"COMPARISION AND ANALYSIS OF GREEN HOME WITH TRADITIONAL BUILDING "

A REPORT

Submitted in partial fulfillment of the requirements for the project presentation of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

By

Devesh Yadav (131634)

Under the supervision of

Mr. Lav Singh

to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT SOLAN – 173 234

HIMACHAL PRADESH , INDIA

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"COMPARISION AND ANALYSIS OF GREEN HOME WITH TRADITIONAL BUILDING"** in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by Devesh Yadav (131634) during a period from July 2015 to June 2016 under the supervision of Mr. Lav Singh, Assistant Professor, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

Date: - ……………………….

Dr. Ashok Kumar Gupta
Professor & Head of Department
Civil Engineering Department
JUIT Waknaghat

Mr. Lav Singh
Assistant Professor
Civil Engineering Department
JUIT Waknaghat

ACKNOWLEDGEMENT

It is our proud privilege and duty to acknowledge the kind of help and guidance received from several people in preparation of this report. It would not have been possible to prepare this report in this form without their valuable help, cooperation and guidance.

The topic **"COMPARISION AND ANALYSIS OF GREEN HOME WITH TRADITIONAL BUILDING** " was very helpful to us in giving the necessary background information and inspiration in choosing this topic for the project. Our sincere thanks to **Mr. Lay Singh ,** Project Guide for having supported the work related to this project. Their contributions and technical support in preparing this report are greatly acknowledged.

We wish to thank **Prof. Ashok Kumar Gupta**, Head of the Department, Civil Engineering Department for all his support by the way of providing wonderful working environment and facilities for the study in general and this work in particular. We are forever grateful to our families for their unconditional support.

Devesh yadav(131634)

INDEX

CHAPTER 1 :INTRODUCTION

1.1 GREEN BUILDING

Green building is the act of making structures and utilizing forms that are earth mindful and asset productive all through a building's life-cycle from siting to plan, development, operation, support, remodel and deconstruction. This practice extends and supplements the established building configuration worries of economy, utility, strength, and solace. Green building is otherwise called a feasible or elite building.

1.2 IMPORTANCE OF GREEN BUILDING

It is safe to say that you are mindful that your office or private building could hurt the earth? Is it conceivable that you're building is regurgitating hurtful contaminations without you understanding it? We are very much aware about different ecological issues, for example, a worldwide temperature alteration, water and air contamination and the measures that should be taken to counteract them. In the event that we change to economical engineering and green structures in India, not only for nature's purpose, but rather for ourselves, we couldn't just spare the earth additionally lessen our aggregate possession costs.

The building development industry creates the second biggest measure of annihilation waste and nursery gasses (35-40%). The real utilization of vitality in structures is amid development and later in lighting or cooling frameworks. While, different civilities like lighting, aerating and cooling, water warming give solace to building inhabitants, additionally devour huge measure of vitality and add to contamination. Promote, tenant exercises produce extensive measure of strong and water squander also.

Feasible engineering is the sort of design that looks to limit the hurtful effect that structures have on nature. Such reasonably constructed green structures are naturally dependable and asset effective, ideal from area determination to the decimation after its lifecycle closes. A green building utilizes less vitality, water and other common assets makes less waste and green house gasses and is sound for individuals living or working inside when contrasted with a standard structure. Building green is not about somewhat more effectiveness. It is about making structures that improve on the utilization of neighborhood materials, nearby biology and in particular they are worked to decrease power, water and material necessities. Consequently, if these things are remembered, then we will understand that our customary design was indeed, extremely green. As indicated by TERI gauges, if all structures in Indian urban regions were made to receive green building ideas, India could spare more than 8,400 megawatts of energy, which is sufficient to light 550,000 homes a year.

1.3 FIVE PRINCIPLES OF SUSTAINABLE DESIGN

1. **Optimizing Use of the Sun.**: Most of us rely on oil, coal, natural gas, and other fossil fuels to heat and cool our homes. Not only are these resources expensive and polluting, they are also being rapidly depleted. A simple and cost-effective alternative is to plug your house into the sun by either active or passive strategies. Active strategies use solar panels that turn the sun's heat into energy. Adopting passive strategies means that you do some of the following: Design and orient the house to minimize summer afternoon solar heat gain and optimize winter solar heat gain. In the northern hemisphere, this means orienting the long sides of the house to face south and north and creating roof overhangs and landscaping that shade the east, south, and west sides of the house. Situate the house to take advantage of prevailing breezes during the spring, summer, and fall. Not only are these breezes valuable for cross-ventilation in the house, but they can make screened-in rooms and porches more comfortable places to live. Shade trees and shrubs around your house. In summer, well-placed foliage helps keep the house cool, while bare branches in winter let the sunlight through to warm the house.

2. **Improving Indoor Air Quality.**.: Average person spend up to 90% of their time indoors where air quality can be more polluted than outdoors. Pollutants range from toxins, such as asbestos and formaldehyde found in building materials, to allergens such as mold, mildew, fungus, bacteria, and dust mites. The negative effects of these pollutants may cause health problems upon initial exposure or even many years later. There are measures that can be taken to improve indoor air quality: Choose ventilation systems that remove dirt, dust, moisture, humidity, and pollutants. Seal off the garage from the house to eliminate fumes from cars and lawn mowers. Select materials, such as those without formaldehyde, that limit off-gassing, ' minimal or no toxic properties, and do not shed dust or fibre.

3. **Using the Land Responsibly :** You can create a sustainable house by making good use of the land your house sits on and by considering the impact of the house on the surrounding environment. When looking to buy a new home, consider the following advantages: Buy a smaller, more compact house on a lot that is located near work, public transportation, and community services to save fuel and money. Choose a neighbourhood where houses are clustered closer together, leaving more open space for residents to enjoy and helping to preserve the natural landscape. Adopt smart gardening practices like using organic pesticides and composts, as well as native plants that do not require extensive irrigation systems. Use landscaping rather than paved surfaces, which impede storm water infiltration, often resulting in the contamination of local water sources.

4. **Creating High-Performance and Moisture-Resistant Houses :** The roof, walls, windows, and doors of a house create an envelope that protects residents from the weather and intruders, including pests, noise, and dirt. It also controls the entry of sunlight and, most importantly, helps maintain indoor comfort. Maintaining a constant level of comfort is often wasteful and expensive but can be done efficiently and economically by the following means: Create a building envelope with more durable and energy-efficient materials that reduce drafts, balance room temperatures, control moisture, and save on heating and cooling costs. Seal any gaps or cracks where moisture can get in and heat or cooling can leak out. Schedule a home energy audit. Many utilities offer them for free and the expert advice can result in big energy savings.

5. **Wisely Using the Earth's Natural Resources :** The earth provides us with a finite amount of natural resources and it is our responsibility to make them last. It is also up to us to use these resources in ways that are not detrimental to the environment or our health. When selecting products and materials to use in your home, look for ones that have: High levels of: Renewability, Reusability & Durability Low levels of: Embodied energy, or energy required to extract, process, and transport materials Environmental impact, or negative effects on outdoor and indoor environments.

1.4 DIFFERENCE BETWEEN GREEN BUILDING & CONVENTIONAL BUILDING

Figure 1.1 Comparison of green and conventional building

Table 1.1 Materials used in green building

Sr. No.	Item	Conventional Material	Green Material
1	Windows and Openings	Aluminium Panelled Plain Glasses	Insulated Glass (IG Units)
2	Lighting Fixtures	Tube Lights & CFLs	Low Watt LED Tube Lights & Bulbs
3	Plumbing Fixtures	Conventional Fixtures	Special Green Fixtures
4	Flooring	Vitrified & Glazed Tiles and China Mosaic	PVC Flooring, Glazed Tiles and China Mosaic
5	Doors	Pine Wood	Engineering Wood

1.5 ABOUT PROJECT

Design of 1BHK home using principle of sustainable design

1.6 PROJECT LOCATION

Location : solan

1.7 AIM OF PROJECT

.Collection of data like land cost, material cost, maintenance cost, growth rate, inflation rate etc

- Calculation of various cost associated with the life cycle of a normal building and green building.
- Calculation of the quantity of material required for the construction of a normal building and a green building.
- Comparison of the life cycle cost of the normal buildings and the green building.

1.8 OBJECTIVES

- Learning and understanding the software Autodesk Revit
- Designing green home with the help of Revit
- Energy analysis and comparison of green home with conventional home
- Determine payback period of extra cost incurred during construction

.

CHAPTER 2 – LITERATURE REVIEW

2.1 Life-Cycle Cost Analysis (LCCA) Method

The purpose of an LCCA is to estimate the overall costs of project alternatives and to select the design that ensures the facility will provide the lowest overall cost of ownership consistent with its quality and function. The LCCA should be performed early in the design process while there is still a chance to refine the design to ensure a reduction in life-cycle costs (LCC).

The first and most challenging task of an LCCA, or any economic evaluation method, is to determine the economic effects of alternative designs of buildings and building systems and to quantify these effects and express them in dollar amounts.

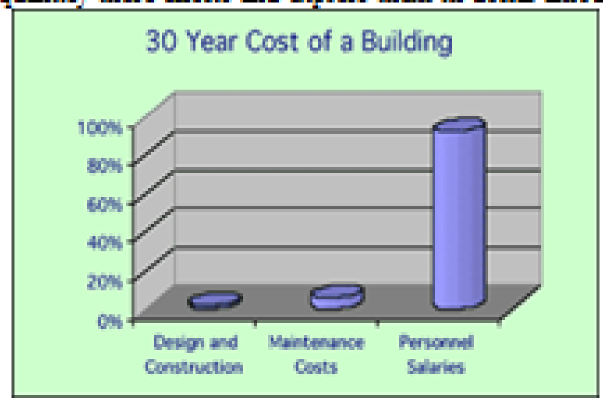


FIG.2.1 Cost of a building

Viewed over a 30 year period, initial building costs account for approximately just 2% of the total, while operations and maintenance costs equal 6%, and personnel costs equal 92%.

2.1.1 Costs

There are numerous costs associated with acquiring, operating, maintaining, and disposing of a building or building system. Building-related costs usually fall into the following categories:

- Initial Costs—Purchase, Acquisition, Construction Costs
- Fuel Costs
- Operation, Maintenance, and Repair Costs
- Replacement Costs
- Residual Values—Resale or Salvage Values or Disposal Costs
- Finance Charges—Loan Interest Payments
- Non-Monetary Benefits or Costs

Only those costs within each category that are relevant to the decision and significant in amount are needed to make a valid investment decision. Costs are relevant when they are different for one alternative compared with another; costs are significant when they are large enough to make a credible difference in the LCC of a project alternative. All costs are entered as base-year amounts in today's dollars; the LCCA method escalates all amounts to their future year of occurrence and discounts them back to the base date to convert them to present values.

2.1.1.1Initial expenses

Beginning expenses may incorporate capital speculation costs for land obtaining, development, or remodel and for the hardware expected to work an office.

Arrive procurement costs should be incorporated into the underlying cost assess on the off chance that they vary among outline options. This would be the situation, for instance, when looking at the cost of revamping a current office with new development on acquired land**.**

Development costs: Detailed assessments of development expenses are a bit much for preparatory financial examinations of option building plans or frameworks. Such gauges are typically not accessible until the outline is very best in class and the open door for cost-diminishing plan changes has been missed. LCCA can be rehashed all through the outline procedure if more nitty gritty cost data ends up noticeably accessible. At first, development expenses are evaluated by reference to verifiable information from comparable offices. On the other hand, they can be resolved from government or private-sectorcost evaluating aides and databases**.**

Vitality and Water CostsOperational costs for vitality, water, and different utilities depend on utilization, ebb and flow rates, and value projections. Since vitality, and to some degree water utilization, and building design and building envelope are related, vitality and water expenses are typically surveyed for the working all in all as opposed to for individual building frameworks or parts**.**

Vitality utilization: Energy expenses are frequently hard to foresee precisely in the plan period of a venture. Suspicions must be made about utilize profiles, inhabitance rates, and timetables, all of which effect vitality utilization. At the underlying plan organize, information on the measure of vitality utilization for a building can originate from designing examination or from a PC program, for example, eQuest.ENERGY PLUS (DOE**)**

Vitality costs: Quotes of current vitality costs from neighborhood providers ought to consider the rate sort, the rate structure, summer and winter differentials, piece rates, and request charges to acquire a gauge as close as conceivable to the genuine vitality cost.

Vitality cost projections: Energy costs are expected to increment or decline at a rate not the same as general value expansion. This differential vitality value acceleration should be considered while assessing future vitality costs. Vitality value projections can be acquired either from the provider or from vitality value acceleration rates distributed every year on April 1 by DOE in Discount Factors forever Cycle Cost**.**

Water Costs: Water expenses ought to be taken care of much like vitality expenses. There are typically two sorts of water costs: water utilization expenses and water transfer costs. DOE does not distribute water value projections**.**

Operation, Maintenance, and Repair Costs

Non-fuel working expenses, and upkeep and repair (OM&R) expenses are regularly more hard to appraise than other building uses. Working timetables and models of support shift from working to working; there is extraordinary variety in these expenses notwithstanding for structures of a similar sort and age. It is subsequently particularly vital to utilize building judgment while evaluating these expenses

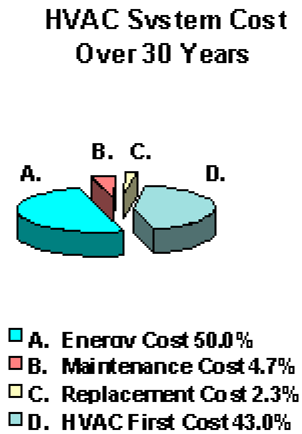


FIG.2.2 Cost distribution of HVAC

Substitution Costs

The number and timing of capital substitutions of building frameworks rely on upon the assessed life of the framework and the length of the review time frame. Utilize similar sources that give cost appraisals to introductory ventures to acquire evaluations of substitution expenses and expected helpful lives. A decent beginning stage for assessing future substitution expenses is to utilize their cost as of the base date. The LCCA strategy will raise base-year adds up to their future time of event**.**

Remaining Values

The leftover estimation of a framework (or part) is its residual incentive toward the finish of the review time frame, or at the time it is supplanted amid the review time frame. Remaining qualities can be founded on an incentive set up, resale esteem, rescue esteem, or scrap esteem, net of any offering, change, or transfer costs. As a dependable guideline, the lingering estimation of a framework with staying helpful life set up can be computed by straightly allocating its underlying expenses. For instance, for a framework with a normal helpful existence of 15 years, which was introduced 5 years before the finish of the review time frame, the leftover esteem would be roughly 2/3 (=(15-10)/15) of its underlying expense.

Different Costs

Fund chargesand charges

Non-financial advantages or costs: Non-fiscal advantages or expenses are venture related impacts for which there is no target method for allocating a dollar esteem. Cases of non-fiscal impacts might be the advantage gotten from an especially calm HVAC framework or from a normal, yet hard-to-quantifyproductivity increase because of enhanced lighting. By their temperament, these impacts are outer to the LCCA, however in the event that they are critical they ought to be considered in the last venture choice and incorporated into the venture documentation.

2.1.2Parameters for Present-Value Analysis

2.2.1.1Discount Rate

With a specific end goal to have the capacity to include and look at money streams that are brought about at various circumstances amid the life cycle of a venture, they must be set aside a few minutes equal. To make money streams time-proportional, the LCC technique changes over them to present values by marking down them to a typical point in time, for the most part the base date. The loan fee utilized for marking down is a rate that mirrors a financial specialist's chance cost of cash after some time, implying that a speculator needs to accomplish an arrival in any event as high as that of her next best venture. Subsequently, the rebate rate speaks to the financial specialist's base satisfactory rate of return**.**

2.2.1.2Cost Period(s)

Length of study period: The review time frame starts with the base date, the date to which all money streams are reduced. The review time frame incorporates any arranging/development/execution period and the administration or inhabitance period. The review time frame must be the same for all choices considered.

Benefit period: The administration time frame starts when the finished building is involved or when a framework is taken into administration. This is the period over which operational expenses and advantages are assessed. In FEMP investigations, the administration time frame is restricted to 40 years.

Contract period: The agreement time frame in ESPC and UESC ventures exists in the review time frame. It begins when the venture is formally acknowledged, vitality investment funds start to collect, and contract installments start to be expected. The agreement time frame by and large finishes when the advance is paid off.

2.1.3 Life-Cycle Cost Calculation

After identifying all costs by year and amount and discounting them to present value, they are added to arrive at total life-cycle costs for each alternative:

LCC=I+Repl-Res+E+W+OM&R+O

LCC=Total LCC in present-value (PV) dollars of a given alternative

I = PV investment costs (if incurred at base date, they need not be discounted)

Repl=PV capital replacement costs

Res = PV residual value (resale value, salvage value) less disposal costs

E = PV of energy costs

W = PV of water costs

OM&R = PV of non-fuel operating, maintenance and repair costs

O = PV of other costs (e.g., contract costs for ESPCs or UESCs)

2.1.4 Supplementary Measures

Supplementary measures of economic evaluation are Net Savings (NS), Savings-to-Investment Ratio (SIR), Adjusted Internal Rate of Return (AIRR), and Simple Payback (SPB) or Discounted Payback (DPB). They are sometimes needed to meet specific regulatory requirements. For example, the FEMP LCC rules (10 CFR 436A) require the use of either the SIR or AIRR for ranking independent projects competing for limited funding. Some federal programs require a Payback Period to be computed as a screening measure in project evaluation. NS, SIR, and AIRR are consistent with the lowest LCC of an alternative if computed and applied correctly, with the same time-adjusted input values and assumptions. Payback measures, either SPB or DPB, are only consistent with LCCA if they are calculated over the entire study period, not only for the years of the payback period.

All supplementary measures are relative measures, i.e., they are computed for an alternative relative to a base case.

NS = Net Savings: operational savings less difference in capital investment costs

SIR = Savings-to-Investment Ratio: ratio of operational savings to difference in capital investment costs

AIRR = Adjusted Internal Rate of Return: yearly yield from an option over the review time frame, considering reinvestment of break returns at the markdown rate

SPB = Simple Payback: time required for the combined reserve funds from a contrasting option to recoup its underlying venture cost and other accumulated expenses, without considering the time estimation of cash

DPB = Discounted Payback: time required for the combined reserve funds from a contrasting option to recoup its underlying speculation cost and other accumulated costs, considering the time estimation of cash

2.1.5Evaluation Criteria

Lowest LCC (for determining cost-effectiveness)
NS > 0 (for determining cost-effectiveness)
SIR > 1 (for ranking projects)
AIRR > discount rate (for ranking projects)
SPB, DPB < than study period (for screening projects)

2.2Uncertainty Assessment in Life-Cycle Cost Analysis

Decisions about building-related investments typically involve a great deal of uncertainty about their costs and potential savings. Performing an LCCA greatly increases the likelihood of choosing a project that saves money in the long run. Yet, there may still be some uncertainty associated with the LCC results. LCCAs are usually performed early in the design process when only estimates of costs and savings are available, rather than certain dollar amounts. Uncertainty in input values means that actual outcomes may differ from estimated outcomes.
There are techniques for estimating the cost of choosing the "wrong" project alternative. Deterministic techniques, such as sensitivity analysis or breakeven analysis, are easily done without requiring additional resources or information. They produce a single-point estimate of how uncertain input data affect the analysis outcome. Probabilistic techniques, on the other hand, quantify risk exposure by deriving probabilities of achieving different values of economic worth from probability distributions for input values that are uncertain. However, they have greater informational and technical requirements than do deterministic techniques. Whether one or the other technique is chosen depends on factors such as the size of the project, its importance, and the resources available. Since sensitivity analysis and break-even analysis are two approaches that are simple to perform, they should be part of every LCCA.

2.3 Sensitivity Analysis

Affectability examination is the method suggested for vitality and water preservation extends by FEMP. Affectability examination is helpful for:

•Identifying which of various indeterminate information values has the best effect on a particular measure of monetary assessment,

•Determining how changeability in the information esteem influences the scope of a measure of monetary assessment, and

•Testing diverse situations to reply "imagine a scenario where" questions.

To distinguish basic parameters, touch base at evaluations of upper and lower limits, or reply "imagine a scenario where" questions, just change the estimation of each contribution up or down, holding all others consistent, and recalculate the financial measure to be tried.

2.4 Break-even Analysis

- Chiefs some of the time need to know the most extreme cost of an information that will enable the venture to in any case earn back the original investment, or then again, what least advantage a venture can create and still take care of the expense of the speculation.

- To play out an earn back the original investment examination, advantages and expenses are set equivalent, all factors are determined, and the equal the initial investment variable is settled arithmetically.

- The utilization of PC projects can extensively lessen the time and exertion spent on detailing the LCCA, playing out the calculations, and recording the review. Recorded underneath are a few LCCA-related programming programs:

- •Building Life-Cycle Cost (BLCC) Program—Economic investigation instrument created by the National Institute of Standards and Technology for the U.S. Branch of Energy Federal Energy Management Program (FEMP).

- •ECONPACK for Windows—A monetary examination device created by the U.S. Armed force Corps of Engineers in support of DOD financing demands.

2.5 CASE STUDIES:

2.5.1 LIFE CYCLE COST ANALYSIS OF MULTI STORIED RESIDENTIAL BUILDING:

Historically investment decisions relating to residential buildings have tended to be based on estimates of the initial construction cost, with little or no consideration for costs relating to operation and maintenance throughout the life of the building. Sharply rising operating, maintenance and energy costs have highlighted the opportunity for overall savings in the life of a building that can be achieved by investing in more cost efficient solutions initially. The study done against this academic paper includes the operations and maintenance (O&M) costs incurred and issues faced in 10, 20 and 27 year old residential building. Comparative Life Cycle Cost analysis (LCCA) was done on new building with 'do nothing' versus 'energy efficient' approach.

2.5.2 Evaluating Construction Cost of Green Building Based on Life-cycle Cost Analysis: An empirical analysis from Nanjing, China:

With the economic development, energy consumption is increasingly serious, land resources becoming scarcer and scarcer. Green building can effectively solve the problem of resource shortage; however, the development of green buildings in China is very slow because of its higher cost, compared with conventional buildings,. In this paper, we analyze the construction cost of green building based on life-cycle cost method, and try to find out the key factors that affect the cost. Through the empirical analysis, the results prove that there are six main factors that influence the cost of green building, such as green building technology, policy support, project positioning, construction technology, building materials prices and local conditions. On this basis, we put forward relevant policy suggestions.

2.5.3 Costs and Benefits of Building Green BY Ms. Alexia Nalewaik, CCE MRICS, and Ms. Valerie Venters, CCC.:

This paper provides a brief overview of green building and available rating systems, followed by a discussion about the tangible and intangible benefits of sustainable design. The relative cost of green construction is debated, and the discourse concludes with some cost-savings guidance.Green construction yields a number of benefits to the owner, both tangible and intangible. Sustainably-designed buildings benefit from lifecycle cost savings (including deferred replacement cost), improvements in human performance (including productivity gain, better health), and an increase in prestige.Reducing the impact of the construction process itself may affect the overall cost of the project. "Environmentally conscious construction practices can markedly reduce site disturbance, the quantity of waste sent to landfills, and the use of natural resources during construction. It can also minimize the prospect of adverse indoor. air quality in the finished building" (Gottfried, 1996).

2.5.4 The economic optimization of tunnels by applying the life-cycle cost analysis BYMarkus Thewes, Univ.-Prof. Dr.-Ing., Ruhr-University Bochum, Germany, Jürgen Schwarz, Univ.-Prof. Dr.-Ing., Bundeswehr University Munich, Germany, Stephan Engelhardt, M.Eng., Dipl. Ing.(FH), Bundeswehr University Munich, Germany ,Peter Vogt, Prof. Dr.-Ing., HRW – University of Applied Sciences, Mulheim, German

The reduction of costs throughout all life-cycle stages of a tunnel increasingly gains importance under the condition that security and availability requirements of a tunnel are not influenced negatively. The development of a comprehensive approach for determining and optimizing the life-cycle costs of tunnels is part of a cooperative collaboration of Ruhr University Bochum, Bundeswehr University Munich and University of Applied Sciences (HRW) in Mulheim. The starting point of the life-cycle cost calculation represents the net present value method, which is adapted for tunnels by establishing the Modular Process Model. After having identified all interdependencies among various cost components, cost types can be substituted and reduced with respect to its number and its volume. Having illustrated the mutual dependencies of cost parameters, a foundation has been laid to develop a holistic perspective to realize economic potential for optimizing and reducing life-cycle costs of tunnels.

2.5.5 Low-energy versus conventional residential buildings:cost and profit BYAgnieszkaZalejska-Jonsson, Hans Lind and StaffanHintze School of Architecture and Built Environment,KTH Royal Institute of Technology, Stockholm, Sweden

The purpose of this paper is to investigate the commercial aspect of "green" building construction and whether increased investment costs are profitable taking the reduction in operating costs into account. The investment viability is approached by comparing investment in conventional and "green"residential building, particularly passive houses, using real construction and post-occupancy conditions.The key data were obtained by surveys and personal interviews.

The first survey was directed to the companies which had experience of building low-energy housing and the second survey to housing companies that actively manage operation of low-energy houses. Findings indicate that low-energy buildings are considered an interesting and sound business opportunity, and investment analysis indicates that low-energy houses (particularly passive houses) can be more attractive investments than conventional residential buildings. The long-term strategy of building low-energy buildings can give competitive advantages. The government initiative and the construction regulations are found to be necessary in eliminating the initial barrier to energy-efficient projects and achieving long-term environmental goals.This paper provides insights into the investment decisions and contributes tothe understanding of the construction, operation and profitability of energy-efficient residentialbuildings.

2.5.6 LIFE CYCLE ASSESSMENT OF RESIDENTIAL BUILDINGS BY Luis Ochoa1, Robert Ries2, H. Scott Matthews3, and Chris Hendrickson, M4

Private building development spoken to around 4.2% of the US Gross Domestic Productin 2000, and living arrangements expended about 20% of aggregate US vitality utilization. However,design and development of private structures is regularly not directed with an examination of thelife cycle costs and ecological effects. In this paper, we plot a way to deal with a lifecycle investigation for homes, utilizing the aftereffects of a run of the mill development cost gauge to mapinto devices for natural life cycle appraisal (utilizing the Carnegie Mellon economicinput-yield life cycle evaluation show) and for assets required amid the utilization stage ofresidences (utilizing the DOE Energy Saver demonstrate). Fundamentally, material expenses are mapped intoinput-yield segments and the EIO-LCA show connected to evaluate ecological impacts.Similarly, working information sources, for example, power or gaseous petrol are assessed from the HomeEnergy Saver display and mapped into EIO-LCA segments. The aftereffect of utilizing our toolset is alife cycle appraisal in view of the development cost assess. We are constrained in the lifecycle appraisal to the building costs and the effects computed by the Carnegie Melloneconomic input-yield life cycle evaluation.

CHAPTER 3 : TECHNIQUES & METHOD

Green building (otherwise called green development or supportable building) alludes to both a structure and the utilizing of procedures that are earth mindful and asset productive all through a building's life-cycle: from siting to plan, development, operation, upkeep, remodel, and devastation. At the end of the day, green building configuration includes finding the harmony amongst homebuilding and the manageable condition. This requires close collaboration of the plan group, the draftsmen, the architects, and the customer at all venture stages. The Green Building rehearse grows and supplements the traditional building configuration worries of economy, utility, strength, and solace.

3.1 KEY DESIGN FEATURES

- **Orientation** : Longer hub of home is from west to east in order to get huge measure of daylight. Suitable introduction of structures can give physically and mentally agreeable conditions in the building. It can help prohibit the undesirable impacts of serious climate all things considered. For instance, in chilly atmospheres, a building must be situated to get most extreme sun powered radiation into the living territories for warmth on one hand, while keeping out the overall icy winds on the other. On the other hand, in hot districts, sun powered radiation and hot, dusty winds should be kept away from in summer, while cool winds must be conceded.

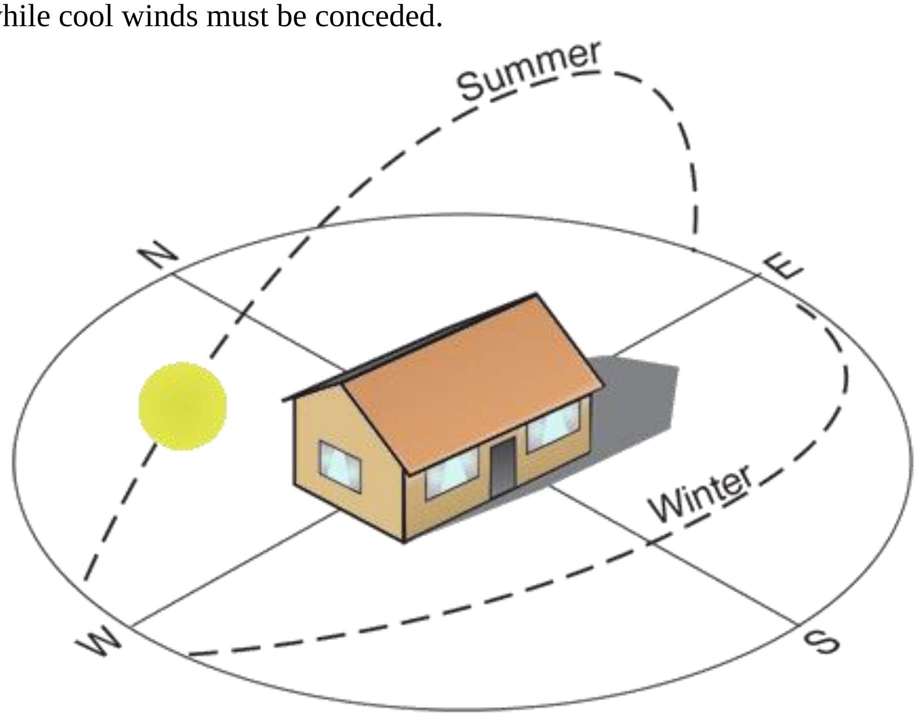
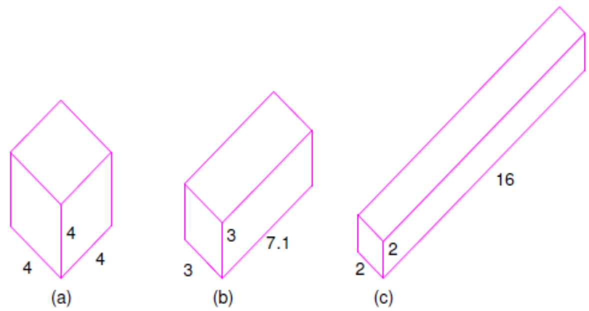


Fig. 3.1 Orientation of home

- **Building Configuration** A minimized building type of least surface-to-volume proportion is best to reduce warm misfortune. The proportion of the surface region to the volume of the building (S/V proportion) decides the size of the warmth move all through the building. The bigger the S/V proportion, the more noteworthy the warmth pick up or misfortune for a given volume of space. Then again, a littler S/V proportion will bring about the lessening of warmth pick up/misfortune. For instance, in frosty atmospheres it is desirable over have minimized house shapes with least S/V proportion.



SOLID SHAPE	SURFACE AREA 'S'	VOLUME 'V'	SURFACE AREA/ VOLUME RATIO 'S/V'
a	96	64	1.5
b	103.2	64	1.61
c	136	64	2.13

Fig. 3.2 Surface area to volume ratio (S/V)

- **Direct warm pick up :** Direct increase (South confronting exteriors) is an aloof warming system that is by and large utilized as a part of frosty atmospheres. It is the most straightforward approach and is in this manner generally utilized. In this method, daylight is conceded into the living spaces straightforwardly through openings or coated windows. The daylight warms the dividers and floors, which then store and transmit the warmth to the indoor condition. The fundamental prerequisites of an immediate pick up framework are vast coated windows to get greatest sunlight based radiation and warm stockpiling mass. Amid the day, the influenced some portion of the house has a tendency to get exceptionally hot, and subsequently, warm capacity mass is given as exposed gigantic dividers or floors to retain and store warm. This likewise anticipates overheating of the room. The put away warmth is discharged during the evening when it is required most for space warming. Covers and drapes ought not be utilized to cover floors and dividers utilized as capacity mass since they obstruct the warmth stream rate. Appropriate shades for shading and openable windows for ventilation must be given to abstain from overheating in the mid year.

- **Indirect warm pick up** : Trombe divider on south. Trombe divider is a warm stockpiling divider made of materials having high warmth stockpiling limit, for example, solid, blocks or composites of blocks, square and sand. A run of the mill Trombe divider is outlined in Fig 3.14. The outer surface of the divider is painted dark to expand its absorptivity and is set straightforwardly behind the coating with an air hole in the middle. Sunlight based radiation is consumed by the darkened surface and is put away as sensible warmth in the divider. In an unvented divider, the put away warmth gradually moves to the inside, where it warms the neighboring living space. On the off chance that legitimately composed, the divider can give satisfactory warmth to the living space for the duration of the night. A portion of the warmth created noticeable all around space between the coating and the capacity divider is lost back to the outside through the glass. The more blazing the air in the airspace, the more noteworthy is the warmth misfortune. This warmth misfortune can be lessened by venting the capacity divider at the top and base. Such units are called as 'vented Trombe dividers'. The air, in the space between the coating and the divider gets warmed up and goes into the family room through the upper vents. Cool room air has its spot through the lower vents, along these lines setting up a characteristic flow design (thermocirculation) that needs no mechanical means for moving the air. In a vented framework, because of course of hot air, the measure of warmth accessible for capacity by the Trombe divider is decreased. An unvented framework does not lose warm along these lines and in this way has the benefit of putting away a more noteworthy rate of the sun based vitality accessible to it than does a vented divider. This put away warmth is, nonetheless, not promptly accessible for quick use, rather, it is moved gradually into the living region. Thus, un-vented Trombe dividers are accommodated homes, which require warming basically amid the night. Moreover, in frosty atmospheres where daytime and evening time warming prerequisites are high, it is attractive to give a specific measure of warmth straightforwardly to the living space. In such circumstances, a vented divider might be given. In more direct atmospheres where daytime warming is not as critical as evening time warming, an unvented framework might be best.

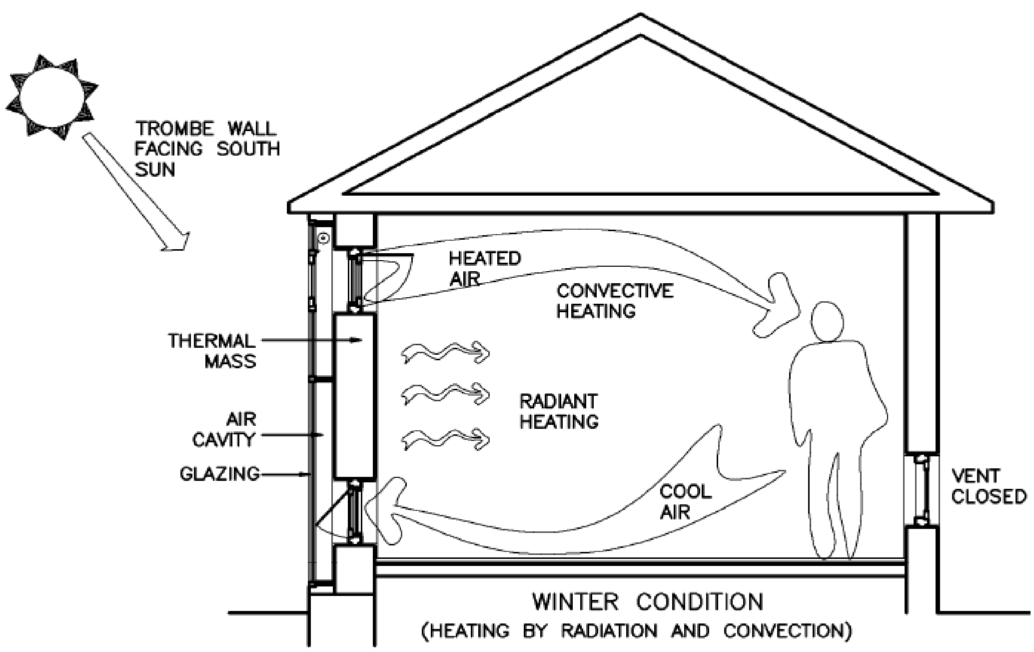


Fig. 3.3(a) Working of trombe wall in winter

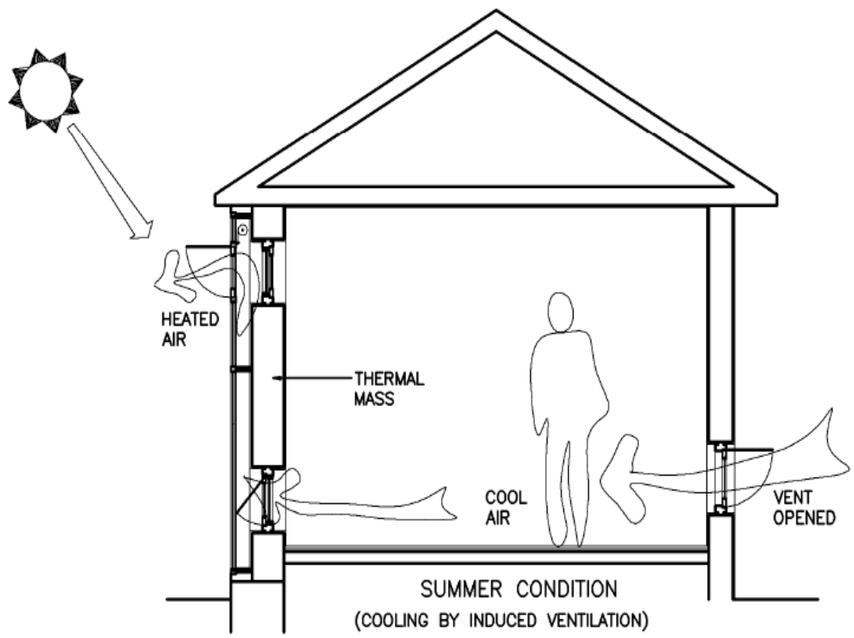


Fig. 3.3 (b) Working of trombe wall in summer

- **Insulation** : Insulated floors, rooftops and dividers are utilized. Protecting materials might be connected remotely or inside to the rooftops. If there should be an occurrence of outer application, the protecting material should be ensured by waterproofing medications. For interior application, the protecting material might be settled by cement or by different means on the underside of the rooftops. Dividers are protected from north and east in order to maintain a strategic distance from warmth misfortune amid winter and are uninsulated from south and west to permit warm pick up. Floors are protected to maintain a strategic distance from warmth misfortune amid winter**.**

•**Day-lighting** : Windows on south and west side of home. South-bound windows bring daylight and sunshine into the home, especially in winter when the sun is lower in the sky and direct daylight adds to warming the house. Light shaded inside surfaces reflect all the more light and diminish the level of fake lighting required.

Fig. 3.4 Daylighting in house

Vegetation : Deciduous tress#on west and south. Planting deciduous trees#such as mulberry to shade#east and west dividers would demonstrate advantageous in hot#and dry zones. In summer, they provide#shade from extraordinary morning and night sun, reduce#glare, and in addition cut off hot breezes. On the#other hand, deciduous trees shed their leaves#in winter and enable solar#radiation to warm the building. The cooling impact of#vegetation in hot and dry#climates comes transcendently from dissipation, while#in hot damp atmospheres the#shading impact is more huge. Trees can be utilized as#windbreaks to secure both buildings#and external zones, for example, yards and patios#from both hot and frosty winds.

- **Solar boards :** Solar boards are#used on south face slanting rooftop. Photovoltaic (PV) innovation has been#used to power homes for a long time, and with#good reason.

PV is moving#beyond its specialty item status to getting to be a#source of value aggressive, zero#greenhouse gas emanation vitality to homes and businesses#across the nation. The average#cost of delivering power from sun based modules over#their lifetime is presently broadly#equivalent to the normal cost of obtaining electricity#from the network. Rooftop#systems can be either incompletely or completely incorporated. In full#integration the components should likewise satisfy the standard functions#such as quality, water tightness#and seepage. The installation#must be precisely arranged and the fitting products#and administrations affirmed.

Fig. 3.5 Solar panels on roof

. Feasible development material : Sustainable development material is utilized which have low typified vitality. Recyclable material is utilized wherever it is conceivable without trading off wellbeing norms. Locally accessible materials is utilized which help in lessening in transportation and add to low epitomized vitality utilization. Non poisonous material is utilized amid development which have non voc mixes. Manageable wood items are utilized.

•Rain water reaping : Rain water gathering system is utilized and rain water is gathered from bended rooftop and slanted rooftop and gathered in water stockpiling tank. sing water can diminish water bills, give an option supply amid water limitations and help keep up a green, solid garden. Contingent upon tank size and atmosphere, mains water utilize can be lessened by up to 100%. This thus can decrease the requirement for new dams or desalination plants, ensure staying ecological streams in waterways and diminish foundation working expenses.

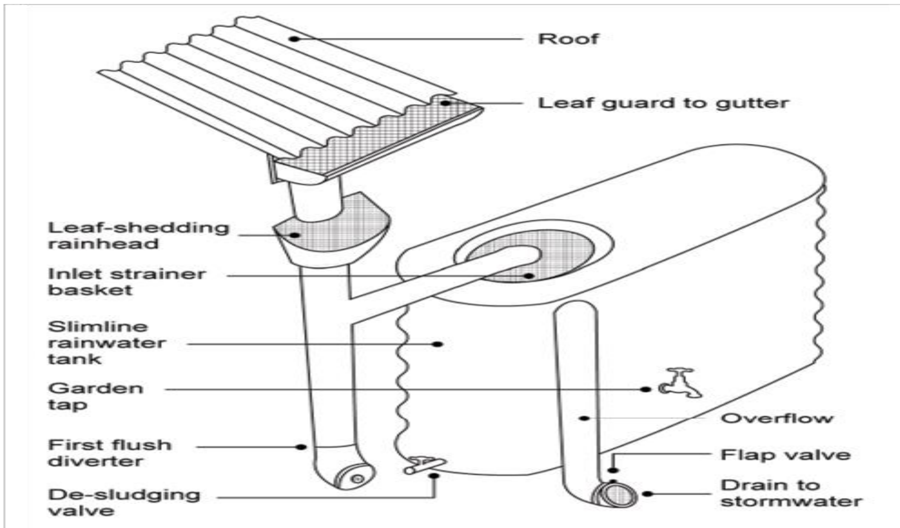


Fig. 3.6 Water harvesting system

- **Reduce water utilize** : Reduced indoor#water use by picking water productive showers, toilets, taps#and apparatuses. Limit open air water use by choosing#plants that are proper for local#growing conditions and by including low water utilize regions in#the cultivate outline through the use#of indigenous plants or low water utilize species**.**

•Energy proficient machines : Using vitality effective and water#efficient apparatuses with high star rating to limit vitality utilize.

Household energy use	%
Heating and cooling	40
Water heating	21
Appliances and equipment including refrigeration and cooking	**33**
Lighting	6
Appliances and equipment energy use data	**% (of the 33% above)**
Fridge freezer	18
Cooking	15
TV	19
Home entertainment	5
Home office	9
Pool and spa	5
Stand-by	10
Microwave	2
Dishwasher	2
Clothes dryer	2
Clothes washer	2
Miscellaneous	11

Source: DEWHA 2008

Fig. 3.7 Energy load of appliances

3.2 GREEN BUILDING MATERIAL

Building materials regularly thought to be "green" incorporate inexhaustible plant materials like straw and mud block, timber from backwoods affirmed to be economically overseen, reused materials and different items that are non-poisonous, reusable and sustainable.

Practical building materials can be characterized as materials with general unrivaled execution interms of indicated criteria. The accompanying criteria are generally utilized:

- Locally delivered and sourced materials
- Transport costs and ecological effect
- Thermal productivity
- Occupant requirements and wellbeing contemplations
- Financial practicality
- Recyclability of building materials and the destroyed building
- Waste and contamination produced in the assembling procedure
- Energy required in the assembling procedure

- Use of sustainable assets

- Toxic outflows created by the item

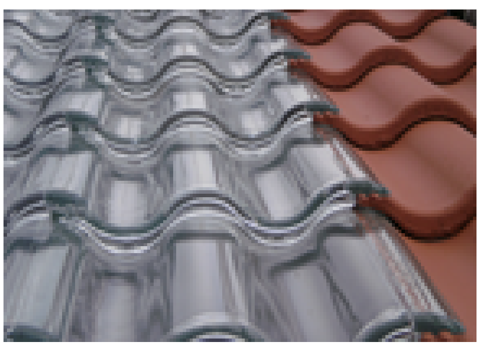
- Maintenance costs

4.3.1 FOLLOWING ARE A FEW GREEN BUILDING MATERIALS:

1.Wool Bricks:

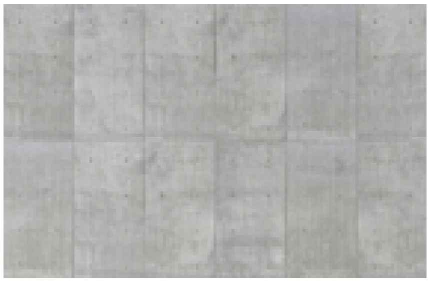
Developed by Spanish and Scottish researchers with an aim to 'obtain a composite that was more sustainable, non-toxic, using abundant local materials that would mechanically improve the bricks' strength', these wool bricks are exactly what the name suggests. Simply by adding wool and a natural polymer found in seaweed to the clay of the brick, the brick is 37% stronger than other bricks, and more resistant to the cold wet climate often found in Britain. They also dry hard, reducing the embodied energy as they don't need to be fired like traditional bricks. The fibres improve the strength of compressed bricks, reduce the formation of fissures and deformities as a result of contraction, reduce drying time and increase the bricks' resistance to flexion.

2. Solar Tiles:



Traditional roof tiles are either mined from the ground or set from concrete or clay – all energy intensive methods. Once installed, they exist to simply protect a building from the elements despite the fact that they spend a large portion of the day absorbing energy from the sun. With this in mind, many companies are now developing solar tiles. Unlike most solar units which are fixed on top of existing roofing, solar tiles are fully integrated into the building, protecting it from the weather and generating power for its inhabitants. Solar tiles operate on the same principle as solar PV panels. The advantage of Solar tiles is that they are manufactured to the same modular size as large format roof tiles. They can be integrated into a new roof at the time of construction or into an existing roof when the roof covering is being replaced. Solar tiles require only daylight, not sunlight, and are therefore capable of generating electricity on a cloudy day. Solar tiles are unobtrusive and there is no heat, noise or radiation produced. They can be installed on the roof of most homes and can be easily connected to the building's electricity supply.

3. Sustainable Concrete



Whilst 95% of a building's CO_2 emissions are a result of the energy consumed during its life, there is much that can be done to reduce that 5% associated with construction. Concrete is an ideal place to start, partly because almost every building uses it, but mostly due to the fact that concrete is responsible for a staggering 7-10% of global CO_2 emissions. More sustainable forms of concrete exist that use recycled materials in the mix. Crushed glass can be added, as can wood chips or slag – a byproduct of steel manufacturing. Whilst these changes aren't radically transforming concrete, by simply using a material that would have otherwise gone to waste, the CO_2 emissions associated with concrete are reduced. Other advantages include increased environmental quality (reduction of CO_2 emissions from cement factories), reduced depletion of resources (by using urban mining and secondary raw materials), saving of valuable and vulnerable areas (by using urban mining and secondary raw materials), reduced transport by recycling on the demolition site

4. Paper Insulation

Made from recycled newspapers and cardboard, paper-based insulation is a superior alternative to chemical foams. Both insect resistant and fire-retardant thanks to the inclusion of borax, boric acid, and calcium carbonate (all completely natural materials that have no associations with health problems), paper insulation can be blown into cavity

•Insulation - reused paper or cellulose protection is a decent type of protection. It offers protection against warmth and cool, and is additionally a decent type of sound protection.

•Fire retardant - in light of the fact that paper protection is treated with a fire retardant, it lessens the danger of flame in the home.

•Loose fill and batts - reused paper protection is accessible in free fill and batts, making it reasonable for various employments.

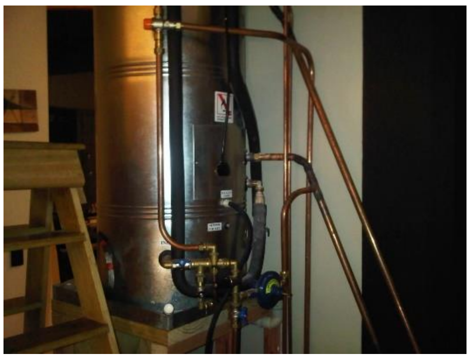
6.Air Conditioning with Non-HCFC Refrigerants:

R-22 is a HCFC refrigerant utilized as a part of private warming and cooling frameworks. R–22 contains chlorine which is an ozone-devastating compound. In 2010, under the Clean Air Act, HVAC makers can no longer deliver new aeration and cooling systems utilizing R-22. Some new AC units as of now utilize contrasting options to R-22 refrigerant, for example, R-410A, and also the exchange mark Puron and others. Extra care ought to be grasped when taking care of refrigerants, constantly select a legitimate merchant who utilizes benefit experts that have accomplished Environmental Protection Agency (EPA) confirmation to deal with refrigerants. Utilizing other options to HCFC refrigerants lessens exhaustion of the ozone layer in the event of spillage amid substitution.

7. High Efficiency Filter:

High proficiency channels expel at least 70% of tidy and particulates from the air. Channels are introduced in the arrival air stream at the air handler, which ought to be estimated to deal with the diminished pneumatic stress brought on by the channel. A few units have an aerating and cooling setting for the fan that will deal with the retrofit channel. The EPA has recognized small scale particulates as a main source of respiratory inconvenience. By evacuating these particles, the channel makes the living space more advantageous.

8. Pre-Plumb for Solar Water Heating:



Protected copper channels are introduced from the upper room to a boiling hot water wardrobe or mechanical space for future sunlight based establishment. This alternative enables the mortgage holder to introduce a dynamic close planetary system at a later date on the off chance that they covet. Give south-bound rooftop zone to gatherers and access for funneling to a mechanical room. This is fundamentally relevant to homes that are by and large widely restored on the inside. The most savvy time to introduce this pre-pipes is amid construction.Solar high temp water pre-plumbing amid the rebuilding procedure can spare cash for the mortgage holder if, sooner or later, they need to introduce a nearby planetary group.

9. Low/No VOC Paint:

Most paint discharges unstable natural mixes (VOCs), a noteworthy indoor air poison, into the home. Once outside, VOCs respond with different poisons, delivering ground-level ozone that additionally influences human wellbeing. Regularly low/no-VOC items are fabricated without mercury or mercury mixes, or shades of lead, cadmium, chromium, or their oxides. Paint with low/no-VOCs is accessible from most significant makers and is connected like conventional paint items. High launderability ought to be indicated for lavatories, kitchens and youngsters' rooms. Each complete and most hues are accessible in low/no-VOC paints.Low/No-VOC paint lessens the discharges of VOCs into the home, enhancing indoor air quality and decreasing the arrangement of urban exhaust cloud.

10. Natural Linoleum In Place of Vinyl:

Characteristic flooring is produced from normal materials, for example, stopper and linseed oil. Not at all like vinyl, flooring does not contain oil based items or chlorinated chemicals, for example, PVC, which might be a wellspring of VOC off-gassing. There is likewise worry of side effects, for example, disease bringing on dioxins, which might be created amid the assembling of vinyl.Use characteristic tile set up of vinyl deck. Tile is low-lethal, simple to repair, strong, and recolor safe. Flooring can last up to 40 years while vinyl keeps going commonly 7-10 years.

CHAPTER 4
LCC OF A MORMAL BUILDING

CHAPTER- 4: LCCA OF A NORMAL BUILDING

.

4.2STUDY AREA PROFILE:

LOCATION	SUNNY SIDE, SOLAN
LAND ACQUIRED	2 BISWAS
BUILT UP AREA	30”X20”
DESCRIPTION	1 BHK
TYPE	NORMAL RESIDENTIAL BUILDING

TABLE 4.1: Salient features of study area

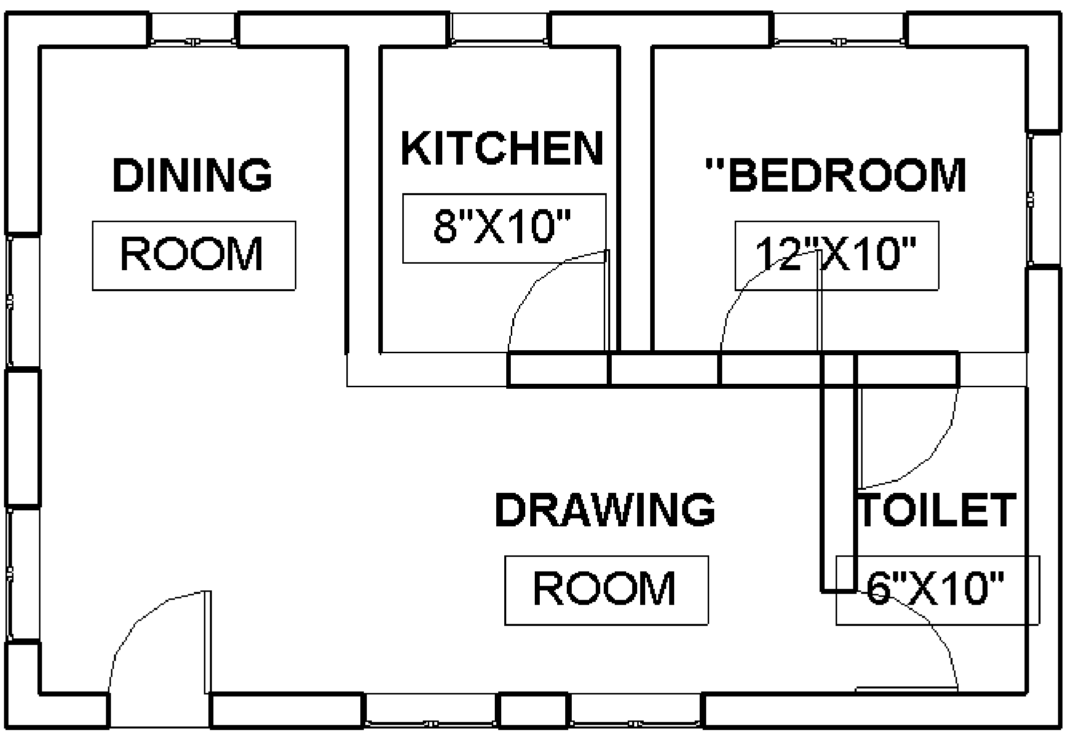


FIG.4.2 PLAN OF 1 BHK

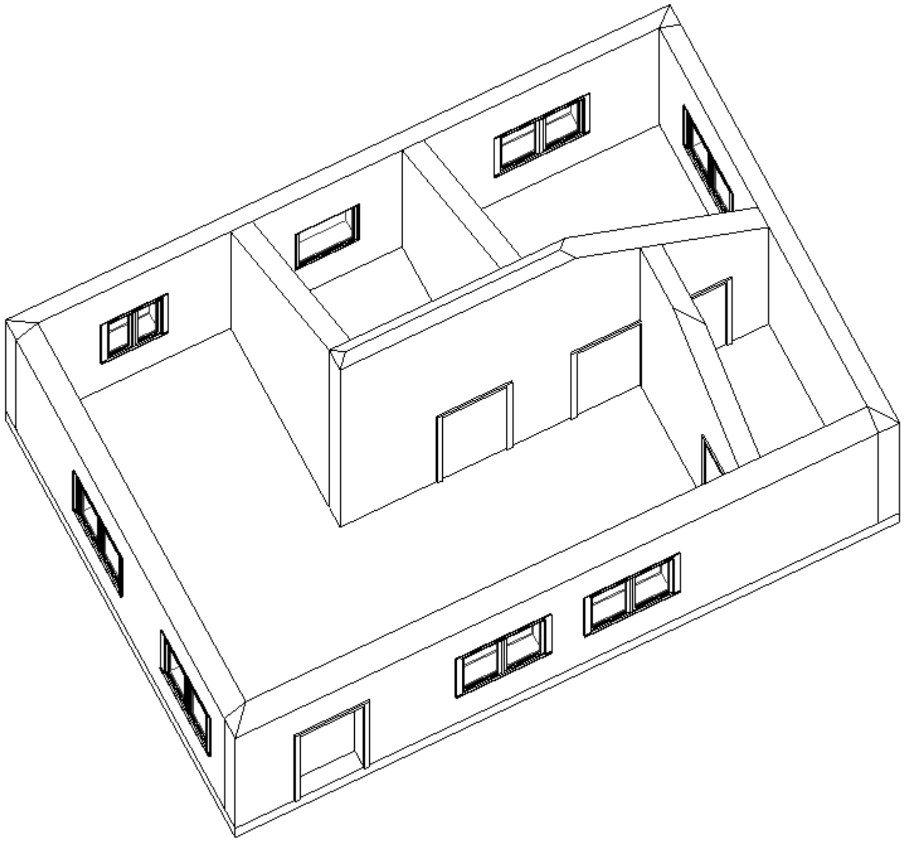


FIG.4.3 TOPVIEW

4.3DATA ASSUMED:

INTEREST RATE	5%
INFLATION(ACTUAL)	5.51%

Table 3.2 Data Assumed

4.4 VARIOUS COSTS ASSOCIATED WITH LCCA:

4.4.1 LAND ACQUISITION:

Cost of land per Biswa in Study Area	Rs 700000
Land required	2 biswas
Total cost of acquisition of finished plot	Rs 1400000

Table4.3 Land Acquisition Cost

CONSTRUCTION COST:

		Estimate					
Item No.	Description Of Items	No.	Length	Breadth	Height	Quantity	Remarks
1	Earthwork in foundation						
	pillars and foundation(excavation)	6	1.524	1.524	3.048	42.47526989	cum
	backfilling	6				38.36046989	size of column=.3*.3
2	RCC in foundation						
	cement concrete in web	6	1.524	1.524	0.05	0.6967728	cum
	cement concrete in column	6	0.3	0.3	3.048	1.64592	cum
	reinforcement in web	6				3.281799888	quintal
	reinforcement in column	6				7.7522832	quintal
3	2.5cm DPC	1	50.2888	0.3		15.08664	sq.m
	deduct door sills	5	1.2	0.3		1.8	sq.m
					total	13.28664	sq.m
4	Brickwork in superstructure	1	50.2888	0.3	3.6576	55.18089446	cum
	deduct doors	5	1.2	0.3	2.1	3.78	
	deduct windows	8	2	0.3	1.5	7.2	
	deduct lintels						
	over doors	5	1.2	0.3	0.1	0.18	
	over windows	8	2	0.3	0.1	0.48	
					total	43.54089446	cum
5	RCC slab						
	cement concrete	1	9.144	6.096	0.12	6.68901888	cum
	reinforcement					5.250879821	qiuntal
6	PCC floor	1	8.244	5.196		42.835824	sq.m
7	Plastering						
	in walls	2	50.2888		3.6576	367.8726298	sq.m
	in ceiling	1	8.244	5.196		42.835824	sq.m
	deduct						
	doors	5	1.2	0.3		1.8	sq.m
	windows	8	2	0.3		4.8	sq.m
					total	404.1084538	sq.m
8	Whitewash						
	in walls	2	50.2888		3.6576	367.8726298	sq.m
	in ceiling	1	8.244	5.196		42.835824	sq.m
	deduct						
	doors	5	1.2	0.3		1.8	sq.m
	windows	8	2	0.3		4.8	sq.m
					total	404.1084538	sq.m
9	Paint						sq.m
	in wallls	2	50.2888		3.6576	367.8726298	sq.m
	in ceiling	1	8.244	5.196		42.835824	sq.m
	deduct						
	doors	5	1.2	0.3		1.8	sq.m
	windows	8	2	0.3		4.8	sq.m
					total	404.1084538	sq.m
10	Woodwork						
	doors	5	1.2		2.1	12.6	sq.m
	windows	8	2		1.5	24	sq.m
11	Painting of doors and windows						
	doors	11.25	1.2		2.1	28.35	sq.m
	windows	18	2		1.5	54	sq.m
12	RCC in columns and beams						
	cement concrete in column	6	0.3	0.3	3.6576	1.975104	cum
	cement concrete in beams	34	3.6576	0.3	0.3	11.192256	cum
	reinforcement in columns	6				1.55045664	quintal
	reinforcement in beams	34				8.78592096	quintal

Table 4.4 Estimate of a normal building

		Labour Charges				
S.No.	Description	Unit	Productivity	Quantity	Rate	Amount
1	earthwork in foundation					
1.1	excavation					
	mate	mandays	0.01	42.47526989	363	154.1852
	mazdoor	mandays	0.11	42.46176989	329	1536.691
1.2	backfilling					
	mate	mandays	0.02	38.36046989	363	278.497
	mazdoor	mandays	0.25	38.36046989	329	3155.149
	bhishti	mandays	0.02	38.36046989	363	278.497
2	rcc work					
2.1	cement concreting					
	mason	mandays	0.17	22.19907168	435	1641.621
	mazdoor	mandays	2	22.19907168	329	14606.99
	bhishti	mandays	0.8	22.19907168	363	6446.61
2.2	reinforcement fixing					
	bar bender	mandays	1	26.62134051	435	11580.28
	mazdoor	mandays	1	26.62134051	329	8758.421
3	DPC					
	mason	mandays	0.1	13.28664	435	577.9688
	mazdoor	mandays	0.1	13.28664	329	437.1305
	bhishti	mandays	0.01	13.28664	363	48.2305
4	Brickwork					
	mason	mandays	0.12	43.54089446	435	2272.835
	mazdoor	mandays	0.2	43.54089446	329	2864.991
	bhishti	mandays	0.07	43.54089446	363	1106.374
5	Flooring					
	mason	mandays	0.8	42.835824	435	14906.87
	mazdoor	mandays	0.12	42.835824	329	1691.158
	bhishti	mandays	0.1	42.835824	363	1554.94
5.1	for concrete mixing					
	mason	mandays	0.1	1.71343296	435	74.53433
	mzdoor	mandays	2.13	1.71343296	329	1200.722
	bhishti	mandays	0.7	1.71343296	363	435.3833
6	Plastering					
	mason	mandays	0.8	404.1084538	435	140629.7
	mazdoor	mandays	0.1	404.1084538	329	13295.17
	bhishti	mandays	0.1	404.1084538	363	14669.14
7	Whitewashing					
	washer	mandays	0.03	404.1084538	435	5273.615
	mazdoor	mandays	0.01	404.1084538	329	1329.517
8	Paint					
	painter	mandays	0.35	404.1084538	435	61525.51
9	woodwork					
	carpenter	mandays	20	36.6	400	292800
	mazdoor	mandays	2	36.6	329	24082.8
					Total Labour Charges	629213.6

Table 4.5 Labor charges for a normal building

		Abstract			
S.No.	Description	Unit	Quantity	Rate	Amount
1	Earthwork in(foundation+ backfilling)				
	Foundation	cum	42.47526989	383	16268.02837
	Backfilling	cum	38.36046989	700	26852.32892
2	RCC work				
2.1	Cement Concrete	cum	22.19907168	5725	127089.6854
2.2	Reinforcement	quintal	26.62134051	4050	107816.4291
3	DPC	sq.m	13.28664	283	3760.11912
4	Brickwork	cum	43.54089446	4919	214177.6599
5	Flooring	sq.m	42.835824	785	33626.12184
6	Plastering	sq.m	404.1084538	217	87691.53447
7	Whitewashing	sq.m	404.1084538	22	8890.385983
8	Paint	litres	404.1084538	230	92944.94436
9	Woodwork	sq.m	36.6	1580	57828
10	Labour Charges				629213.6
11	Tools and tackles @1 %				14061.58837
12	Water charges @2 %				28123.17675
13	Sanitary fittings @5%				70307.94187
14	Contractors profit@10%				140615.8837
				Grand total	1659267.428

Table 4.6 Abstract of cost for a normal building

4.4.3 OPERATION AND MAINTENANCE COST(INCLUDING MAJOR AND MINOR REPAIRS):

ANNUAL ELECTRICITY BILL	6000
ANNUAL WATER SUPPLY BILL	2400
ANNUAL COST OF PLUMBING REPAIRS	Rs 9000
COST OF PAINTING PER SQ.FT	Rs 35
USPWF	9.45
COST OF ELECTRICITY USAGE FOR 50 YEARS	Rs56700
COST OF WATER USAGE FOR 50 YEARS	Rs22680
COST OF PAINTING FOR 50 YEARS	Rs 63000
COST OF PLUMBING FOR 50 YEARS	Rs85050
COST OF MAJOR AND MINOR REPAIR FOR 50 YEARS(TAKEN 3 TIMES THE COST OF CONSTRUCTION)	Rs4977804
TOTAL COST OF OPERATION AND MAINTENANCE	Rs 5205234

Table 4.7 Operation and maintenance cost

4.4.4DEMOLITION AND DISPOSAL COST:

AREA TO BE DEMOLISHED	600 SQ.FT
COST OF DEMOLITION PER SQ.FT	Rs 22
TOTAL COST OF DEMOLITION	Rs 13200
RUBBLE TO BE DISPOSED	5 trucks
COST OF DISPOSAL PER TRUCK	5000
TOTAL COST OF DISPOSAL	Rs 25000
TOTAL COST OF DEMOLIITON AND DISPOSAL	Rs 28200

Table 3.8 Demolition and disposal cost

4.4.5 SALVAGE VALUE:

Salvage value on an average is 5% of the construction cost of a building. Thus for our project the salvage value shall be Rs82964

4.5 LIFE CYCLE COST OF 1 BHK:

ACQUISITION COST	Rs 1400000
CONSTRUCTION COST	Rs 1659268
OPERATION AND MAINTENANCE COST	Rs 5205234
DEMOLITION NAD DISPOSAL COST	Rs 28200
SALVAGE VALUE	Rs 82964
LIFE CYCLE COST	Rs 8126775

Table 3.9 Life cycle cost

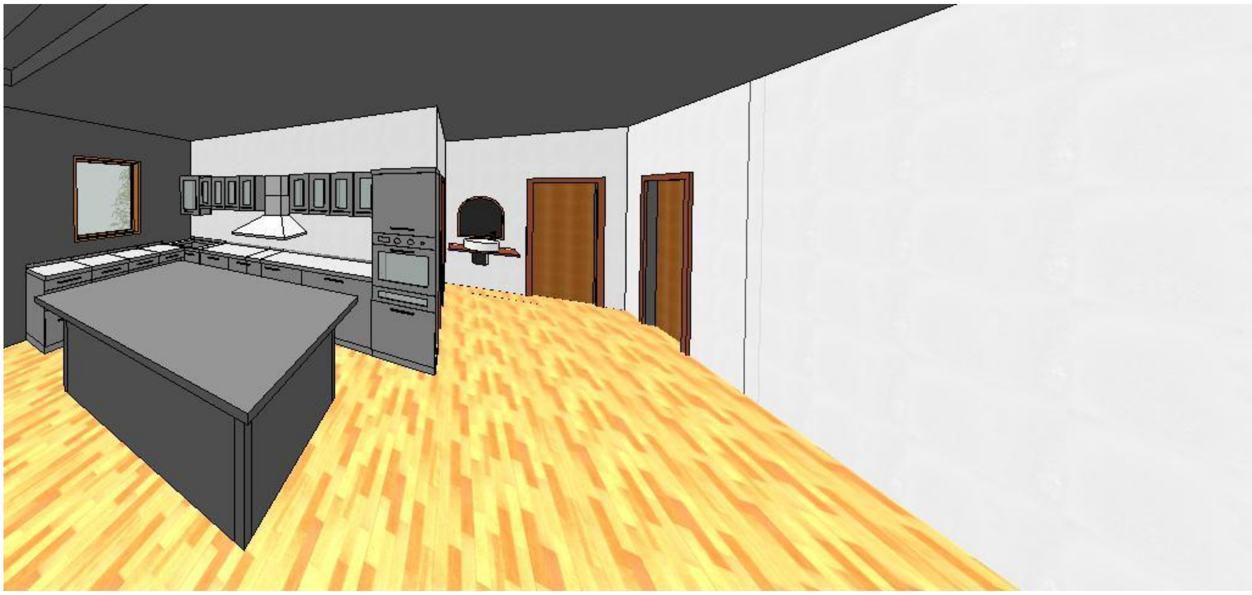
Chapter 5

LCC of a green building

1.1 views

a) drawing room

b)kitchen



c)Trombe wall

Trombe wall

1.2 STUDY AREA PROFILE:

LOCATION	SUNNY SIDE, SOLAN
LAND ACQUIRED	2 BISWAS
BUILT UP AREA	30"X20"
DESCRIPTION	1 BHK
TYPE	GREEN RESIDENTIAL BUILDING
BRICKS USED	FLASH BRICKS
WINDOWS USED	DOUBLE GLAZED WINDOWS
PAINT USED	NO VOC PAINT
SOLAR PANEL	150KW
SOLAR WATER HEATER	100 LCD
RAIN WATER HARVESTING SYSTEM (9 cum)	FOR 1 BHK AS PER ITEGRATED GREEN DESIGN BOOKLET BY MINISTRY OF URBAN DEVLOPMENT

Table 5.1: Salient features of study area

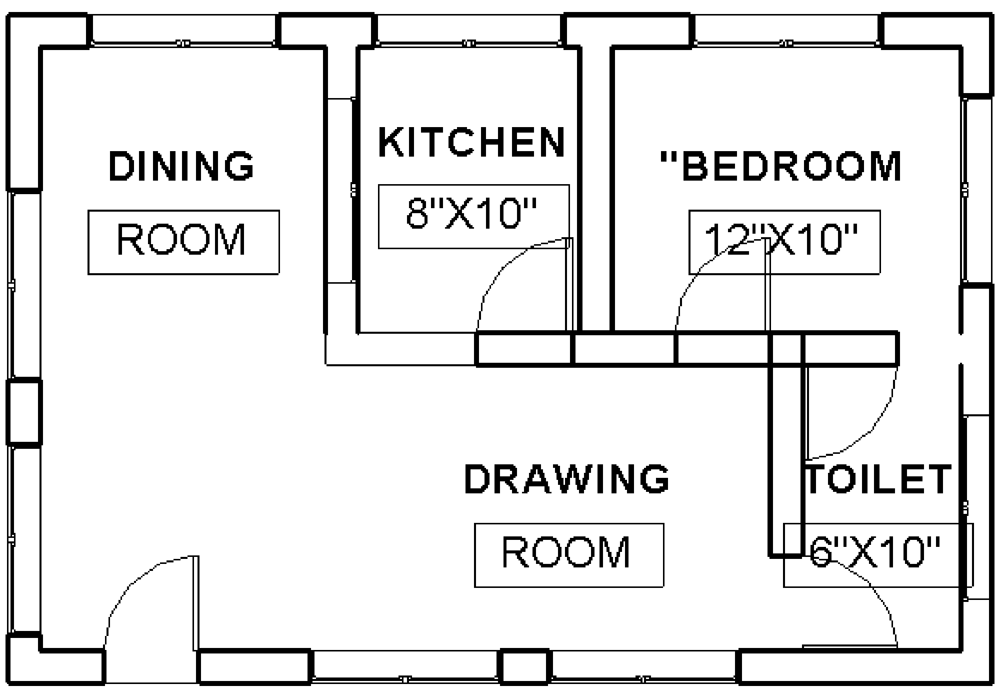


Fig. 5.1 Plan of the green building

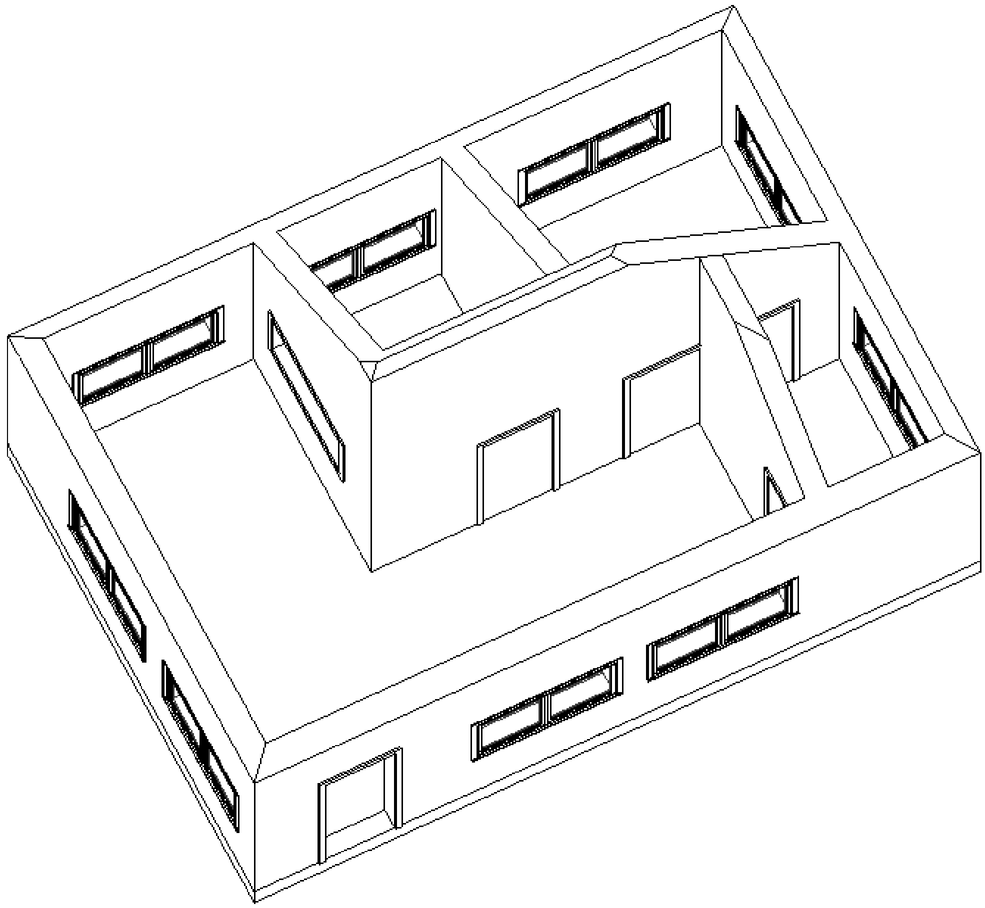


Fig. 5.2 Top view of the green building

1.3 DATA ASSUMED

INTEREST RATE	5%
INFLATION(ACTUAL)	5.51%

Table 5.2 Data Assumed

1.4 VARIOUS COSTS ASSOCIATED WITH LCCA

1.4.1 LAND ACQUISITION

Cost of land per Biswa in Study Area	Rs 700000

Land required	2 biswas
Total cost of acquisition of finished plot	Rs 1400000

Table 5.3 Land Acquisition Cost

1.4.2 CONSTRUCTION COST

		Estimate					
Item No.	Description Of Items	No.	Length	Breadth	Height	Quantity	Remarks
1	Earthwork in foundation						
	pillars and foundation(excavation)	6	1.524	1.524	3.048	42.47526989	cum
	backfilling	6				38.36046989	size of column=.3*.3
2	RCC in foundation						
	cement concrete in web	6	1.524	1.524	0.05	0.6967728	cum
	cement concrete in column	6	0.3	0.3	3.048	1.64592	cum
	reinforcement in web	6				3.281799888	quintal
	reinforcement in column	6				7.7522832	quintal
3	2.5cm DPC	1	50.2888	0.3		15.08664	sq.m
	deduct door sills	5	1.2	0.3		1.8	sq.m
					total	13.28664	sq.m
4	Brickwork in superstructure	1	50.2888	0.3	3.6576	55.18089446	cum
	deduct doors	5	1.2	0.3	2.1	3.78	
	deduct windows	10	2	0.3	1.5	9	
	deduct lintels						
	over doors	5	1.2	0.3	0.1	0.18	
	over windows	10	2	0.3	0.1	0.6	
					total	41.62089446	cum
5	RCC slab						
	cement concrete	1	9.144	6.096	0.12	6.68901888	cum
	reinforcement					5.250879821	qiuntal
6	PCC floor	1	8.244	5.196		42.835824	sq.m
7	Plastering						
	in walls	2	50.2888		3.6576	367.8726298	sq.m
	in ceiling	1	8.244	5.196		42.835824	sq.m
	deduct						
	doors	5	1.2	0.3		1.8	sq.m
	windows	10	2	0.3		6	sq.m
					total	402.9084538	sq.m
8	Whitewash						
	in walls	2	50.2888		3.6576	367.8726298	sq.m
	in ceiling	1	8.244	5.196		42.835824	sq.m
	deduct						
	doors	5	1.2	0.3		1.8	sq.m
	windows	10	2	0.3		6	sq.m
					total	402.9084538	sq.m
9	Paint						sq.m
	in wallls	2	50.2888		3.6576	367.8726298	sq.m
	in ceiling	1	8.244	5.196		42.835824	sq.m
	deduct						
	doors	5	1.2	0.3		1.8	sq.m
	windows	10	2	0.3		6	sq.m
					total	402.9084538	sq.m
10	Woodwork						
	doors	5	1.2		2.1	12.6	sq.m
	windows	10	2		1.5	30	sq.m
11	Painting of doors and windows						
	doors	11.25	1.2		2.1	28.35	sq.m
	windows	22.5	2		1.5	67.5	sq.m
12	RCC in columns and beams						
	cement concrete in column	6	0.3	0.3	3.6576	1.975104	cum
	cement concrete in beams	34	3.6576	0.3	0.3	11.192256	cum
	reinforcement in columns	6				1.55045664	quintal
	reinforcement in beams	34				8.78592096	quintal

Table 5.4 Estimate of the green building

		Labour Charges				
S.No.	**Description**	**Unit**	**Productivity**	**Quantity**	**Rate**	**Amount**
1	earthwork in foundation					
1.1	excavation					
	mate	mandays	0.01	42.47526989	363	154.1852
	mazdoor	mandays	0.11	42.46176989	329	1536.691
1.2	backfilling					
	mate	mandays	0.02	38.36046989	363	278.497
	mazdoor	mandays	0.25	38.36046989	329	3155.149
	bhishti	mandays	0.02	38.36046989	363	278.497
2	rcc work					
2.1	cement concreting					
	mason	mandays	0.17	22.19907168	435	1641.621
	mazdoor	mandays	2	22.19907168	329	14606.99
	bhishti	mandays	0.8	22.19907168	363	6446.61
2.2	reinforcement fixing					
	bar bender	mandays	1	26.62134051	435	11580.28
	mazdoor	mandays	1	26.62134051	329	8758.421
3	DPC					
	mason	mandays	0.1	13.28664	435	577.9688
	mazdoor	mandays	0.1	13.28664	329	437.1305
	bhishti	mandays	0.01	13.28664	363	48.2305
4	Brickwork					
	mason	mandays	0.12	41.62089446	435	2172.611
	mazdoor	mandays	0.2	41.62089446	329	2738.655
	bhishti	mandays	0.07	41.62089446	363	1057.587
5	Flooring					
	mason	mandays	0.8	42.835824	435	14906.87
	mazdoor	mandays	0.12	42.835824	329	1691.158
	bhishti	mandays	0.1	42.835824	363	1554.94
5.1	for concrete mixing					
	mason	mandays	0.1	1.71343296	435	74.53433
	mzdoor	mandays	2.13	1.71343296	329	1200.722
	bhishti	mandays	0.7	1.71343296	363	435.3833
6	Plastering					
	mason	mandays	0.8	402.9084538	435	140212.1
	mazdoor	mandays	0.1	402.9084538	329	13255.69
	bhishti	mandays	0.1	402.9084538	363	14625.58
7	Whitewashing					
	washer	mandays	0.03	402.9084538	435	5257.955
	mazdoor	mandays	0.01	402.9084538	329	1325.569
8	Paint					
	painter	mandays	0.35	498.7584538	435	75935.97
9	woodwork					
	carpenter	mandays	20	42.6	400	340800
	mazdoor	mandays	2	36.6	329	24082.8
					Total Labour Charges	690828.4

Table 5.5 Labor charges of the green building

		Abstract			
S.No.	Description	Unit	Quantity	Rate	Amount
1	Earthwork in(foundation+ backfilling)				
	Foundation	cum	42.47526989	383	16268.02837
	Backfilling	cum	38.36046989	700	26852.32892
2	RCC work				
2.1	Cement Concrete	cum	22.19907168	5725	127089.6854
2.2	Reinforcement	quintal	26.62134051	4050	107816.4291
3	DPC	sq.m	13.28664	283	3760.11912
4	Brickwork	cum	41.06208944	5919	243046.5074
5	Flooring	sq.m	42.835824	900	38552.2416
6	Plastering	sq.m	402.9084538	217	87431.13447
7	Whitewashing	sq.m	402.9084538	22	8863.985984
8	Paint	litres	49.87584538	390	19451.5797
9	Woodwork	sq.m	42.6	2580	109908
10	Solar panel	per watt	15000	35	525000
11	Solar water heater				17200
12	Rain water harvesting system				52461
13	Labour Charges				690828.4
14	Tools and tackles @1 %				20745.2944
15	Water charges @2 %				41490.5888
16	Sanitary fittings @5%				103726.472
17	Contractors profit@10%				207452.944
				Grand total	2447944.739

Table 5.6 Abstract of cost for a green building

1.4.3 OPERATION AND MAINTENANCE COST(INCLUDING MAJOR AND MINOR REPAIRS):

2. ANNUAL WATER SUPPLY BILL	1200
ANNUAL COST OF PLUMBING REPAIRS	Rs 9000
COST OF PAINTING PER SQ.FT	Rs 52.5
USPWF	9.45
COST OF WATER USAGE FOR 50 YEARS	Rs 11340
COST OF PAINTING FOR 50 YEARS	Rs 63000
COST OF PLUMBING FOR 50 YEARS	Rs85050
COST OF MAJOR AND MINOR REPAIR FOR 50 YEARS(TAKEN 1.5 TIMES THE COST OF CONSTRUCTION)	Rs 3671916
TOTAL COST OF OPERATION AND MAINTENANCE	Rs 3831306

Table 5.7 Operation and maintenance cost

5.4.4 DEMOLITION AND DISPOSAL COST:

AREA TO BE DEMOLISHED	600 SQ.FT
COST OF DEMOLITION PER SQ.FT	Rs 22
TOTAL COST OF DEMOLITION	Rs 13200
RUBBLE TO BE DISPOSED	5 trucks
COST OF DISPOSAL PER TRUCK	5000
TOTAL COST OF DISPOSAL	Rs 25000
TOTAL COST OF DEMOLIITON AND DISPOSAL	Rs 28200

Table 5.8 Demolition and disposal cost

5.5.5 SALVAGE VALUE:

Salvage value on an average is 10% of the construction cost of a green building. Thus for our project the salvage value shall be Rs244794.4

5.5.6 LIFE CYCLE COST OF 1 BHK:

ACQUISITION COST	Rs 1400000
CONSTRUCTION COST	Rs 2447944
OPERATION AND MAINTENANCE COST	Rs 3831306
DEMOLITION NAD DISPOSAL COST	Rs 28200
SALVAGE VALUE	Rs 244795
LIFE CYCLE COST	Rs7462655

Table 5.9 Life cycle cost of a green building

CHAPTER 6

CONCLUSION

6.1 COMPARISON OF COSTS:

COST OF	NORMAL RESIDENTIAL BUILDING	GREEN RESIDENTIAL BUILDING
LAND ACQUISITION	Rs 1400000	Rs 1400000
CONSTRUCTION	Rs 1659268	Rs 2447944
OPERATION AND MAINTENANCE	Rs 5205234	Rs 3831306
DEMOLITION AND DISPOSAL	Rs 28200	Rs 28200
SALVAGE	Rs 82964	Rs 244795
LIFE CYCLE	Rs 8209738	Rs7462655

Table 6.1 Comparison of costs

6.2 COMPARATIVE ANALYSIS

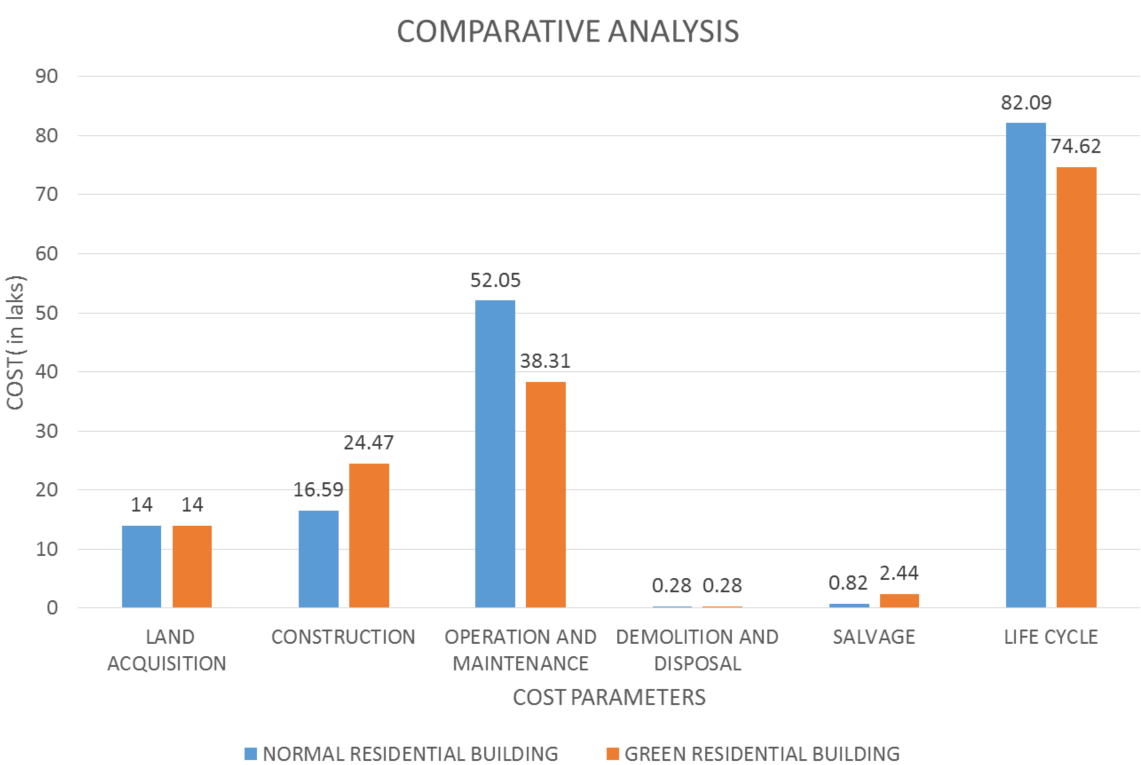


Fig. 5.1 Comparative analysis

5.3 CONCLUSION:

The major parameters that impact the life cycle of a building include construction cost, operation and maintenance cost and the salvage value of the building.

- Construction cost of the two buildings varies greatly because of change in the material used for construction and also due to the addition of sustainable technologies in the green building
- It's because of the use of green building materials and sustainable technologies that the returns from the green buildings are higher as can be seen clearly from the low operation and maintenance cost of the green building.
- As far as the higher salvage value of the green building is concerned, this can be attributed to the fact that the material used in construction of green building, though costly, can be reused and recycled way more efficiently than normal building material, which has a limited usage.

Thus it is very evident from the study that the life cycle cost of a green building and the returns associated with it are more than a normal building. Hence, being the need of the hour, green building construction should be laid more emphasis on and should be promoted.

REFERENCES

- Integrated Green Design By Ministry of Urban Development.
- J. Zuo and Z. Zhao, "Green building research current status and future agenda: A review", Renewable and Sustainable Energy Reviews,vol.30, (2014)
- Northbridge Environmental Management Consultants. Analyzing the Cost of Obtaining LEED Certification. Arlington VA: The American Chemistry Council (2003)
- ASTM International: ASTM E917 - 05(2010) – Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems. DOI: 10.1520/E0917-05R10, 2010
- ISO/FDIS 15686-5: Buildings and constructed assets – Service-life planning – Part 5: Life-cycle costing. International Organization for Standardization, Genf, 2008
- GDI (2004) Green Design Institute, "Economic Input-Output Life Cycle Assessment (Last accessed October 20, 2004), Carnegie Mellon,Pittsburgh
- Heijings (2002) Heijungs, R. and Suh, S., "The Computational Structure of Life Cycle Assessment," Kluwer Academic Publishers.Hendrickson (2005)
- Hendrickson, C.T. et. al., "Environmental Life Cycle Assessment Using Economic Input-Output Analysis," (forthcoming)
- Hendrickson (1998) Hendrickson, C., A. Horvath, S. Joshi and L.B. Lave, "Economic Input-Output Models for Environmental Life Cycle Analysis," Envir. Science & Techn., April.

- lcca/LifeCycle%20Cost%20Analysis%20(LCCA)%20_%20Whole%20Building%20Design%20Guide.html
- lcca/LifeCycle%20Cost%20Analysis%20for%20Buildings%20Is%20Easier%20Than%20You%20Thought,%20page%2001.html
- lcca/Overview_%20What%20is%20Life%20Cycle%20Costing_.html
- lcca/The%20Environmentally%20Responsible%20Green%20Office%20at%20a%20Glance%20%20Appendix%20D%20Lifecycle%20Cost%20and%20Economic%20Analysis%20Example%20-%20Real%20Property%20
- DWDO Office Solan