%, 95%	3	3
IEQ Credit 7.0	Cross Ventilation	2	2
IEQ Credit 8.0		13	9
INNOVATION AND DESIGN PROCESS			
INN Credit 1.1	Innovation and Design Process	1	1
INN Credit 1.2	Innovation and Design Process	1	1
INN Credit 1.3	Innovation and Design Process	1	1
INN Credit 2.0	IGBC AP	1	1
TOTAL		**80**	**75**

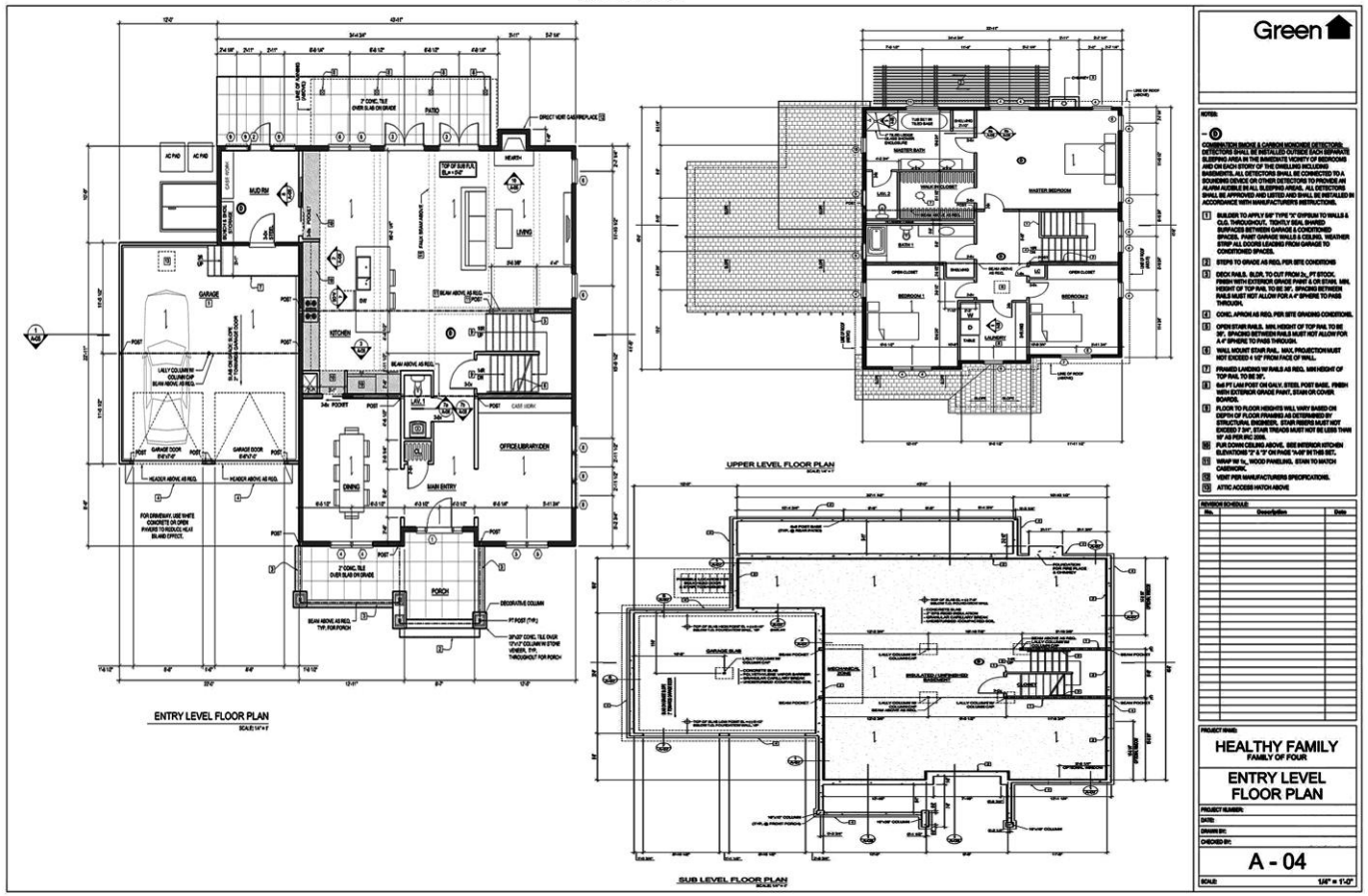
APPENDICS IV

SPECIFIC DETAILS OF HEALTHY FAMILY

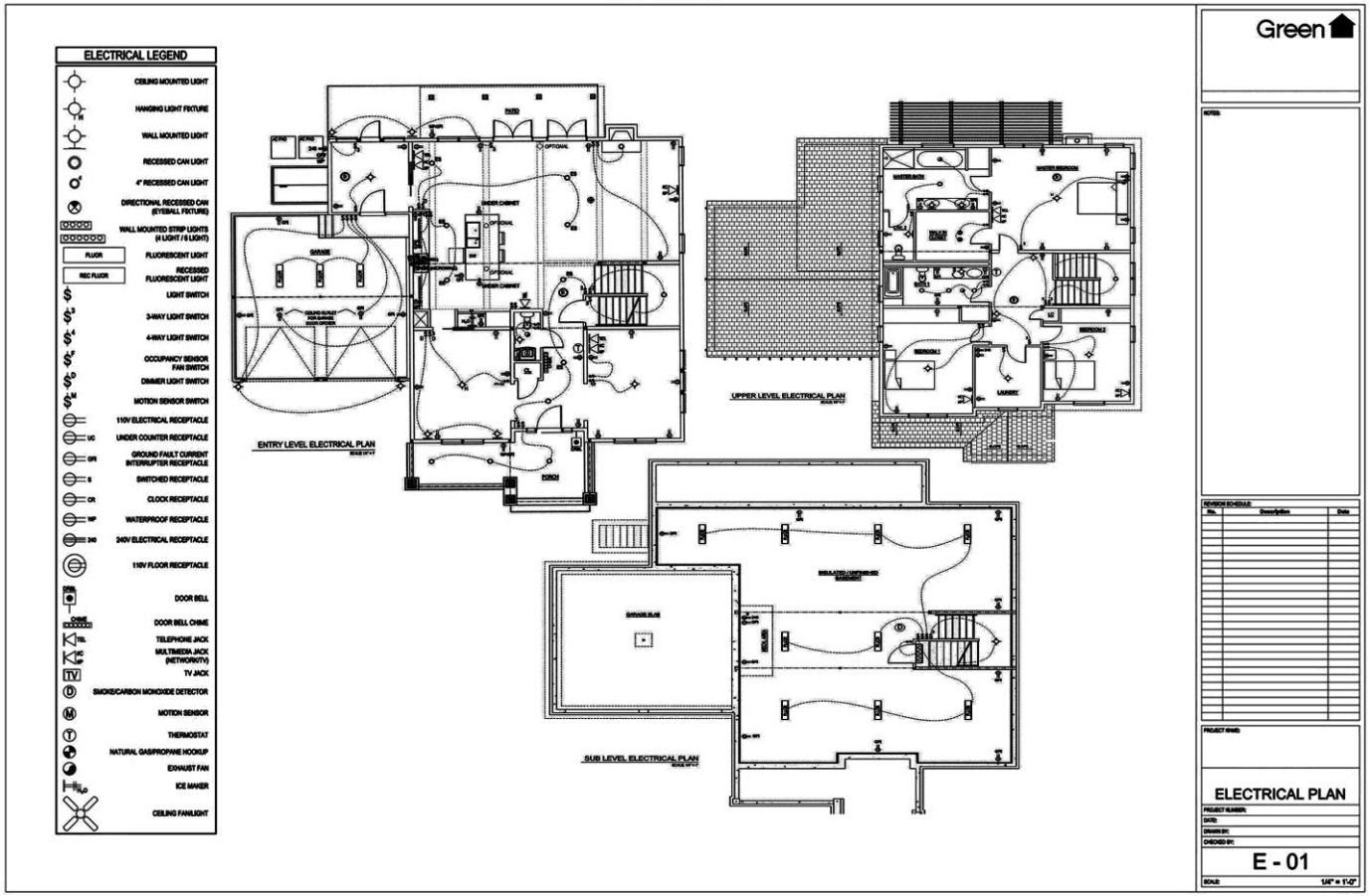
PROJECT DETAILS	SPECIFICATIONS
Project Title	Healthy family(family for four)
Building Use	Residential
Location	Chennai
Size	2,395 Sq. Ft.
Civil Works	
Walls	Fly ash solid blocks/Fly ash bricks
Structure	R.C.C. framed structure
Kitchen Platform	Linoleum slabs
Staircase steps	black granite Raiser, Treads, and for skirting also. Handrail with SS 304 grade material.
Floor Claddings	
Toilet floor, balcony & terrace	12” x 12” branded Antiskid ceramic tiles
Entire floor area	2’0” x 2’0” branded Vitrified flooring tiles
Bathroom walls	12” x 18” Up to 7’0” height branded ceramic wall tiles
Above the kitchen counter	ceramic tiles doing up to 2’0”
Doors	
Main doors	Forest Certified teakwood frame with paneled shutters
Bedroom doors	Forest Certified teakwood frame with hardcore flush doors

Toilets & Balcony doors	Forest Certified teakwood frame with both sides waterproof/film coated/PU coated flush doors
Windows	Eco-friendly UPVC openable windows with single glazing low heat transferring glass with wall mounted M.S. Grill
Painting	
Ceilings	Putty finish.
External wall	Low VOC exterior weather shield paint
Toilet doors	Low VOC enamel paint for bedrooms
Main doors	M.S. Grills. Melamine finish
Plumbing	
CPVC pipes	All concealed ¾" & 1" pipe lines
Concealed cistern & wash basin	All ceramic fittings Dura it/equivalent brand wall mounted EWC
All CP fittings	Groh/equivalent with diverter
Branded kitchen	stainless steel sink, single bowl with drain board.
Electrical	
Switches/equivalent	MK Brand Modular
Wires	Polycot PVC FRLS

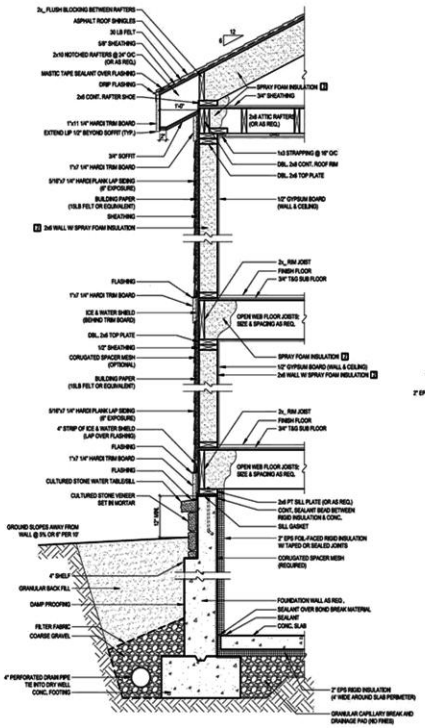
APPENDIX V


ENTRY LEVEL FLOOR PLAN
UPPER LEVEL FLOOR PLAN
SUB LEVEL FLOOR PLAN
Green
HEALTHY FAMILY
FAMILY OF FOUR
ENTRY LEVEL FLOOR PLAN
A - 04
1/4" = 1'-0"

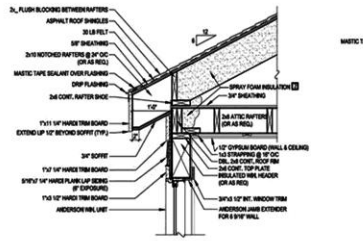
APPENDIX VI


ELECTRICAL LEGEND
CEILING MOUNTED LIGHT
HANGING LIGHT FIXTURE
WALL MOUNTED LIGHT
RECESSED CAN LIGHT
4" RECESSED CAN LIGHT
DIRECTIONAL RECESSED CAN (EYEBALL FIXTURE)
WALL MOUNTED STRIP LIGHTS (4 LIGHT / 6 LIGHT)
FLUOR
FLUORESCENT LIGHT
REC FLUOR
RECESSED FLUORESCENT LIGHT
LIGHT SWITCH
3-WAY LIGHT SWITCH
4-WAY LIGHT SWITCH
OCCUPANCY SENSOR FAN SWITCH
DIMMER LIGHT SWITCH
MOTION SENSOR SWITCH
110V ELECTRICAL RECEPTACLE
UC
UNDER COUNTER RECEPTACLE
GFI
GROUND FAULT CURRENT INTERRUPTER RECEPTACLE
S
SWITCHED RECEPTACLE
CR
CLOCK RECEPTACLE
WP
WATERPROOF RECEPTACLE
240
240V ELECTRICAL RECEPTACLE
110V FLOOR RECEPTACLE
DOOR BELL
DOOR BELL CHIME
TEL
TELEPHONE JACK
MULTIMEDIA JACK (NETWORK/TV)
TV
TV JACK
D
SMOKE/CARBON MONOXIDE DETECTOR
M
MOTION SENSOR
T
THERMOSTAT
NATURAL GAS/PROPANE HOOKUP
EXHAUST FAN
ICE MAKER
CEILING FAN/LIGHT
ENTRY LEVEL ELECTRICAL PLAN
UPPER LEVEL ELECTRICAL PLAN
SUB LEVEL ELECTRICAL PLAN
Green
REVISION SCHEDULE
No.
Description
Date
ELECTRICAL PLAN
E - 01
1/4" = 1'-0"

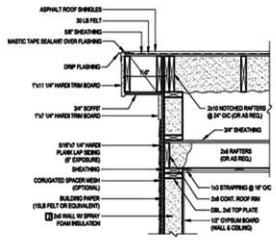
APPENDIX VII



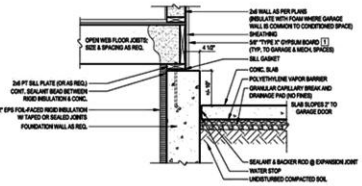
1 TYPICAL WALL SECTION
1" = 1'-0"



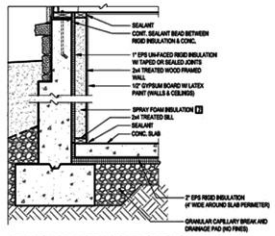
2 ROOF EVE OVER WINDOW
1" = 1'-0"



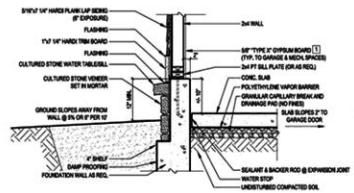
3 ROOF RAKE TYPICAL
1" = 1'-0"



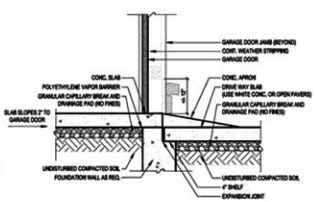
4 FOUNDATION @ SHARED WALL
1" = 1'-0"



5 FINISH BASEMENT OPTION
1" = 1'-0"



6 FOUNDATION @ GARAGE WALL
1" = 1'-0"



7 FOUNDATION @ GARAGE DOOR
1" = 1'-0"

Green

NOTES:

1 BUILDER TO APPLY 5/8" TYPE "X" GYPSUM TO WALLS & CLG. THROUGHOUT., TIGHTLY SEAL SHARED SURFACES BETWEEN GARAGE & CONDITIONED SPACES. PAINT GARAGE WALLS & CEILING. WEATHER STRIP ALL DOORS LEADING FROM GARAGE TO CONDITIONED SPACES.

2 SPRAY FOAM INSULATION:

SEE THE ENERGY MODEL SPECIFICATION SHEET FOR R-VALUE REQUIREMENTS SPECIFIC TO YOUR SITE LOCATION AND DESIRED PERFORMANCE LEVEL.

REVISION SCHEDULE:

No.	Description	Date

PROJECT NAME:

HEALTHY FAMILY
FAMILY OF FOUR

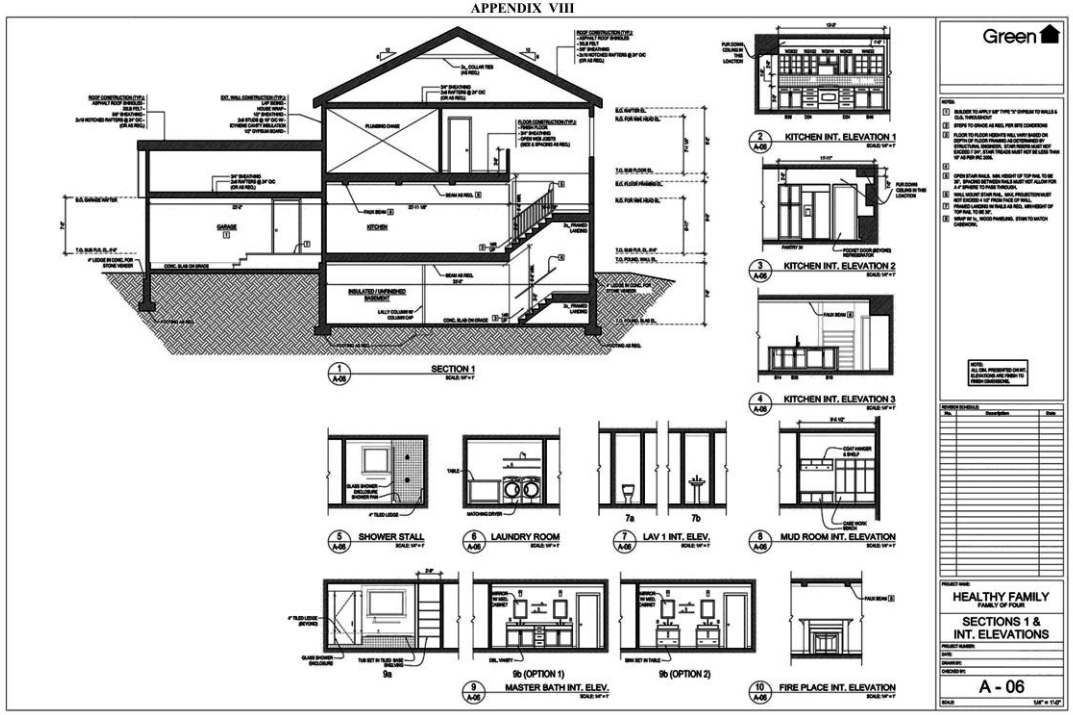
DETAILS 1

PROJECT NUMBER:
DATE:
DRAWN BY:
CHECKED BY:

A - 07

SCALE: 1/4" = 1'-0"

APPENDIX VIII



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