ENHANCING THE PRACTICE OF CONSTRUCTING RESIDENTIAL BUILDINGS WITH RESPECT TO GREEN BUILDING STANDARDS

- A SUSTAINABLE APPROACH

A PROJECT REPORT

Submitted by

ARAVIND.R	**715514103006**
KAVIN KUMA.R	**715514103020**
NITIN SAYOON.V	**715514103036**

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

in

CIVIL ENGINEERING

PSG INSTITUTE OF TECHNOLOGY AND APPLIED RESEARCH

COIMBATORE - 641 062.

ANNA UNIVERSITY: CHENNAI 600 025

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BONAFIDE CERTIFICATE

Certified that this project report **"ENHANCING THE PRACTICE OF CONSTRUCTING RESIDENTIAL BUILDINGS WITH RESPECT TO GREEN BUILDING STANDARDS – A SUSTAINABLE APPROACH"** is the bonafide work of

ARAVIND.R	**715514103006**
KAVIN KUMA.R	**715514103020**
NITIN SAYOON.V	**715514103036**

who carried out the project work under my supervision.

SIGNATURE	**SIGNATURE**
Dr. M.I.ABDUL ALEEM, Ph.D.	**Ms D.PRICILLA, M.Tech.**
PROFESSOR &	**SUPERVISOR**
HEAD OF THE DEPARTMENT	**ASSISTANTPROFESSOR**
Department of Civil Engineering	Department of Civil Engineering
PSG Institute of Technology and	PSG Institute of Technology and
Applied Research	Applied Research
Neelambur, Coimbatore-641 062	Neelambur, Coimbatore-641 062

INTERNAL EXAMINER **EXTERNAL EXAMINER**

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ABSTRACT

Green Building is environmentally conscious construction and operation of buildings. Concerns over the effects of climate change have risen dramatically in the past few years and have heightened the anxiety about the dwindling supply of natural resources for construction. A recent study reveals that 81% of global consumers surveyed are willing to make sacrifices to preserve the environment. 80% stated that they are willing to buy products from unknown brands that have a strong commitment to environmental responsibility. Internationally, voluntary building rating systems have been instrumental in raising awareness and popularizing green design.

GRIHA (Green Rating for Integrated Habitat Assessment) and LEED (Leadership in Energy and Environment Design) was developed in response to this need. The GRIHA is considered as Indian National Rating System which has been finalized after incorporating various modifications suggested by a group of architects and experts. The buildings which come under GRIHA are those which are having land area more than 2,500 Sq.m. (except for industrial complexes). These buildings can undergo this certification program.

The GRIHA doesn't cover buildings having area less than 2500 sq.m, so this study focuses on providing a rating system for small residential buildings. A Survey was conducted with the criteria listed under GRIHA and LEED among Builders in the sector, Inmates and Students whose thought process would be the future of construction Industry. Based on the results, a comprehensive rating system meeting the requirements of house hold sector was devised. The result shows that among various requirements Water management, Energy efficiency and Indoor air quality and comfort are of top priority. By adopting this rating system, more and more buildings may be covered for sustainable development. It gives a boost to nearby surroundings.

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LIST OF ABBREVIATIONS

USGBC	United States Green Building Council
LEED	Leadership in Energy and Environment Design
GRIHA	Green Rating for Integrated Habitat Assessment
BEE	Bureau of Energy Efficiency
BREEAM	Building Research Establishment Environmental Assessment Method
ECBC	Energy Conservation Building Code
IGBC	Indian Green Building Council
NZEB	Net Zero Energy Building

CHAPTER 1

INTRODUCTION

The building constructions have major environmental effect on surroundings and natural resources during their life cycle. The natural resources like ground water, soil, trees and fuels are dwindling to give way to buildings. The soil cover is used for landscaping, energy-consuming systems for lighting, space cooling and heating, ventilation and water heating system to provide comfort to the resident. Hi-tech controls like lux sensor, occupancy sensor add intelligence to the buildings. Fire fighting system, security and building management system controls and monitor the resource use. Water is major resource for an occupant who gets used by the occupants during construction and operation time. Large occupied buildings generate good amount of waste like solid waste, liquid waste air pollution and noise pollution. Buildings are now considered as one of major pollutants that have huge impact on various environments.

Hence, the need of present is to design a green building to save the climate as well as natural resources. The cost of constructing green building is more than the conventional building design but the operation and maintenance cost is less as compared to other buildings and have good environmental benefits. The main hurdle is to achieve these benefits with less or affordable cost.

According to Ministry of Environment & Forest, India, Green Building is the “practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building life-cycle from sitting to design, construction, operation, maintenance, renovation, and deconstruction.” Green building shows our efforts in the construction practices. With the development of technology and new construction and building materials the status of the efforts also changes. Therefore, we have to emphasize the green building concept on all scale projects including small residential buildings as it contributes to the major share of construction.

The purpose of green building design is to bring down the demand to minimal and maximize the utilization efficiency. The parameters to be considered for green building design are use of version soil, vegetation of landscaped area, maximum use of recycled water efficient building material, minimum energy usage, and maximum use of renewable energy like solar, wind, ventilated building design, and efficient waste management technique. The agency critically evaluates the impacts of the building design and then arrives at a cost effective design solutions which can minimize the environmental impacts and therefore enhance the efficiency of the building. Green building (also known as green construction or sustainable building) refers to both a structure and the application of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from planning to design, construction, operation, maintenance, renovation, and demolition. This requires close cooperation of the contractor, the architects, the engineers, and the client at all project stages. The Green Building practice expands and complements the classical building design concerns of economy, utility, durability, and comfort.

Leadership in Energy and Environmental Design (LEED) is a set of rating systems for the design, construction, operation, and maintenance of green buildings which was Developed by the U.S. Green Building Council. Other certificates system that confirms the sustainability of buildings is the British BREEAM (Building Research Establishment Environmental Assessment Method) for buildings and large-scale developments. Currently, World Green Building Council is conducting research on the effects of green buildings on the health and productivity of their users and is working with World Bank to promote Green Buildings in Emerging Markets through EDGE (Excellence in Design for Greater

Efficiencies) Market Transformation Program and certification. There are also other tools such as Green Star in Australia and the Green Building Index (GBI) predominantly used in Malaysia.

Globally, buildings are responsible for a huge share of energy, electricity, water and materials consumption. The building sector has the greatest potential to deliver significant cuts in emissions at little or no cost. Buildings account for 18% of global emissions today, or the equivalent of 9 billion tonnes of CO2 annually. If new technologies in construction are not adopted during this time of rapid growth, emissions could double by 2050, according to the United Nations Environment Program. Green building practices aim to reduce the environmental impact of building. Since construction almost always degrades a building site, not building at all is preferable to green building, in terms of reducing environmental impact. The second rule is that every building should be as small as possible. The third rule is not to contribute to sprawl, even if the most energy-efficient, environmentally sound methods are used in design and construction.

Buildings account for a large amount of land. According to the National Resources Inventory, approximately 107 million acres (430,000 km^2) of land in the United States are developed. The International Energy Agency released a publication that estimated that existing buildings are responsible for more than 40% of the world’s total primary energy consumption and for 24% of global carbon dioxide emissions.

It has been reported that the consumption of natural resources is very less in green building as compared to conventional buildings.

The resources in a building with their respective reasons are follows:

- Due to passive architectural intervention, efficient material consumption and innovative technologies in design of the building, green buildings consume lesser electricity as compared to conventional buildings.
- Green Buildings generate the renewable energy at on-site and utilize its energy needs. Solar panel uses for hot-water generation and can replace the electrical geyser in buildings fully or partially. Solar PV panels can also be used to generate electricity which will ultimately reduce the buildings dependency on the grid power.
- Water consumption of Green buildings is very less as compared to conventional buildings. Green Building utilizes low-flow faucets, waste-water recycling systems through tertiary treatment, dual plumbing systems and water conservation techniques like rain-water harvesting etc.
- By using waste management strategies on site Green buildings generate less waste. They help to reduce the load on the municipal waste management system and landfills.
- At the time of construction and while in use Green Buildings generate less pollution. The proper storage and usage of construction materials, measure to prevent air and noise pollution during construction activities etc. ensures reduced impact on the surrounding environment.
- During Construction and while operation Green buildings ensure safety, health and sanitation facilities for the laborers.
- Green buildings are in demand and can be leased out at higher price as compared to conventional building.

1.1 Goals of green building

The concept of sustainable development can be traced to the energy (especially fossil oil) crisis and environmental pollution concerns of the 1960s and 1970s. The Rachel Carson book, “Silent Spring”, published in 1962, is considered to be one of the first initial efforts to describe sustainable development as related to green building. The green building movement in the U.S. originated from the need and desire for more energy efficient and environmentally friendly construction practices. There are a number of motives for 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 existing structures. 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 among the practices used.

Green building brings together a vast array of practices, techniques, and skills 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 equipment, and using plants and trees through green roofs, rain gardens, and reduction of rainwater run-off. Many other techniques are used, such as using low-impact building materials or using packed gravel or permeable concrete instead of conventional concrete or asphalt to enhance replenishment of ground water.

While the practices or technologies employed in green building are constantly evolving and may differ from region to region, fundamental principles persist from which the method is derived: citing and structure design efficiency, energy efficiency, water efficiency, materials efficiency, indoor environmental quality enhancement, operations and maintenance optimization and waste and toxics reduction. The essence of green building is an optimization of one or more of these principles. Also, 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 or sustainable design is the philosophy of designing a building that is in harmony with the natural features and resources surrounding the site. There are several key steps in designing sustainable buildings: specify 'green' building materials from local sources, reduce loads, optimize systems, and generate on-site renewable energy.

1.2 Life cycle assessment

A life cycle assessment (LCA) can help avoid a narrow outlook on environmental, social and economic concerns by assessing a full range of impacts associated with all cradle-to-grave stages of a process: from extraction of raw materials through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. Impacts taken into account include (among others) embodied energy, global warming potential, resource use, air pollution, water pollution, and waste.

In terms of green building, the last few years have seen a shift away from a prescriptive approach, which assumes that certain prescribed practices are better for the environment, toward the scientific evaluation of actual performance through LCA. Although LCA is widely recognized as the best way to evaluate the environmental impacts of buildings (ISO 14040 provides a recognized LCA methodology), it is not yet a consistent requirement of green building rating systems and codes, despite the fact that embodied energy and other life cycle impacts are critical to the design of environmentally responsible buildings.

In North America, LCA is rewarded to some extent in the Green Globes® rating system, and is part of the new American National Standard based on Green Globes, ANSI/GBI 01-2010: Green Building Protocol for Commercial Buildings. LCA is also included as a pilot credit in the LEED system, though a decision has not been made as to whether it will be incorporated fully into the next major revision. The state of California also included LCA as a voluntary measure in its 2010 draft Green Building Standards Code.

Although LCA is often perceived as overly complex and time consuming for regular use by design professionals, research organizations such as BRE in the UK and the Athena Sustainable Materials Institute in North America are working to make it more accessible. In the UK, the BRE Green Guide to Specifications offers ratings for 1,500 building materials based on LCA.

In North America, the Eco Calculator for Assemblies provides LCA results for several hundred common building assembles based on data generated by its more complex parent software, the Impact Estimator for Buildings. Athena software tools are especially useful early in the design process when material choices have far-reaching implications for overall environmental impact.

1.3 Aspects of Green building

1.3.1 Siting and structure design efficiency

The foundation of any construction project is rooted in the concept and design stages. The concept stage, in fact, is one of the major steps in a project life cycle, as it has the largest impact on cost and performance. In designing environmentally optimal buildings, the objective is to minimize the total environmental impact associated with all life-cycle stages of the building project.

Fig .1.1 Exterior Light Shelves - Green Office Building, Denver Colorado

However, building as a process, is not as streamlined as an industrial process and varies from one building to the other, never repeating itself identically. In addition, buildings are much more complex products, composed of a multitude of materials and components each constituting various design variables to be decided at the design stage. A variation of every design variable may affect the environment during all the building's relevant life-cycle stages.

1.3.2 Energy efficiency

Green buildings often include measures to reduce energy consumption – both the embodied energy required to extract, process, transport and install building materials and operating energy to provide services such as heating and power for equipment.

As high-performance buildings use less operating energy, embodied energy has assumed much greater importance – and may make up as much as 30% of the overall life cycle energy consumption. Studies such as the U.S. LCI Database Project show buildings built primarily with wood will have a lower embodied energy than those built primarily with brick, concrete, or steel.

To reduce operating energy use, designers use details that reduce air leakage through the building envelope (the barrier between conditioned and unconditioned space). They also specify high-performance windows and extra insulation in walls, ceilings, and floors. Another strategy, passive solar building design, is often implemented in low-energy homes. Designers orient windows and walls and place awnings, porches, and trees to shade windows and roofs during the summer while maximizing solar gain in the winter. In addition, effective window placement (day lighting) can provide more natural light and lessen the need for electric lighting during the day. 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.

1.3.3 Water efficiency

Reducing water consumption and protecting water quality are key objectives in sustainable building. One critical issue of water consumption is that in many areas, the demands on the supplying aquifer exceed its ability to replenish itself. To the maximum extent feasible, facilities should increase their dependence on water that is collected, used, purified, and reused on-site. 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 or by using water for washing of the cars.

Waste-water may be minimized by utilizing water conserving fixtures such as ultra-low flush toilets and low-flow shower heads. Bidets help eliminate the 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. The use of non-sewage and grey water for on-site use such as site-irrigation will minimize demands on the local aquifer.[22]

Large commercial buildings with water and energy efficiency can qualify for an LEED Certification. Philadelphia's Comcast Center is the tallest building in Philadelphia. It's also one of the tallest buildings in the USA that is LEED Certified. Their environmental engineering consists of a hybrid central chilled water system which cools floor-by-floor with steam instead of water. Burn's Mechanical set-up the entire renovation of the 58 story, 1.4 million square foot sky scraper.

1.3.4 Materials efficiency

Building materials typically considered to be 'green' include lumber from forests that have been certified to a third-party forest standard, rapidly renewable plant materials like bamboo and straw, dimension stone, recycled stone, recycled metal (see: copper sustainability and recyclability), and other products that are non-toxic, reusable, renewable, and/or recyclable. For concrete a high performance or Roman self-healing concrete is available. The EPA (Environmental Protection Agency) also suggests using recycled industrial goods, such as coal combustion products, foundry sand, and demolition debris in construction projects. Energy efficient building materials and appliances are promoted in the United States through energy rebate programs.

1.3.5 Indoor environmental quality enhancement

The Indoor Environmental Quality category in LEED standards, one of the five environmental categories, was created to provide comfort, well-being, and productivity of occupants. The LEED Indoor Environmental Quality category addresses design and construction guidelines especially: indoor air quality, thermal quality, and lighting quality.

Indoor Air Quality seeks to reduce volatile organic compounds, or VOCs, 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 recirculated, 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. Most building materials and cleaning/maintenance products emit gases, some of them toxic, such as many VOCs including formaldehyde. These gases can have a detrimental impact on occupants' health, comfort, and productivity. Avoiding these products will increase a building's IEQ. Draft LEED 2012 is about to expand the scope of the involved products. MAS Certified Green is a registered trademark to delineate low VOC-emitting products in the marketplace.

The MAS Certified Green Program ensures that any potentially hazardous chemicals released from manufactured products have been thoroughly tested and meet rigorous standards established by independent toxicologists to address recognized long term health concerns. These IAQ standards have been adopted by and incorporated into the following programs: (1) The United States Green Building Council (USGBC) in their LEED rating system (2) The California Department of Public Health (CDPH) in their section 01350 standards (3) The Collaborative for High Performance Schools (CHPS) in their Best Practices Manual and (4) The Business and Institutional Furniture Manufacturers Association (BIFMA) in their level® sustainability standard.

Also important to indoor air quality is the control of moisture accumulation (dampness) leading to mold growth and the presence of bacteria and viruses as well as dust mites and other organisms and microbiological concerns. Water intrusion through a building's envelope or water condensing on cold surfaces on the building's interior can enhance and sustain microbial growth. 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 coupled with a properly designed building envelope will also aid in increasing a building's thermal quality. Creating a high performance luminous environment through the careful integration of daylight and electrical light sources will improve on the lighting quality and energy performance of a structure.

Solid wood products, particularly flooring, are often specified in environments where occupants are known to have allergies to dust or other particulates. Wood itself is considered to be hypo-allergenic and its smooth surfaces prevent the buildup of particles common in soft finishes like carpet. 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.

Interactions among all the indoor components and the occupants together form the processes that determine the indoor air quality. Extensive investigation of such processes is the subject of indoor air scientific research and is well documented in the journal Indoor Air.

1.3.6 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. Ensuring operations and maintenance (O&M) personnel are part of the project's planning and development process will help retain the green criteria designed at the onset of the project. Every aspect of green building is integrated into the O&M phase of a building's life. The addition of new green technologies also falls on the O&M staff. Although 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. O&M staff should aim to establish best practices in energy efficiency, resource conservation, ecologically sensitive products and other sustainable practices. Education of building operators and occupants is a key to effective implementation of sustainable strategies in O&M services.

1.3.7 Waste reduction

Green architecture also seeks to reduce waste of energy, water and materials used during construction. For example, in California nearly 60% of the state's waste comes from commercial buildings. During the construction phase, one goal should be to reduce the amount of material going to landfills. Well-designed buildings also help reduce the amount of waste generated by the occupants as well, by providing on-site solutions such as compost bins to reduce matter going to landfills.

To reduce the amount of wood that goes to landfill, Neutral Alliance (a coalition of government, NGOs and the forest industry) created the website dontwastewood.com. The site includes a variety of resources for regulators, municipalities, contractors, owner/operators and individuals/homeowners looking for information on wood recycling. When buildings reach the end of their useful life, they are typically demolished and hauled to landfills. Deconstruction is a method of harvesting what is commonly considered "waste" and reclaiming it into useful building material. Extending the useful life of a structure also reduces waste – building materials such as wood that are light and easy to work with make renovations easier.

To reduce the impact on wells or water treatment plants, several options exist. "Grey water", wastewater from sources such as dishwashing or washing machines, can be used for subsurface irrigation, or if treated, for non-potable purposes, e.g., to flush toilets and wash cars. Rainwater collectors are used for similar purposes.

Centralized wastewater treatment systems can be costly and use a lot of energy. An alternative to this process is converting waste and wastewater into fertilizer, which avoids these costs and shows other benefits. By collecting human waste at the source and running it to a semi-centralized biogas plant with other biological waste, liquid fertilizer can be produced. This concept was demonstrated by a settlement in Lubeck Germany in the late 1990s. Practices like these provide soil with organic nutrients and create carbon sinks that remove carbon dioxide from the atmosphere, offsetting greenhouse gas emission. Producing artificial fertilizer is also more costly in energy than this process.

1.3.8 Reducing impact on electricity network

Electricity networks are built based on peak demand (another name is peak load). Peak demand is measured in the units of watts (W). It shows how fast electrical energy is consumed. Residential electricity is often charged on electrical energy (kilowatt hour, kWh). Green buildings or sustainable buildings are often capable of saving electrical energy but not necessarily reducing peak demand.

When sustainable building features are designed, constructed and operated efficiently, peak demand can be reduced so that there is less desire for electricity network expansion and there is less impact onto carbon emission and climate change. These sustainable features can be good orientation, sufficient indoor thermal mass, good insulation, photovoltaic panels, thermal or electrical energy storage systems, smart building (home) energy management systems.

1.4 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 money. Most green buildings cost a premium of <2%, but yield 10 times as much over the entire life of the building. In regards to the financial benefits of green building, “Over 20 years, the financial payback typically exceeds the additional cost of greening by a factor of 4-6 times. And broader benefits, such as reductions in greenhouse gases (GHGs) and other pollutants have large positive impacts on surrounding communities and on the planet.” 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. It is projected that different sectors could save $130 Billion on energy bills. Also, higher worker or student productivity can be factored into savings and cost deductions.

Numerous studies have shown the measurable benefit of green building initiatives on worker productivity. In general it has been found that, "there is a direct correlation between increased productivity and employees who love being in their work space.” Specifically, worker productivity can be significantly impacted by certain aspects of green building design such as improved lighting, reduction of pollutants, advanced ventilation systems and the use of non-toxic building materials. In “The Business Case for Green Building”, the U.S. Green Building Council gives another specific example of how commercial energy retrofits increase worker health and thus productivity, “People in the U.S. spend about 90% of their time indoors. EPA studies indicate indoor levels of pollutants may be up to ten times higher than outdoor levels. LEED-certified buildings are designed to have healthier, cleaner indoor environmental quality, which means health benefits for occupants."

Studies have shown over a 20-year life period, some green buildings have yielded $53 to $71 per square foot back on investment. 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.

1.5 Regulation and operation

As a result of the increased interest in green building concepts and practices, a number of organizations have developed standards, codes and rating systems that let government regulators, building professionals and consumers embrace green building with confidence. In some cases, codes are written so local governments can adopt them as bylaws to reduce the local environmental impact of buildings.

Green building rating systems such as BREEAM (United Kingdom), LEED (United States and Canada), DGNB (Germany), and CASBEE (Japan), help consumers determine a structure’s level of environmental performance. They award credits for optional building features that support green design in categories such as location and maintenance of building site, conservation of water, energy, and building materials, and occupant comfort and health. The number of credits generally determines the level of achievement.

Green building codes and standards, such as the International Code Council's draft International Green Construction Code, are sets of rules created by standards development organizations that establish minimum requirements for elements of green building such as materials or heating and cooling.

CHAPTER 2

SCOPE AND OBJECTIVE

The green building concept is becoming more and more popular these days because these are considered as environment friendly building. The government is taking appropriate steps in implementation of green building concepts by providing increase in floor area ratio. They are making action plan on climate change on sustainable habitats by proposing smart city concepts. Further in addition to that BEE is putting their effort on appliance labeling program which helps in appraisal and clearance of large construction projects. Several corporate organizations, institutions and construction companies are now practicing green building concept in the construction. There are many green building rating systems in place. GRIHA (Green Rating for Integrated Habitat Assessment) and LEED (Leadership in Energy and Environment Design) was developed in response to this need. The GRIHA is considered as Indian National Rating System which have been finalized after incorporating various modifications suggested by a group of architects and experts. United States Green Building Council administered (LEED) as the leading green building rating system which is ranked first among other systems. LEED is contributing heavily in converting the built environment towards sustainable development. The buildings which come under GRIHA are those which are having land area more than 2,500 Sq m. (except for industrial complexes). These buildings can undergo this certification program.

The GRIHA doesn’t cover buildings having area less than 2500 sq.m so the present study focuses on providing a rating system for small residential buildings. For finding the requirements of the residential sector, we conducted a survey. The target segment of the survey was primarily comprised of builders in the sector, inmates in the house and students whose thought process which would be the future of the construction industry. The findings of the survey indicated a marginal difference in the three categories of target group. By adopting this rating system more and more buildings may be covered for sustainable development. It gives a boost to nearby surroundings.

CHAPTER 3

LITERATURE REVIEW

1. Ms.Mamta has come up with a idea , ‘Green building : A new wave in India’ and said that India is experiencing an incredible growth in the construction and real estate industry. Due to this rise in the construction sector raised many issues related to the environment and sustainability. As per economic policy forum, in its report mentioned that in India the energy consumption in buildings is for heating, ventilation and air Conditioner accounts for between 45% and 65% of total electricity consumption. Another study states that the construction sector of India emits about 22% of the total annual emission of CO2 which is very harmful for the environment. So to handle the adverse situation a new and important concept is emerging in India that is Green Building. So this article gives you the understanding about the green buildings, How the green building get rating from the rating agencies, Importance of green buildings, and examples of some companies and organization that are taking the advantage of green wave and is flourishing.

2. Akshay B. Mokal , Allaudin I. Shaikh, Shamashree S. Raundal, Sushma J.Prajapati, Uday J. Phatak have proposed a idea on ‘Green building materials - a way towards sustainable construction’. They observed that India’s various tremendous environmental problem are rising in construction industry due to leading urbanization. Increase in demand of houses which lead to consumes more energy, resources and raw materials which are responsible for the rise in carbon content in air and which are harmful to environment and human health. Nowadays we are facing various environmental impacts due to which we need to build with more sustainable materials which will lead to reduction of impacts on environment. In cities like Pune we are already noticing the change in weather patterns, hotter summers, shorter winters, insufficient monsoons. So taking the preservation of the city's ecology and finite energy resources seriously is now more than important. Developers need to find better, more sustainable methods of designing their buildings in order to reduce their negative environmental impact. Therefore it is need of an hour to use more sustainable materials and locally available materials which are eco-friendly and a lead for better tomorrow. Considering to all this impacts this paper consist a five green construction materials with their advantages, disadvantages, durability and economical aspects in construction industry which can be an effective alternate material for conventional materials.

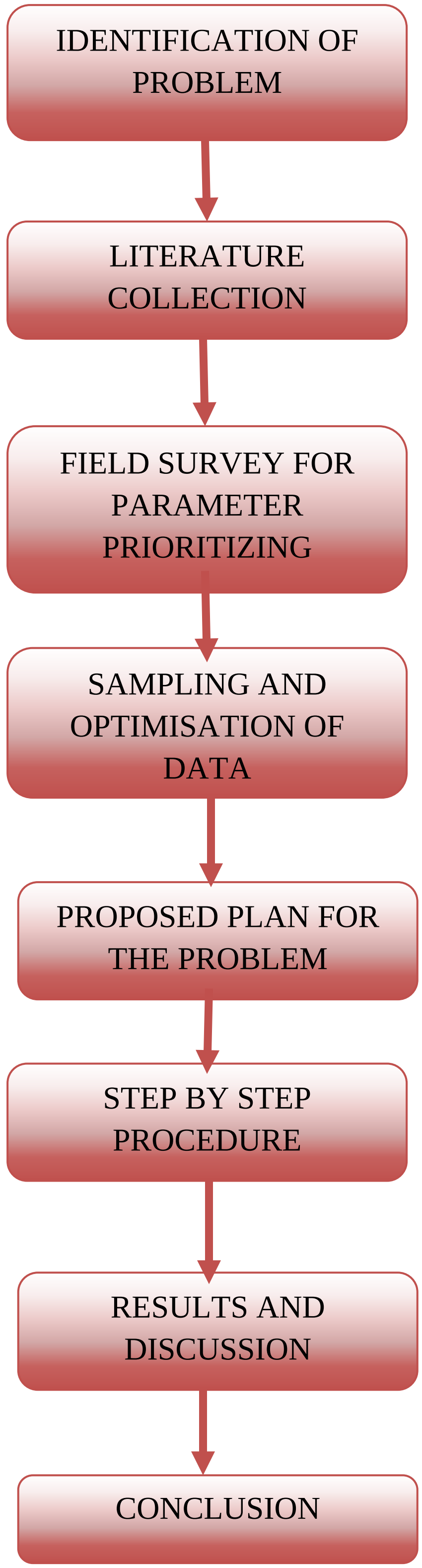
3. Devarshi Tathagat, Dr.Ramesh D Dod have proposed a idea on 'Role of Green buildings in sustainable construction -need, challenges and scope in Indian scenario' and gave their views on change in climate, caused by the release of greenhouse effect causing gases (primarily carbon dioxide) into the atmosphere, has been recognized as one of the greatest threats of the 21st century. Share of the global energy consumption in India and China has also been on the rise due to heavy industrialization, urbanization, population explosion, and intensive growth of IT. Buildings are the prime energy consumers in modern cities accounting upto 40 to 45% energy consumption. Their consumption can be largely confined through improving efficiency, which is an effective means to lessen greenhouse gas emissions and slow down depletion of fossil fuels. There is a heavy (over 50%) saving potential in the building sector and thus it is considered as a potential sector to meet the challenges of global energy demand and climate change. Along with the advent of energy efficient measures, more effective means are needed to induce or compel greater efforts, especially to the signatories of the Kyoto Protocol. This technical paper highlights the importance of sustainable construction, discusses role of energy efficiency in green buildings in Indian context to reduce the energy consumption and environmental degradation through Green House Gas emission (GHG). Also it points out to the benefits of green construction as well as the incentives from govt. and municipal bodies for GRIHA certified green building.

4. Narayanan Tiadi , Ritesh Dash , S.M Ali , Aryadhara Pradhan have proposed a idea on 'Green building: an efficient natural resource to create a sustainable environment'. They studied the concept of Zero energy. Zero Energy is a common concept adopted by many building designers. It basically combines state-of-art with commercially available renewable sources of energy. A zero energy building returns much more energy as compared to the energy it takes from the utilities. Sustainable building involves the consideration of many issues, including land use, site impact, indoor environment, energy and water use. This paper studied the definition of a green building and the elements associated with the construction of single family home versus office buildings. The development of infra structure is one of the main drivers of growth in an economy. Moreover the infrastructure provides the organizational structure and support to the organization system. It supports either vertically or horizontal system. This paper focus on the key technologies which can be adapted to create a green building which becomes technically fit , commercially acceptable and environment friendly

5. Nibedita Panigrahi1G.R.K.D. Satya Prasad, Vikas kumar pandey, Gautam choubey Rohit kumar singh, Peenaki priyadarsan nayak have done a research on Impact of GRIHA parameters on designing of Green buildings: field investigation analysis. They did a study on GRIHA in designing Green Buildings. GRIHA (Green Rating for Integrated Habitat Assessment), is one which will identify the benchmark parameters with a standard regulation to suit the local climatic condition and it was developed by TERI (The Energy resource institute). It has been identified to estimate that lot of energy is wasted with an inefficient approaches in building sector. In this paper by considering an Engineering college Campus as its point of concern for the analysis of GRIHA parameters and checking conformance with the ECBC by using ECO nirman tool. This will help to identify the benchmark parameters to improve the energy efficiency and reducing the unnecessary energy usage in any building or campus.

CHAPTER 4

METHODOLOGY



CHAPTER 5

STUDY AREA

5.1 LEED

LEED, or Leadership in Energy and Environmental Design, is the most widely used green building rating system in the world. Available for virtually all building, community and home project types, LEED provides a framework to create healthy, highly efficient and cost-saving green buildings. LEED certification is a globally recognized symbol of sustainability achievement.

LEED has evolved since 1998 to more accurately represent and incorporate emerging green building technologies. The pilot version, LEED New Construction (NC) v1.0, led to LEED NCv2.0, LEED NCv2.2 in 2005, and LEED 2009 (previously named LEED v3) in 2009. LEED v4 was introduced in November, 2013. Until October 31, 2016, new projects could choose between LEED 2009 and LEED v4. New projects registering after October 31, 2016 have been required to use LEED v4.

5.1.1 Credit weighting process

The weighting process has three steps:

1. A collection of reference buildings are used to estimate the environmental impacts of any building seeking LEED certification in a designated rating scheme.
2. NIST weightings are used to judge the relative importance of these impacts in each category.

3. Data regarding actual impacts on environmental and human health are used to assign points to individual categories and measures.

This system results in a weighted average for each rating scheme based upon actual impacts and the relative importance of those impacts to human health and environmental quality.

Table .5.1 LEED points breakup

KEY PERFORMANCE AREAS	POTENTIAL POINTS
Sustainable site planning	26
Water management	10
Energy optimization	35
Materials & Resources	14
Indoor environmental quality	15
Innovation & Design process	6
Regional priority credits	4
TOTAL POTENTIAL POINTS	110

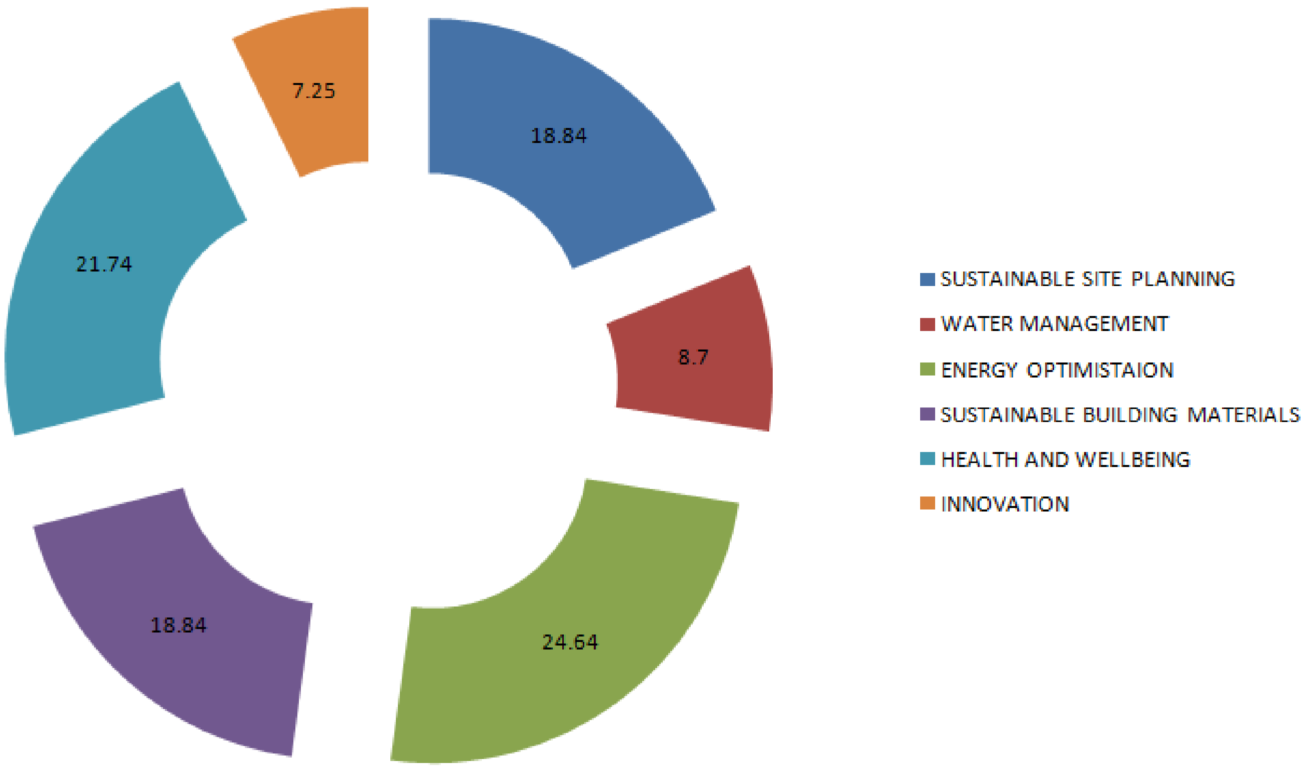


Fig.5.1 LEED Percentage Break up

5.2 GRIHA

GRIHA V 3 rating system consists of 34 criteria covering various subjects such as sustainable site planning, energy and water optimization, sustainable building materials, waste management and building operations & maintenance. There are bonus points for strategies implemented over and above the listed GRIHA Criteria.

5.2.1 ELIGIBILITY

All buildings, which are in the design stage and have built up area more than 2,500 m^2, which are in the design stage, are eligible for certification under GRIHA. Building types include but are not limited to offices, retail spaces, institutional buildings, hotels, hospital buildings, healthcare facilities, residences, and multi-family high-rise buildings.

5.2.2 CRITERIA AND THEIR WEIGHTAGE

GRIHA is a performance-oriented system where points are earned for meeting the design and performance intent of the criteria. Each criterion has certain points assigned to it. It means that a project demonstrating compliance with a criterion would achieve the associated points.

GRIHA is a 100-point system consisting of some core points, which are mandatory, while the rest are optional. Different levels of certification (one star to five stars) are awarded based on the number of points earned. The minimum points required for certification are 50.

Table.5.2 GRIHA point breakup

Points achieved	GRIHA Rating
50-60	★
61-70	★★
71-80	★★★
81-90	★★★★
91-100	★★★★★

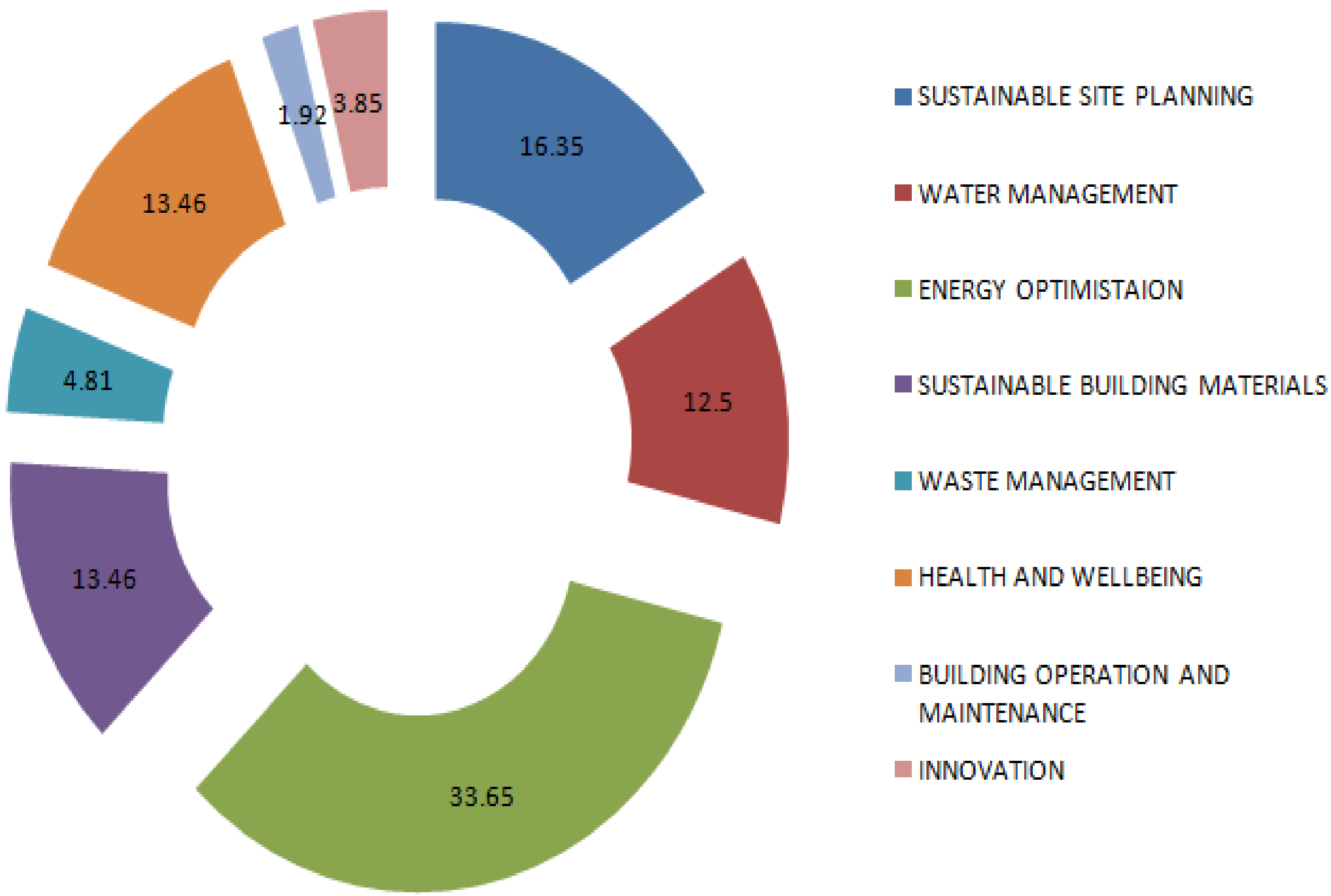


Fig.5.2 GRIHA Percentage Break Up

Table.5.3 GRIHA Criteria

CRITERION	CHECKLIST	POINTS
1	Site Selection	1
2	Preserve and protect landscape during construction/compensatory depository forestation	5
3	Soil conservation (post construction)	2
4	Design to include existing site features	4
5	Reduce hard paving on site	2
6	Enhance outdoor lighting system efficiency	3
7	Plan utilities efficiently and optimize on-site circulation efficiency	3
8	Provide minimum level of sanitation/safety facilities for construction workers	2
9	Reduce air pollution during construction	2
10	Reduce landscape water demand	3
11	Reduce building water use	2
12	Efficient water use during construction	1
13	Optimize building design to reduce conventional energy demand	8
14	Optimize energy performance of building within specified comfort limits	16
15	Utilization of fly-ash or equivalent industrial/agricultural waste as recommended by BIS in building structures	6
16	Reduce embodied energy of construction is reduced by adopting material efficient technologies and/or	4

	low-energy materials	
17	Use low-energy materials in Interiors	4
18	Renewable energy utilization	5
19	Renewable energy based hot water system	3
20	Waste water treatment	2
21	Water recycle and reuse (including rainwater)	5
22	Reduction in waste during construction	1
23	Efficient Waste segregation	1
24	Storage and disposal of wastes	1
25	Resource recovery from waste	2
26	Use of low-VOC paints/adhesives/sealants	3
27	Minimize ozone depleting substances	1
28	Ensure water quality	2
29	Acceptable outdoor and indoor noise levels	2
30	Tobacco and smoke control	1
31	Provide at least the minimum level of accessibility for persons with disabilities	1
32	Energy audit and validation	Mandatory
33	Operation and Maintenance	2
34	Innovation Points	4

Compliances, as specified in the relevant criterion, have to be submitted in the prescribed format. While the intent of some of the criteria is self-validating in nature, there are others such as energy consumption, thermal and visual comfort, noise control, and indoor pollution levels which need to be validated on-site through performance monitoring. The points related to these criteria (specified under the relevant sections) are awarded provisionally while certifying and are converted into firm points through monitoring, validation, and documents/photographs to support the award of point.

5.2.4 RATING PROCESS

REGISTRATION

A project must be registered with GRIHA Council through the GRIHA website by filling in the registration form online. Registration should preferably be done at beginning of a project, as several issues need to be addressed at the pre-design stage. The registration process includes access to the essential information related to rating.

POST-REGISTRATIONWORKSHOP

An orientation workshop is conducted by the GRIHA Council, for the entire project team comprising of the owner, architect, MEP Consultants, landscape consultants, project manager, etc. The workshop serves the dual purpose of awareness of GRIHA System for all involved and identification and evaluation of the optional criteria to enhance the rating of the project.

ONLINE SUBMISSION OF DOCUMENTS

The project proponent is required to provide documentary evidence to demonstrate compliance with the criteria. The required list of documents is mentioned in the criteria in the GRIHA Manual. All compliance documents shall be submitted through the online portal on the GRIHA website. Submitted documents will be checked and vetted by GRIHA Council.

DUE DILIGENCE

Three site visits will be conducted as part of the rating process to verify the compliances on site. The first site visit will be done when the project is at plinth level, the second one will be done when the structural work is complete and interior finishing is in progress. The third and final site visit will be done after the preliminary document assessment by GRIHA.

EVALUATION PROCESS

Complete and consolidated rating documents submitted by the project proponent shall be sent for a third-party review. Third party reviewers are identified and trained by the GRIHA Council under the supervision of the Technical Advisory Committee of GRIHA. On-site checks will be carried out by the GRIHA Council 3 times during the project execution phase for auditing the green features as part of the Due-Diligence visits.

a. The submission summary report generated by the online portal will be sent to the evaluators. The evaluators will award provisional points and comment on specific criteria, if need be.
b. The evaluation report will be sent to the project proponent to review the same and, if desired, take steps to increase the score. The report will have elaborate remarks of the evaluation committee along with comments. The report will list the criteria for which the documentation is incomplete, detailing the information, which is required.
c. The project proponent will be given one-month time to resubmit the documents with necessary modifications /additions. The resubmitted documents will comprise only of the additional documents / information desired in the evaluation report.

d. The resubmitted documents will again be put through the vetting process described above. The evaluation committee will then award the final score.
e. The final score will be presented to the National Advisory committee comprising of eminent personalities and renowned professionals in the field, for approval and award of the provisional rating.
f. Final award of rating will be subject to an independent energy audit of the project after a year of commissioning the building.

Once rated, the rating will be valid for a period of five years from the date of commissioning of the building. GRIHA reserves the right to undertake a random on-site audit of any criteria for which points have been awarded.

Note: It may please be noted that rating is subject to fulfillment of minimum requirements as necessary under GRIHA. Projects that do not fulfill mandatory criteria and minimum required optional criteria are not eligible for rating.

The fee includes:

- GRIHA costs for preliminary assessment, administration, and coordination of online documentation submission, and support over the project duration.
- Third party evaluator fees.
- One-day training workshop for project team.

A third-party, post-occupancy (at the operational stage) audit is to be conducted for the confirmation of provisional rating after 12 months. A BEE certified energy auditor shall be appointed by the project proponent to conduct the audit. This is not included in the GRIHA cost.

If the preliminary assessment or workshop or site visits are out of station for New Delhi, all expenditure incurred on travel by flight (to & fro) and accommodation shall be arranged by the project proponent. Two members from GRIHA Council will conduct 3 site visits, in the beginning of the project, middle and towards the end of the project execution stages. Their travel and accommodation arrangements will have to be made by the client. Government taxes as applicable during registration are added to registration and rating fees.

CHAPTER 6

RESULTS AND DISCUSSIONS

- For finding the requirements of the residential sector, we conducted a survey to prioritize the needs of the household sector.
- The target segment of the survey was primarily comprised of builders in the sector, inmates and students whose thought process which would be the future of the construction industry.
- Based on the GRIHA rating system we have assessed and proposed a set of potential points for residential buildings.

6.1 INFERENCE

- The findings of the survey indicated a marginal difference in the two categories of target group.

- The builders and inmates review showed that indoor comfort and water efficiency were the prime of their concerns.
- The students on the other hand had an opinion to improve the water and energy efficiency.
- Collectively the least mentioned areas where sustainable building materials, site planning and innovation.
- The main emphasis is on usage of electricity and water which are critical parameters for sustainable design and directly linked to the living cost.
- Further the survey indicated a low level of awareness on certification for buildings and standards required to achieve the status.

- It also showed that a relatively meager group of people find green buildings economical, which is a myth. As the operation and maintenance cost of Green buildings in the long run and the benefits attained are not recognized.

6.2 PROPOSED PLAN FOR RESIDENTIAL BUILDINGS

The data collected was studied in detail and was optimized for solution regarding the problem statement. The proposed plan consists of 100 base points segregated for each category. Certain aspects regarding buildings of a larger scale were altercated according to the needs of the residential sector. The point breakup was done with the help of scaled weighted average and normalization of values obtained. The point's breakup in the proposed plan is as follows.

Table.6.1Performance Areas

Key performance areas	**Potential points**
Water management	29
Energy optimization	25
Indoor quality and comfort	19
Operation and maintenance	8
Waste management	9
Sustainable site planning	10
Total	100

6.2.1 WATER MANAGEMENT

With water management being the top of priorities in the survey, the maximum points were allocated for this aspect. Continuing urbanization in developing nations is increasing the demand yet the supply is inadequate or non-existent. Decentralized urban water recycling systems are an alternative source of water that could relieve the demand from public utilities. However, there are social, economic, environmental and technological factors that affect the uptake of these systems. The point's breakup were as followed.

Table.6.2 Water Management

Specifications	Potential points
Water recycle and reuse	9
Reduction of water construction	2
Reduce landscape water demand	3
Reduce building water use	4
Ensure water quality	7
Grey water reuse	4
Total	29

6.2.2 ENERGY OPTIMIZATION

The second major priority was given to that of energy optimization. According to the Sustainable Buildings & Climate Initiative (SBCI) issued by the United Nations Environment Program (UNEP), the building sector is responsible for 30% of the greenhouse gas (GHG) emissions globally and consumes more than 40% of the world's energy. Hence proper planning is needed.

Table.6.3Energy Optimization

Specifications	Potential points
Optimum building design to reduce conventional energy demand	4
Optimize energy performance of the building with specified comfort limits	7
Low energy materials	3
Renewable energy utilization	9
Energy audit and validation	2
Total	25

6.2.3 INDOOR QUALITY AND COMFORT

Designing energy efficient and comfortable buildings requires harmonizing the complex interactions of architecture, construction and building service engineering. The building envelope has a particular importance, since it integrates many functions and has direct influence on indoor climate. Focusing on satisfaction of the user means that the indoor climate is a key for a holistic design approach. Only a satisfied user will not intervene with the designed energy concept or the indoor climate control; dissatisfaction results in multiple system interventions which may cause waste of energy and sometimes even damage to building envelope components.

Table.6.4.Indoor quality and comfort

Specifications	**Potential points**
Indoor noise levels	4
Minimize ozone depletion substances (ODP)	4
Smoke control	2
Low VOC paints/sealants/adhesives usage	5
Interior air circulation and lighting	4
Total	19

6.2.4 SUSTAINABLE SITE PLANNING

Site planning is very crucial in any architectural drawing; close attention must be paid to it and important details must never be neglected or ignored in order to make it sustainable. It is an important aspect that shows site boundaries, improves the overall quality of building design as well as helps restore and preserve natural features on site. Although design vary and depend on the type of projects, however, detailed site plans are often neglected and in many instances are not in collaboration with the client; especially in smaller scale projects in developing countries. To achieve a sustainable site planning, the design process must be collaborative; bringing all the project stakeholders together, that is, the architect, client, engineers and the contractor.

Table.6.5.Sustainable site Planning

Specifications	**Potential points**
Soil testing	2
Soil conservation	3
Preservation and protection of landscape	3
Reduce hard paving of site	2
Total	10

6.2.5 WASTE MANAGEMENT

Waste management or waste disposal are all the activities and actions required to manage waste from its inception to its final disposal. This includes amongst other things collection, transport, treatment and disposal of waste together with monitoring and regulation. Waste can take any form that is solid, liquid, or gas and each have different methods of disposal and management. Waste management normally deals with all types of waste whether it was created in forms that are industrial, biological, household, and special cases where it may pose a threat to human health. It is produced due to human activity such as when factories extract and process raw materials. Waste management is intended to reduce adverse effects of waste on health, the environment or aesthetics.

Table.6.6.Waste Management

Specifications	**Potential points**
Reduction of waste during construction	2
Efficient waste segregation	3
Storage and disposal of waste	3
Resource recovery from waste	1
Total	9

6.2.6 EASE OF MAINTAINENCE AND OPERATION

Generally, water and sanitation experience their most serious problems with operation and maintenance and with cost recovery aspects. Hundreds of projects around the world demonstrate how the newly built infrastructure deteriorates after the project's termination. Therefore, it is imperative to plan for operation and maintenance, with a planned withdrawal of external support as local ownership builds. Operation and maintenance (O&M) activities, which encompass not only technical issues, but also managerial, social, financial and institutional issues, must be directed towards the elimination or reduction of the major constraints which prevent the achievement of sustainability.

Table6.7.Maintainance and Operation

Specifications	**Potential Points**
Safety facility and sanitation of construction workers	3
Ease of operation and maintenance	3
Accessibility to site	2
Total	8

CHAPTER 7

ACTION PLAN

7.1 WATER MANAGEMENT

7.1.1 Water re-cycle and reuse

Water recycling- reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing & groundwater Domestic water recycling Toilet recharge. A common type of recycled water is water that has been reclaimed Kitchen Reuse is water that has been reclaimed from municipal wastewater or sewage. Through the natural water cycle, the earth has recycled & reused water for millions of years.

Water recycling offers resource and financial savings. Wastewater treatment can be tailored to meet the water quality requirements of a planned reuse. Recycled water for landscape irrigation requires lessν treatment than recycled water for drinking water. Water is sometimes recycled and reused onsite. Eg Industrial facility recycles water for cooling processes. Another common type of recycled water is water that has been reclaimed from municipal wastewater, or sewage. Gray water, or grey water, is reusable wastewater from residential, commercial & industrial bathroom sinks, bath tub shower drains, & clothes washing equipment drains. Gray water is reused onsite for landscape irrigation. Gray water is reused onsite, for landscape irrigation.

Benefits of Water Recycling

Reduction of treated wastewater discharge to sensitive or impaired surface water, reduction of imported water & avoided costs associated with importing water. Recycled water can also be used to create or enhance wetlands and riparian habitats. Conservation of other resources besides water (e.g. Chromium removal from leather industry). Reuse at little extra cost savings on water abstraction cost. Reduced dependence on vagaries of river flows. Gaining tax advantages in arid & designated zones. Reduction in effluent discharge volume.

7.1.2 Reduction of Water usage during Construction

Reducing water use on construction sites will be successful only if the following challenges can be overcome:

i. **Value for money**

As water is a relatively ‘cheap’ resource, it is unlikely that the introduction of expensive processes on temporary construction sites will be viable

ii. **The work environment**

Any technology must be robust and able to stand up to the demands of construction sites

iii. **Habit**

Behaviour change is not a process that will happen overnight and therefore technological intervention, or technology that actively influences a behaviour change (e.g. incorporation of trigger guns on all hoses) is likely to be more successful than purely behavioral interventions. A mix of approaches is more likely to be successful than considering either behaviour or technology in isolation. The other major challenge that the industry currently faces is a lack of understanding of where water is used on construction sites. Without understanding where water is used, and therefore where water is wasted, it will be very difficult to justify water conservation measures on sites. The Action Plan seeks to address this by encouraging and promoting water audit activity to obtain better information.

7.1.3 Water Action Plan

The Water Action Plan identifies a number of actions required to reduce water use on construction sites. If completed, these will contribute greatly to achieving the target of reducing water use by 20% by 2012. The actions will also result in a much more detailed understanding of the uses of water on construction sites leading to a greater understanding of how contractors can reduce wastage.

The priority for improving efficiency of water use in construction follows the following hierarchy:

- Eliminate water wastage on site
- Improve efficiency of water using processes
- Offset consumption of mains water with alternative sources such as rainwater harvesting.

There are two main aims of this Action Plan:

- To improve construction site water use behaviour .
- To improve understanding of water use on sites to allow focused action.

7.1.4 Reduce Landscape Water Demand

Summer irrigation is essential for most of the urban and suburban landscapes in the warm Mediterranean climates of California. However, the amount of water used for irrigation often exceeds the amount needed. It is estimated that millions of gallons of excess irrigation water are annually washed down drains that flow directly to levees, rivers, and the ocean. Not only is water being wasted, but the runoff can contain fertilizers, pesticides, and other chemicals that are used in the maintenance of lawns and landscapes.

In order to maximize water use efficiency, it is helpful to select plants that are appropriate for designated areas. Drought-tolerant plants that do not need great amounts of water in the summer should be placed in warm, sunny areas. Similarly, plants should be grouped by their water needs. Plants that need to be irrigated more than once a week should be placed in shady areas, while plants that need less irrigation can be placed in less-sheltered areas.

Through research designed to help with proper selection of landscape plants and the use of proper irrigation practices, homeowners and landscapers should be able to reduce the amount of water applied, while also reducing the amount of potential contaminants in the water runoff.

It is important to prevent runoff by maximizing water use efficiency through proper plant selection and placement, and by maximizing water infiltration through the use of appropriate watering devices and utilization of permeable surfaces throughout lawn and garden areas. To achieve maximum water infiltration, it is crucial to use proper water control equipment when watering lawns or gardens. Watering plans should be established based on the location of water-demanding and drought-tolerant plants. Though water may be delivered through various irrigation devices, it is imperative to apply water in adequate but not excessive amounts. Water should not be applied faster than the soil can absorb it.

According to Oki, waste water is often runoff that was unable to be absorbed due to oversaturation of the ground. Another key aspect to maximum infiltration is to use permeable paving materials that promote absorption, such as permeable concrete, bricks, pavers, stones, cobbles, and turf block rather than watertight concrete and asphalt.

7.1.5 Reducing Building Water Use

Reducing water consumption will not only lower costs, it will also convey the corporate message that the environment matters. Basic ideas that can reduce your property's water consumption.

Cooling Towers

Make sure to regularly check make up water systems, blow down systems (keeping the cycles of concentration within limits), and filtration systems for leaks and proper operation. Towers with improperly maintained or old fill media will have uncontrolled drift (water droplets coming out the sides of the tower) resulting in large losses.

Aerators

An aerator can be screwed onto the tip of a faucet to deliver a mixture of air and water. The aerator pushes the water out at a higher velocity making it appear as if the water pressure is stronger while using less water. Depending on your current hardware and facility usage, Aerators can save

Maintain

Ensure your plumbing systems are properly maintained by your engineering staff. Stuck flush meters, and leaking faucets valves add up to a lot of wasted water down the drain.

Irrigation systems

Turn off any unnecessary irrigation and check proper operation of controllers, sprinklers, and regularly monitor meters to check over consumption

Measure

You can't monitor what you don't measure. Ensure you have accurate information by enrolling in Sea Suite to track your water use.

7.1.6 Ensure Water Quality

Water is one of the most important elements in construction and is required for the preparation of mortar, mixing of cement concrete and for curing work etc. The quality of water used has a direct impact on the strength of the motor and cement concrete in the construction work. The water used for curing and mixing must be free from high quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth, etc that might be deleterious to bricks, concrete or iron.

Raw materials-To ensure quality of materials, all raw materials used in construction project such as Re- Bar, cement, Stone Chips, bricks, stone, sand, Flooring Materials, Paint, Electrical fitting fixtures, Plumbing fitting fixtures, Sanitary Ware etc should be from reputed branded companies. This is the primary step for ensuring quality, after which all raw materials and finishing materials need to be tested for quality control through appropriate field tests and laboratory tests from accredited institutions. And the lab authority will supply reports for individual materials mentioning the test results and the concerned engineer will see if the results conform to the required quality.

Workmanship-In case of quality of workmanship, the work force has to be a skilled work force and they need to be aware of the quality requirements and the purpose of it. The workforce also needs to be trained periodically for ensuring consistency of quality in construction. It can be done department wise- for instance training programs should be held for civil engineers, electrical engineers, plumbing engineers and so on regularly in real estate companies so that concerned people are aware of the standard quality to be maintained in construction work. Reputed developer usually use check list to ensure quality in every step of construction.

Construction time-A third parameter in ensuring quality of construction is time management for the construction of the project. For instance, reputed developer companies in Bangladesh will offer good quality construction in a reasonable time frame required for project completion and provide on time handover. For this, a master construction work plan needs to be developed in the primary stage considering a standard time frame. Apart from this construction work progress is monitored closely through multilayer supervision such as Assistant Project Engineer, Deputy project Engineers, Project Engineers, Electrical Engineer, Plumbing Engineer, Higher management of Construction and so on. For ensuring smooth construction work, the work force also needs to undergo project management training and have ownership to complete project on time without compromising the quality of construction work.

Construction procedure-Since Bangladesh is on a moderately earthquake prone zone, care has to be taken to ensure buildings are earthquake resistant. In such cases, apart from designing a building to make it earthquake resistant, implementation of design during construction of building is also imperative. For instance, real estate companies in Bangladesh follow BNBC and ACI Code guideline to make standard building design that are durable and earthquake resistant. Some developer companies also employ other advanced technology to make buildings greater earthquake resistant.

For making a building durable, the concrete strength is another important factor. The shuttering for concrete should be waterproof.Mixing, transportation, placement, compaction of concrete is also very important so that the concrete does not weaken. And the water cement ratio needs to be in right proportion to have the desired concrete strength. Concrete curing is another important factor for adding structural strength to the building**.**

Throughout the different construction phases proper testing and procedures need to be followed so that the building is robust and no future problems arise, such as water soaking before brick works to prevent suction of water from wet mortar which will make mortar weaker and cannot provide any strength. For electric work, it has to be ensured that no cracks develop on plastering surface due to groove cutting and conduit laying on walls afterwards through use of wire mesh. For plumbing work, water test is done for water supply line to avoid any leakage. Successively, plaster work, tiles work, paint work etc are carried out with quality control in each step.

7.1.7 Grey Water Reuse

Grey water is gently used water from your bathroom sinks, showers, tubs, and washing machines. It is not water that has come into contact with feces, either from the toilet or from washing diapers. Grey water may contain traces of dirt, food, grease, hair, and certain household cleaning products. While grey water may look “dirty,” it is a safe and even beneficial source of irrigation water in a yard. Keep in mind that if grey water is released into rivers, lakes, or estuaries, its nutrients become pollutants, but to plants, they are valuable fertilizer.

Aside from the obvious benefits of saving water (and money on your water bill), reusing your grey water keeps it out of the sewer or septic system, thereby reducing the chance that it will pollute local water bodies. Reusing grey water for irrigation reconnects urban residents and our backyard gardens to the natural water cycle.

The easiest way to use grey water is to pipe it directly outside and use it to water ornamental plants or fruit trees. Grey water can also be used to irrigate vegetable plants as long as it doesn't touch edible parts of the plants. In any grey water system, it is essential to use "plant friendly" products, those without salts, boron, or chlorine bleach. The build-up of salts and boron in the soil can damage plants. While you're at it, watch out for your own health: "natural" body products often contain substances toxic to humans.

Grey water is different from fresh water and requires different guidelines for it to be reused.

1. Don't store grey water (more than 24 hours). If you store grey water the nutrients in it will start to break down, creating bad odors.
2. Minimize contact with grey water**.** Grey water could potentially contain a pathogen if an infected person's feces got into the water, so your system should be designed for the water to soak into the ground and not be available for people or animals to drink.
3. Infiltrate grey water into the ground, don't allow it to pool up or run off (knowing how well water drains into your soil (or the soil percolation rate of your soil) will help with proper design. Pooling grey water can provide mosquito breeding grounds, as well as a place for human contact with grey water.

4. Keep your system as simple as possible, avoid pumps, avoid filters that need upkeep. Simple systems last longer, require less maintenance, require less energy and cost less money.
5. Install a 3-way valve for easy switching between the greywater system and the sewer/septic.

7.2 ENERGY OPTIMISATION

7.2.1 Optimum Building Design to reduce conventional Energy Demand

A sustainable building is constructed of materials that could decrease environmental impacts, such as energy usage, during the lifecycle of the building. Energy consumption and greenhouse gas emissions to the environment attributed to buildings are significant contributors to this environmental impact. The consumption of operational energy by buildings has the single largest impact on the environment. Green buildings often include measures to reduce energy consumption.

To reduce the thermal aspects of energy consumption in the operational stage, high-efficiency windows and insulation in walls, ceilings, and floors increase the efficiency of the building. Reducing the use of operational energy should be the main concern of architects who wish to design and build “green” buildings. Analysis of the energy consumption of buildings is a difficult task, because it requires considering the detailed interactions between the building, the HVAC system, and the surroundings (weather), as well as obtaining mathematical/physical models that are effective in characterizing each of those items. Concerning architectural design, it became apparent that we could increase the comfortable space available in the building by using some of the traditional patterns of this region that have been developed by the indigenous people over many decades. This comfort is considered as a strategy in sustainable architecture, so it can be concluded that we can achieve sustainable architecture and also achieve sustainability by integrating the traditional patterns of this region with the architecture of the building. The traditional patterns use large, high terraces many of which could be beneficially applied to the case-study building, making it more sustainable.

7.2.2 Optimizing energy performance with specified comfort limits

Designing energy efficient and comfortable buildings requires harmonizing the complex interactions of architecture, construction and building service engineering. The building envelope has a particular importance, since it integrates many functions and has direct influence on indoor climate. Focusing on satisfaction of the user means that the indoor climate is a key for a holistic design approach. Only a satisfied user will not intervene with the designed energy concept or the indoor climate control; dissatisfaction results in multiple system interventions which may cause waste of energy and sometimes even damage to building envelope components. Satisfaction with the indoor environment also increases working productivity or enables effective recreation of residents.

The consideration of user's behavior and the user acceptance is essential, since the users have to understand and accept the energy saving measures; otherwise the users interact in a way which is probably not supporting the designed energy control. Whether the targeted savings potentials can be achieved in practice depends not only on the used technology but also on degree to which the design process is integrated and on the quality of craftsmanship. A holistic building design considers the specific outdoor condition of the climate zone as well as the cultural peculiarities which lead to formulating specific requirements. A sustainable energy control requires focusing on the users, the climate and the cost-effectiveness. A combined comfort and energy demand monitoring is of value, to gain profound understanding of the reaction of a building to the specific climate as well as of users' behavior or user acceptance.

7.2.3 Low Energy Materials

Buildings account for a large share of global energy use. Designing and upgrading them to use less energy is key to reducing fuel bills, increasing energy security and building a low-carbon world. Design techniques include optimizing the amount of natural light and the volume of air that flows in and out of the building. Energy is used in buildings to deliver comfortable conditions for occupants and to power appliances: this is known as 'energy-in-use'. Energy is also used in the production of building materials and during construction: this is known as 'embodied energy'. Currently the energy-in-use over the lifetime of most UK buildings greatly exceeds their embodied energy. Passive design can use wind-driven and stack-driven natural ventilation to provide cooling in summer without the need for air conditioning. To minimize heat losses during cold weather, airflow is reduced to the minimum needed to provide fresh air.

Low energy buildings use a mixture of passive techniques and active systems to deliver a comfortable environment with low energy use and low greenhouse gas emissions. Passive techniques relate to the shape of the building and the materials that it is built with, while active systems use machinery to provide services to the building which minimize energy use. Incorporating renewable energy generation on site can reduce emissions further. However, low energy use should be the first priority, since this is the cheapest way to cut greenhouse gas emissions. In addition, low energy use makes the adoption of renewable energy technologies more viable because less capacity is required to meet the building demand. It's possible to reach the point where a building produces net zero greenhouse gas emissions in use, known as 'zero carbon in use'. Embodied energy can also be reduced by using low-carbon building materials and construction methods.

7.2.4 Renewable Energy Utilization

Solar energy can be converted into electricity by photovoltaic modules or into heat by solar thermal collectors. Both systems can be used for solar assisted heating and cooling using different transformation techniques. The most straight forward design of solar heating and cooling systems using photovoltaic modules. A normal boiler using fuel (e.g. natural gas, oil or biomass) is used for heating and hot water production and a vapor compression chiller is used for cooling. In such systems the electricity generated by the photovoltaic system can only be used for cooling, not for heating and domestic hot water. Excess electricity which exceeds the actual electric load of the building might be fed into the electricity grid depending on local regulations. A control in the switchboard can be adjusted such that the local use of locally produced electricity within the building is maximized. A more sophisticated design uses an electrically driven reversible heat pump based on a vapour compression cycle that can be used to produce heat in the heating season and cooling in the cooling season.

The production of hot water, which is also needed in cooling seasons, requires a periodic change of the operation of the reversible heat pump between heating and cooling operation. In this system the boiler is used as back-up in case there is not enough heat from the reversible heat pump available to cover the heating load or the hot water load. The reversible heat pump might also be used to completely cover the heat demand of the building. When not enough electricity from the photovoltaic generator is available electricity from the grid is used to operate the reversible heat pump not only for cooling but also for heating. A control in the switch board can be adjusted such that the use of locally produced electricity by the photovoltaic system is maximized.

7.2.5 Energy Audit and Validation

The Energy Audit is a result of a validation of the energy consumption of building, aiming to provide information in order to identify and quantify the opportunities for energy savings. The point is to understand how Energy is used, which the reasons for possible leaks are, and which interventions can be suggested to the client, performing an assessment and a systematic survey of parameters for the specific consumption and the operating conditions of building and its facilities. During the diagnostic operations, is provided to collect data about consumption and relative energy costs, data`s about uses of electricity, of heating, cooling, data of water consumption (power, efficiency factor, working hours, etc). There are also collected all relative data about the building as a construction (stratigraphy) and its structure. The energetic situation, framed in this way, is analyzed critically with the aim to identify necessary interventions for reduction of the consumption and of the costs with the preliminary feasibility assessment.

Building energy simulation tools are now being used in a number of new roles such as building operation optimization, performance verification for efficiency programs, and – recently – building energy code analysis, design, and compliance verification in the residential sector. But increasing numbers of studies show major differences between the results of these simulations and the actual measured performance of the buildings they are intended to model. The accuracy and calibration of building simulations have been studied extensively in the commercial sector, but these new applications have created a need to better understand the performance of home energy simulations.

7.3 INDOOR QUALITY AND COMFORT

7.3.1 Indoor Noise Levels

Noise is one of the main pollution of the environment causing various hazardous consequences for human life. Noise not only impairs sensibility to auditory stimuli by masking effects, it has other consequence too. Studies have proved that a loud noise during peak hours creates tiredness, irritation and impairs brain activities, so as to reduce thinking and working abilities. Its general effects on human being are that, it covers disturbance in sleep which lead to other side effects. The effects of noise pollution can be categorized into following ways. Physiological effects This form of environmental degradation has implication for health as serious as air or water pollution. Noise can change men's physiological state by speeding up pulse and respiratory rates. It can impair hearing either permanently or temporarily, millions of industrial workers are threatened with hearing damage. Medical evidence suggests that noise can cause heart attacks.

Noise can cause chronic effects as hypertension or ulcers. Noise can cause deafness. Some empirical research conducted on pregnant female mice reveals that air craft taking off which bring 120 to 160 dB caused miscarriages in them, if the findings on mice are made applicable on human being. The effect of these categories includes, annoyance, tensions in muscles, nervous irritability and strain. It creates annoyance to the receptors due to sound level fluctuations. The periodic sound due to its irregular occurrences causes displeasure to hearing and causes annoyance. The physiological features like breathing amplitude, blood pressure, heart-beat rate, pulse rate, blood cholesterol are affected.12 Behavioral effects It has been reported that performance of school going children is poor in comprehension, when schools are in the busy / traffic area. Noise can cause irritation, which results in learning disabilities. The working performance of human will be affected as they will be losing their concentration. It affects the sleeping there by inducing the people to become restless and lose concentration and presence of mind during their activities. Person logical effects ,If the injurious effects of noise tend to persist for longer duration they may cause mal adaptive reactions in the individuals, disturbing his total personality make up. Insomnia, fatigue, hypertension, blood pressure and deafness are the symptoms shown by the people living in the noise polluted area. It causes pain, ringing in the ears, feeling of tiredness, thereby effecting the functioning of human system

It is easy enough to measure the noise of a space after it has been built. But by then, rectification to reduce noise levels may prove to be expensive and a hassle. As such, what is more important is how we effectively specify and measure buildings to achieve the desired acoustic comfort during planning and building stage. Traditionally, the method for mitigating noise intrusion is by introducing the rating system called Sound Transmission Class (STC) or sometimes referred as ISO's Weighted Sound Reduction .STC essentially describes the ability of a particular material to resist airborne sound. For example, each wall of a room may be given a certain STC rating, which indicates an average quantum of external noise that could potentially be isolated through it. A higher rating will ‘block’ more noise from transmitting through that particular material or wall. Although STC is a norm specified in building designs, it does not provide us the desired acoustic comfort within a room. STC only provides the performance of individual walls and materials. It is not a measurement or specification used for defining the acoustic outcome of the entire functional space.

In reality, the desired acoustic comfort of a particular space depends on a complex combination of sound isolation of partitioning elements, indoor acoustics design and finishes; also noise and vibration mitigation of building equipments (typically mechanical and electrical equipments). It requires a more comprehensive method of measurement and design that provides a better reflection of the total noise levels of that space. Hence, a more defining approach for specifying and measuring indoor acoustic comfort should be used. In specifying building designs, acoustician, mechanical engineers and architects adopt an approach to use ambient noise level to specify their desired design outcome. Ambient noise level is described as a background sound level for a desired indoor functional space. A good acoustic environment provides an ambient noise level that suits its environment, providing a degree of human comfort and speech intelligibility.

7.3.2 Minimize Ozone Depletion Substances

Chlorofluorocarbons (CFCs)

They are compounds formed by chlorine, fluorine and carbon. They are often used as refrigerants, solvents, and for the manufacture of spongy plastics. The most common are CFC-11, CFC-12, CFC-113, CFC-114, and CFC-115 which respectively have an ozone depletion potential of 1, 1, 0.8, 1, and 0.6.

Chlorofluorocarbons, the chemicals used as the propellant for aerosol cans and Bromo-fluorocarbons, Halon, are destroying the earth’s Ozone layer. These chemicals were used in Freon and for fighting fires. Manufactures thought the chemicals were inert and not harmful to the environment.

When the chemicals reached the earth's stratosphere, they reacted with Ultraviolet radiation, which caused them to break down and release Chlorine and Bromine into the earth's ozone layer. The Ozone layer protects the earth from UV-B Rays. The chemicals caused a reaction, which made the ozone layer break down into pure oxygen. The layer lost its shielding effect from the suns UV rays. The Bromine and Chlorine kept interacting with the ozone molecules until they eventually left the ozone layer to bond with other compounds.

Hydrochlorofluorocarbons (HCFCs)

Compounds formed by H, Cl, F and C. They are being used as substitutes for CFCs because many of their properties are similar and are less harmful to ozone by having a shorter half-life and releasing fewer Cl atoms. Decreases are between 0.01 and 0.1. But as they remain harmful to the ozone layer, they are considered only a temporary solution and their use has been banned in developed countries since the year 1930.

Halons

They are compounds formed by Br, F and C. Because of their ability to put out fires are used in fire extinguishers, although their manufacture and use is prohibited in many countries because of their ozone-depleting action. Their ability to harm the ozone layer is very high because they contain Br which is a much more effective atom destroying ozone than the Cl. Thus, halon 1301 and halon 1211 have ozone depletion potentials of 13 and 4 respectively.

Note: Technically all compounds containing C and F and / or Cl are halons, but in many legislation halon only means fire extinguishing substances with the characteristics indicated above.

Methyl bromide

It is a very effective pesticide that is used to fumigate soils and in many crops. Given its content in Br damages the ozone layer and has an ozone depletion potential of 0.6. In many countries dates have been set around 2000, from which it will be banned.

Carbon tetra-chloride (CCl_4)

It is a compound that has been widely used as a raw material in many industries, for example, to manufacture CFCs and as a solvent. It was no longer used as a solvent when it was found to be carcinogenic. It is also used as catalysts in certain processes where chlorine ions need to be released. Its ozone depletion potential is 1.2.

7.3.3 Effects of the depletion of the ozone layer on human health

Skin Cancer

Today, it is estimated that skin cancer rates increased due to the decrease in stratospheric ozone (ozone layer). The most common type of skin cancer, called non-melanoma, is the cause of exposures to UV-B radiation for several years. There are already people who have received the dose of UV-B that can cause this type of cancer.

The United Nations Environment Program (UNEP) predicts that at an annual rate of 10 percent ozone loss over several decades, the increase in skin cancer will be around 250,000 per year. Even taking into account existing agreements for the phase-out of ozone-depleting substances (ODS), a realistic model would indicate that skin cancer would increase to 25 percent above the level of 1980 by the year 2050, along Of the 50 ° North latitude. The most lethal skin cancer, called melanoma, could also increase its frequency.

The Immune System

A person's defenses against infection depend on the strength of his immune system. It is known that exposure to ultraviolet light reduces the effectiveness of the immune system, not only relating to infections to the skin but also to those that can be verified in other parts of the body.

Exposure to UV-B radiation may well enable the immune system to tolerate disease rather than combat it. This could mean the uselessness of vaccination programs in both industrialized and developing countries.

7.3.4 Smoke Control

Smoke control systems are required in multi-storey residential buildings, principally to protect the stairs to assist escape in the event of a fire, in compliance with the recommendations of Approved Document B and BS 9991:2011.

In multi-storey residential buildings, the main escape route is always via common corridors and/or lobbies into the stairs. The aim is to keep stairs reasonably free of smoke and to improve conditions in corridors and lobbies opening onto the stairs.

When the door to the apartment which is on fire is open (typically for occupants to escape), a significant amount of smoke can quickly fill a corridor or lobby, making escape difficult for occupants. So legislation limits the distance between fire doors in corridors to 30m and the length of dead-end corridors to 7.5m to limit the distance people may have to travel through smoke.

If this smoke enters the stairs it can also make escape difficult for occupants of other storey's and hamper fire service entry and deployment. Smoke control systems are provided for each stair and for the lobbies or corridors opening onto each stair in order to stop smoke from spreading to the stairs. Ventilation may be either natural or mechanical, or alternatively a pressurization system may be used.

Protection for the stairs

Stairs are generally ventilated by a 1.5 m^2 automatic stairwell ventilator (AOV) at the head of the stairs

Pressurization

A pressurization system may be used in place of natural ventilators or shaft systems and generally provides better protection. An air supply system maintains a positive air pressure in the staircase, which prevents smoke from entering it from the fire location. Excess air pressure needs to be avoided, either by fan speed control or by pressure relief from the staircase. An air leakage path from the non-pressurized area to outside needs to be provided to prevent the area from becoming pressurized if a door is kept open. This can be either by natural ventilators to outside, or by a common natural shaft through the building, or by a mechanical shaft system.

Such systems are generally relatively expensive, so they are normally only used where demanded by regulations or standards or by Building Control, usually as a trade off. Environmental ventilation systems – providing added value to a shaft system

The quest for energy efficiency has led to very good insulation in residential buildings. While this is very good for the environment and electricity bills, it is having unintended consequences stair lobbies, corridors and entrance halls, which tend to overheat.

Using the equipment specified to provide smoke control of the common areas, it is possible to provide a simple and effective cross flow ventilation system to extract warm, stale air from these spaces and their ceiling voids.

7.3.5 Use of Low VOC

Low VOC paints are those that contain less "Volatile Organic Compounds" (VOC) or VOC Solvents than traditional coatings. The VOC solvents act to slow the initial drying by maintaining a "wet-edge" which gives a longer time to work with the product. So, when VOC solvents are removed, the coating must be formulated differently to compensate for the lower level of VOC solvents. The application methods will also need to be altered to achieve the best finish.

Low VOC paints usually exhibit shorter drying times. This means that there is less time and opportunity for the paint to flow-out, which can result in slightly rougher surfaces. These surfaces will scatter light more inconsistently, which is often detected as uneven sheen, glossy peaks & flat troughs, patchiness, lapping or just an uneven "dry looking" appearance.

The move to low VOC paints means that application and drying properties can differ significantly from what the user is accustomed to, hence new application techniques will need to be adopted in order to accommodate these difference is properties, so that a consistently great looking finish can be produced. Wet-edge" and drying problems can be minimized or eliminated by using the recommended roller sleeve and nap length for each product.

7.4 SUSTAINABLE SITE PLANNING

7.4.1 SOIL TESTING

Types of Soil tests for building construction works depend on properties of soil. Design of foundation is based on soil test report of construction site. Soil tests for construction of buildings or any structure is the first step in construction planning to understand the suitability of soil for proposed construction work. Soil which is responsible for allowing the stresses coming from the structure should be well tested to give excellent performance. If soil shouldn't test correctly then the whole building or structure is damaged or collapsed or leaned like leaning tower of Pisa. So, soil inspection or various tests on soil are conducted to decide the quality of soil for building construction. Some tests are conducted in laboratory and some are in the field. Here we will discuss about the importance of various soil tests for building construction. The tests on soil are as follows.

- Moisture content test
- Atterberg's limits tests
- Specific gravity of soil
- Dry density of soil
- Compaction test (Proctor's test)

7.4.2 SOIL CONSERVATION

- Conduct a soil test to ensure adequate fertility of the soil to support vegetative growth.
- Ensure adequate topsoil laying for vegetative growth.
- Ensure stabilization of soil in the area where the topsoil is vulnerable to erosion.
- Protect the top soil from erosion. Use collection storage and reapplication of the top soil, sediment basin, contour trenching, mulching, soil stabilization methods to protect the top soil from erosion during construction.

Fig.7.1 Grassing over top soil

7.4.3 PRESERVATION AND PROTECTION OF LANDSCAPE

- Select proper timing for the construction activity to minimize site disturbance such as soil pollution due to spilling of the construction material and its mixing with rainwater.
- Use staging and spill prevention and control plan to restrict the spilling of the contaminated material on site. Specify and limit construction activity in pre-designated areas.
- Preserve existing mature trees on-site during the course of construction by preserving and transplanting them.
- Compensate the loss of vegetation (trees) due to the construction activity by compensatory plantation. Replant the same, native and/or non-invasive species, which existed on the site before elimination in the proportion of 1:3.
- Plant in excess of 25% to the minimum required within the site premises (plantation to follow same criteria as above).

Fig.7.2 Rainfall data

Fig.7.3(a) Proper segregation of materials to prevent contamination

Fig.7.3(b) Proper segregation of materials to prevent contamination

7.4.4 REDUCE HARDPAVING ON SITE

Of course the very best thing to do is to avoid paving as far as possible. However, there are many situations when we really have no choice. At such times, the least we can do is to use materials and systems to mitigate the problems we cause.

Figure 7.4 Previous concrete paving

This is a type of concrete where the fine aggregate (sand) is missing so that the concrete becomes porous enough for water to percolate through. This means, of course, that it is not as solid as other concretes and cannot sustain the same heavy-duty usage. On the other hand, it is perfectly usable in areas where traffic density is low or, for example, in parking lots.

Some cities like Portland, Oregon in the USA have experimented quite extensively with permeable paving. Unfortunately, there is little sign of anything even remotely close being done here.

Fig.7.5 Perforated paving block

These are easily available here but not as commonly used as I wish they were. They are easy to lay and, to my eye, they make a space look much nicer than if were completely covered with a hard surface.

Permeability is excellent but, like porous concrete, it can only be used for low-traffic areas or parking lots.

Fig.7.6 Tree guards

If all else fails — and even if not, it is wise to have tree guards which allow the soil around the roots to breathe. This is something that is conspicuously lacking in our cities. Instead, we see a low brick wall made as close to the trunk as possible. Apart from being undersized and ugly, these are also tripping hazards for pedestrians.

It would be so simple, instead, to embed a cast iron tree guard that is level with the pavement. If the city authorities feel that the iron will be pilfered, they can do something similar in ferro-crete. It won't look half as nice but at least it will be effective.

Fig.7.7 Green Roofs

While a green roof can't do very much for the surface runoff and the storm-water systems, it can certainly be help reduce the urban heat island effect.

Planted roofs haven't caught on too well here as yet. That will not change until waterproofing systems become much more reliable. People who have running battles with monsoon leakage are unlikely to tempt fate.

7.5 Waste Management

7.5.1 Reduction of Waste During Construction

Firstly, aim to reduce the amount of waste you create. If waste is created, identify ways you can reuse the materials .Finally, if materials cannot be reused then collect them to recycle. Only dispose of waste as a last resort. Reducing, reusing and recycling your construction waste can bring many benefits, generate income from collecting some materials, reduce your costs from purchasing less material and maximizing skip space comply with legislation, reduce accidents by storing materials carefully to ensure a tidy site, reduce CO_2 emissions and help conserve natural resources.

Try to be involved early in a project to encourage designs that cause less waste to be created. Use standard sizes and quantities of materials and plan ahead to reduce off cuts. Avoid over-ordering and arrange deliveries to match work stages to avoid materials being stored on site longer than necessary. Ensure storage areas are safe, secure and weatherproof. Minimize rework from errors and poor workmanship.

Suggestions

The site induction and toolbox talks are opportunities to raise awareness of good waste management .Having one person responsible for ordering materials helps avoid surplus being purchased.›Buying sand and gravel in bulk bags rather than loose helps reduce wastage. Computer software is available to estimate required quantities accurately. Don’t accept poor quality or damaged deliveries. Don’t remove protective packaging from materials before they are needed.

7.5.2 Efficient Waste Segregation

Waste management is the process of treating solid wastes and offers variety of solutions for recycling items that don’t belong to trash. It is about how garbage can be used as a valuable resource. Waste management is something that each and every household and business owner in the world needs. Waste management disposes of the products and substances that you have use in a safe and efficient manner.

Effective management of building-related waste requires coordinated action of governmental, business, and professional groups and their activities. Several non-governmental organizations and societies in the US promote coordinated action, and have identified best management practices in the interest of public health and welfare (see resources.) Absent coordinated regulations, realistic business opportunities, and the commitment of design and construction professionals and their clients for continual improvement of industry practices, consistent and stable markets for recovered materials cannot be achieved or sustained.

Management of building-related waste is expensive and often presents unintended consequences. However, common sense suggests that failure to reduce, reuse and recycle societal wastes is unsustainable. It stands to reason that efficient and effective elimination and minimization of waste and reuse of materials are essential aspects of design and construction activity. Creativity, persistence, knowledge of available markets and businesses, and understanding of applicable regulations are important skills for design and construction professionals.

Some waste generated in the process of construction can be eliminated. For example, durable modular metal form systems for use in concrete construction may be selected on the basis of being readily demountable and reusable on other projects, thus eliminating wood waste associated with formwork fabricated of plywood and dimensional lumber. Elimination of waste can be beneficial to reduce impacts on human health and the environment. Some building-related waste can be minimized. For example, construction products can be selected on the basis of its being designed and manufactured to be shipped with minimal packaging. Also consider that selection and use of recyclable materials and products offers potential to minimize waste.

7.5.3 Storage and Disposal of Waste

Storage Containers Required. It shall be the duty and responsibility of every person in possession, charge or control of any establishment where garbage or refuse is created or accumulated to at all times keep or cause to be kept adequate portable storage containers of approved size, type and construction and to deposit or cause to be deposited all garbage, rubbish or waste in said storage containers. Storage containers shall be strong, watertight, not easily corrodible, rodent-resistant, insect-resistant, of not less than 20 and not more than 33 gallons capacity, have handles at the sides and tight fitting overlapping covers and shall not exceed 60 pounds in weight when full; provided, however, that by agreement with the director of public works, bulk containers, such as dumpster units, may be used. Each storage container shall be kept clean inside and out by the customer. Covers shall not be removed except when necessary to place garbage and refuse in the storage container or to remove the same there from.

All putrescible solid waste shall be drained of surplus liquids and shall be securely wrapped in paper or placed in watertight bags before being placed in the storage containers. Storage containers shall not be overloaded to the extent covers cannot be securely replaced. Where the director of public works or his designee deems necessary, a suitable raised platform, hanger or device shall be provided so that storage containers shall not freeze onto the ground or rest in water or on ice or be tipped over by animals. At the time of collection, storage containers shall be placed at accessible locations approved by the director of public works or his designee. Storage containers shall be loaded in such a manner as to be conveniently handled without spilling contents. Containers without handles or lids or with sharp edges or holes shall be considered solid waste and after written notice to the customer has been left with the container on the previous collection date, may, without liability, be collected and discarded by the solid waste collector. It shall be the duty of every person in possession, charge or control of any establishment to keep the area surrounding a storage container clean and free of any materials which may appear to be garbage, rubbish or waste. Any such material may without liability be collected and discarded by the solid waste collector.

Ketchikan Solid Waste Handling and recycling facility. The city of Ketchikan's solid waste handling and recycling facility is designed, constructed and operated primarily for the handling and disposal of mixed municipal solid waste by baling and shipping of non inert waste and recycling or landfilling of inert waste. Methods for operations of the facility and policies for acceptance and disposal of solid wastes are matters within the sole discretion of the city of Ketchikan. Waste other than mixed municipal waste or inert waste may be accepted with conditions or prohibited.

All garbage, household hazardous wastes and white goods shall be disposed of at the municipal landfill or at any other landfill approved by the city and all applicable governmental agencies. Construction wastes, demolition wastes, industrial wastes, recyclables, rubbish, tires and yard wastes shall be disposed of at the municipal landfill or any other Alaska Department of Environmental Conservation approved landfill or disposed of by any other method or means approved by the Alaska Department of Environmental Conservation.

Community Solid Waste Disposal - All owners or occupants of residential dwelling units shall pay a community solid waste disposal fee of $18.00 per month which shall be billed and collected in the same manner as the solid waste collection fee unless otherwise determined by the city manager. The community solid waste disposal fee shall be charged to all residential dwelling units, regardless of the amount of solid waste, if any, generated by any particular residence, in order to protect the public health, safety and welfare and to enhance the environment of the people of the city of Ketchikan. Suspension of the community solid waste disposal fee will not be permitted for absences or vacancies.

Landfill Disposal - Solid waste separated in accordance with subsection (c) of this section and delivered to the municipal landfill shall be charged a landfill disposal fee set forth as follows; notwithstanding, however, the director of public works or his designee may increase or decrease the landfill disposal fee if, in his opinion, acceptance of such solid waste would create additional costs or be a benefit to the operations of the landfill

7.5.4 Resource Recovery from Waste

Building materials account for about half of all materials used and about half the solid waste generated worldwide. They have an environmental impact at every step of the building process—extraction of raw materials, processing, manufacturing, transportation, construction and disposal at the end of a building's useful life. here are now, more than ever, clear opportunities for business and industry to invest in activities that will create profit and improve environmental outcomes by extracting valuable resources from the C&D waste stream.

The built environment of the future is being constructed at the beginning of a new ecological era where governments are framing markets with regulation and legislation that respond to the challenges of environmental sustainability, and where industry must respond to the challenges of low-carbon economies and resource depletion. Businesses that are profiting and growing are adapting to these new challenges and responding with innovations that turn waste into valuable resources to supply the construction industry, which has traditionally been adverse to behavioural change. This guide outlines the opportunities available for effective markets and presents 15 initiatives where companies are profiting and growing while contributing to a more ecologically sustainable built environment.

7.6 OPERATION AND MAINTENANCE

7.6.1 SAFETY FACILITY AND SANITATION OF CONSTRUCTION WORKERS

To ensure health and safety of workers during construction, with effective provisions for the basic facilities such as sanitation and drinking water and safety of equipment or machinery, comply with the safety procedures, norms and guidelines (as applicable) as outlined in NBC 2005 (BIS 2005c). Adopt additional best practices and prescribed norms as in NBC 2005 (BIS 2005c).

Fig.7.8 Proper drinking water

Fig.7.9 Safety of workers

Fig.7.10 Toilet facility

7.6.2 EASE OF OPERATION AND MAINTENANCE

Hygiene and Sanitation is one of top priorities and we maintain it to perfection. Having carefully understood the harmful nature of chemical cleaners and the adverse effect that it can have on the environment and living things. Use of organic cleaning methods and refer it to as Green cleaning. Our Green cleaning solutions consists of biology benefitting bacteria and are multi-purpose solutions.

Our Green Cleaning solutions use less water compared to conventional cleaning methods and add on to water savings. Green cleaning solutions are a clear winner over others conventional cleaning solutions as there are no toxic exposures and health hazards. Metallic mats can be used near the entry way systems and thus can prevent excess dust from entering.

7.6.3 ACCESSIBILITY

Access to the site should be effective which includes access to public transport. In case of emergency, the exit ways should be easily accessible. A real estate development often produces negative impacts towards the environment such as the reduction of the ecological capacity in the site and its surroundings, energy exploitation, and excessive pollutant emission. Proper planning is needed for the above said situations.

CHAPTER 8

CONCLUSION

The project book would act as a reference for all the residential building projects under construction to attain green building status with step by step procedures, investigations and validation required. The final rating system for small residential building shows that people are mainly focused towards conservation & reuse of water and energy optimization because it is directly related to their daily usage and cost of living. So as per above study we would like to recommend the credit point as shown in figure. It helps to preserve natural resources because the small housing numbers are much higher than high rise buildings.

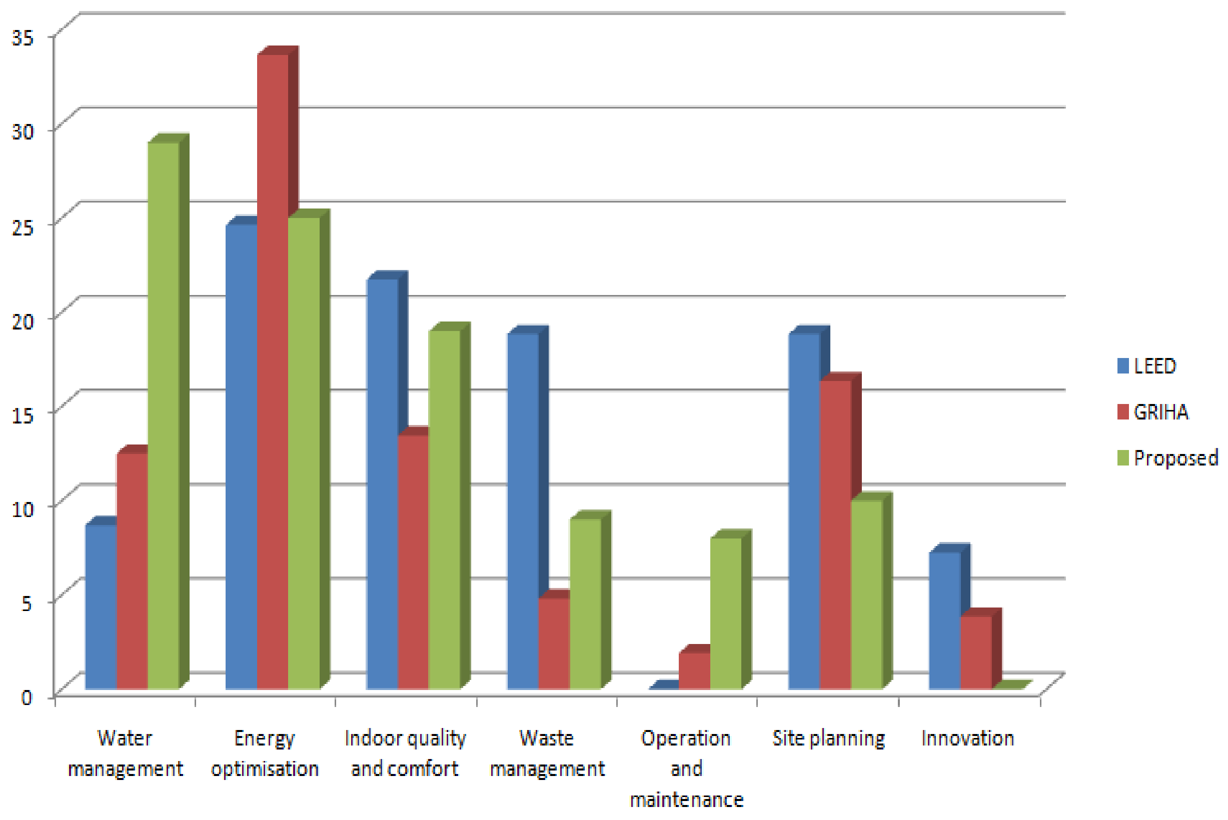


Fig. 8.1 Assessment graph for the proposed plan

However, to achieve sustainable development, certain mandatory criteria must be followed to achieve good economic, environmental and social system. Hence new development in green building is required which can focus more on the life cycle analysis in all product stages, knowledge integration and involving more expert people from all areas. Also using the renewable materials, utilization of the solar energy, rain water harvesting system and water reuse considering geo graphical condition of the area where Green Building to be build.

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