"MODELING AND COMPARISON OF ENERGY EFFICIENT GREEN BUILDING WITH CONVENTIONAL BUILDING FOR DIFFERENT CLIMATIC ZONES"

A Thesis

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY

IN

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With specialization in

CONSTRUCTION MANAGEMENT

Under the supervision of

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CERTIFICATE

This is to certify that the work which is being presented in the thesis titled **"MODELING AND COMPARISON OF ENERGY EFFICIENT GREEN BUILDING WITH CONVENTIONAL BUILDING FOR DIFFERENT CLIMATIC ZONES"** in partial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering with specialization in "**CONSTRUCTION TECHNOLOGY AND MANAGEMENT** and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Neha Jangta** (Enrolment No.152604) during a period from June 2016 to May 2017 under the supervision of **Mr. Santu Kar** Assistant Professor, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

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ABBREVATIONS

S. No.	*ABBREVATION*	FULL FORM
1	*N*	North
2	*S*	South
3	*E*	East
4	*W*	West
5	*K*	Conductivity
6	*1/K*	Resistivity
7	*b*	Thickness
8	*b/K*	Conductance
9	*1/fi*	Internal Surface resistance
10	$1/f_o$	External Surface Resistance
11	$1/R_c$	Resistance Of Cavities
12	*Ra*	Resistance Of Construction
13	*U*	Transmittance Of Construction
14	*Qc*	Rate Of Conduction Of Heat
15	*Qs*	Rate Of Solar Heat Gain
16	*Qm*	Rate Of Heat Flow Through Mechanical Means
17	ΔT	Temperature Difference
18	T_o	Outer Temperature
19	*Ti*	Inner Temperature
20	*ASHRAE*	American Society Heating, Ventilating, Refrigerating and Air-Conditioning

21	*LEED*	Leadership in Energy and Environmental Design
22	*USEPA*	United States Energy Protection Egency
23	*USGBC*	United States Green Building Council
24	*IGBC*	Indian Green Building Council

ABSTRACT

Green energy efficient building is one scientific approach which is gaining a lot of attention in the construction industry due to its sustainability and environment friendly approaches. In 21st century, world is seeing rapid growth in construction phases to meet the needs of people at any cost. This arise the demand for the well documented, integrated solution in pre project planning including choosing of greener materials, adopting water and energy saving techniques in and around the built environment. Various international and national organizations* are working integrally to make efficient and effective solutions to cater the ways out for meeting the maximum demands of greener solutions and rely less on demands for natural resources.

This topic is worthy of study because it allows the worthy health and living by implementing improved and integrated design strategies which are surely efficient and effective.
Steady heat flow is taken for modeling of the building on different climatic location. Material is selected on the basis of their thermal and mechanical properties. From the above modeling , heat loss and heat gain from inside of the house is find out so that the thermal comfort within the house is find out on the basis of maintaining the indoor air temperature accordingly w.r.t. the ambient air temperature outside of the house. Main purpose of the design is to build the house in a way to provide the maximum thermal comfort within the building without using or minimal use of thermal control devices for providing comfortable environment within the building. This strategy uses some of the designs features aided by organizations working with green environment to achieve the optimum certification level. Cold and cloudy region uses passive heating concepts and composite region uses passive cooling concepts. Maximum use of sun for the heating purpose, orientation of the walls and windows with respect to the sun, adopting shading techniques improved the thermal comfort in these locations.
The thesis study is mainly is to find out the energy analysis and cost effectiveness of the green buildings built for different climatic zones and comparison of it with the conventional building. Modeling and analysis is done for the improved energy efficient structure which has improved building performance, reduced life cycle energy cost, reduced monthly heating and cooling loads, energy generation potential, savings in electricity bills. Modeling is done using software like , AUTODESK REVIT 2016 and MS EXCEL for calculating the Qi, Qm, Qc, Qv, Ti values for the spaces.
Detailed construction cost for green the buildings are calculated for the different regions and it has been compared to the conventional buildings. DSR-2016 rates are taken to find out the detailed cost for each time and abstract of cost is made .

Author Keywords **:** cold and cloudy and composite climate, energy model, energy analysis, MS EXCEL, AUTODESK REVIT 2016, ESTIMATOR.

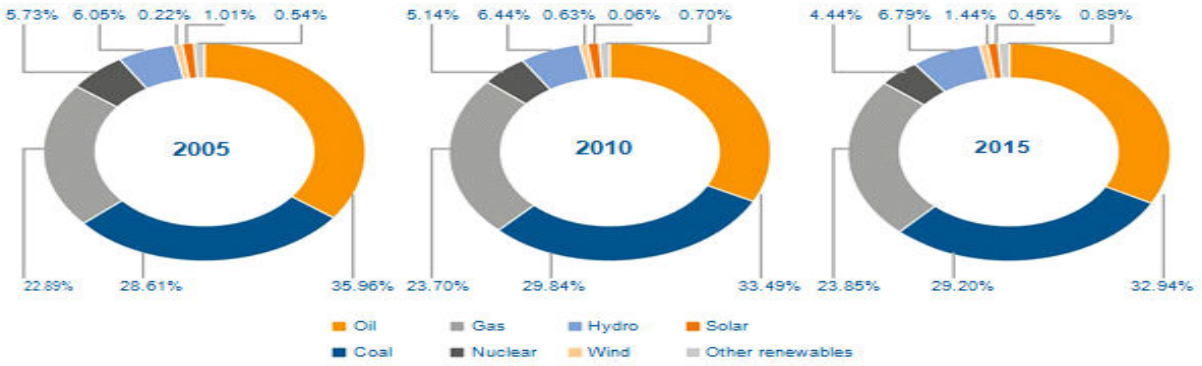
CONTENTS

CHAPTER 1
INTRODUCTION

1.1 General

To build the green environment and make it possible to relate with the surrounding environment for achieving the better seeing perspective with respect to the whole worlds scenario which is growing immensely due to rapid urbanization , excessive use of earth's natural resources, increase in global economy, increasing population, fast hands on the industrialization has set the high demand for the construction of the sustainable construction which has less harmful impact on the living beings and surrounding environment as the world is growing at a faster pace. According to the survey done by the EPA (2007) 40% of the construction industry is responsible for the environmental pollution. Energy release from the construction material manufacturing, transporting and placing imparts huge impact on the atmospheric temperature fluctuations, well beings health and other living organisms. This is one important factor contributing toward pollution which is causing the climatic change and in turn is increasing atmospheric temperature gradually imparting the greenhouse effect.

WEC 2015 (world energy council) has given the energy trends showing the fluctuations in using the conventional energy resources from the 2005-2015.



COMPARATIVE PRIMARY ENERGY CONSUMPTION OVER THE PAST 15 YEARS [WORLD ENERGY COUNCIL]

Fig 1.1 World energy council report on the energy trends from the 2005 to 2015.[WEC]

These issues are emerging and important to look upon. In the construction industry more pre-planning , innovative designs and constructing techniques are needed to somehow reduce the climatic changes which is occurring gradually with the increasing industrialization.

IEA (International Energy Agency) in 2014 international statistics shows the progressive rate of carbon emission which is 32723 million metric tons in 2012.This generation is causing several problems such as global warming and climatic change . Figure shows the CO_2 emissions (million metric tons/year) from 1980-2014. This is clear from the figure that carbon emission is increasing as the demand for it is going high year by year.

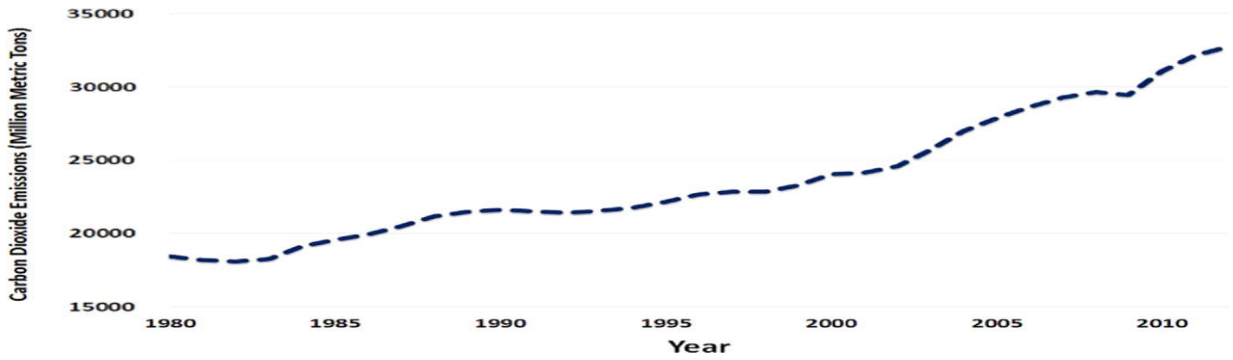


Fig. 1.2 CO_2 emissions from the consumption of energy(million metric tons) [IEA(Energy statics)]

Study done by **Umberto berardi(2015)** compares the energy consumption in U.S., EU, BRIC countries. Figure shows the variation in energy requirement from the 1990 to 2011 .

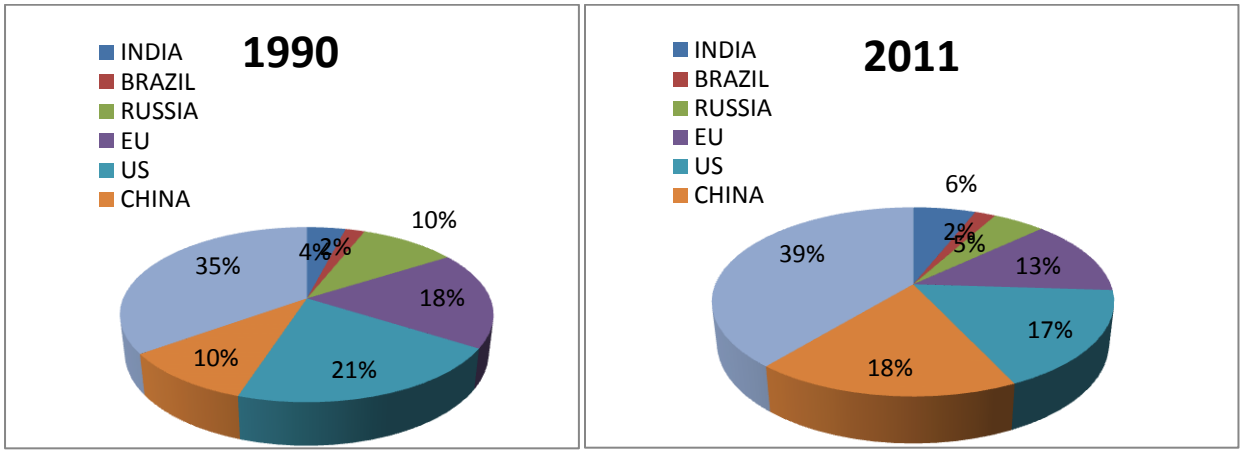


Fig. 1.3 % of energy consumption in world in 1990 and 2011 [EIA]

As the INDIA falls in the tropical region , most part of the country falls in warm , hot and humid climatic zones less is in the category of the cold climatic zone. The demand for cooling is frequent **[Umberto Berardi(2015)]** and is fulfilled by the efficient cooling systems. However there is much wider source of efficient energy that comes from the sun and today's construction is stressing on it.

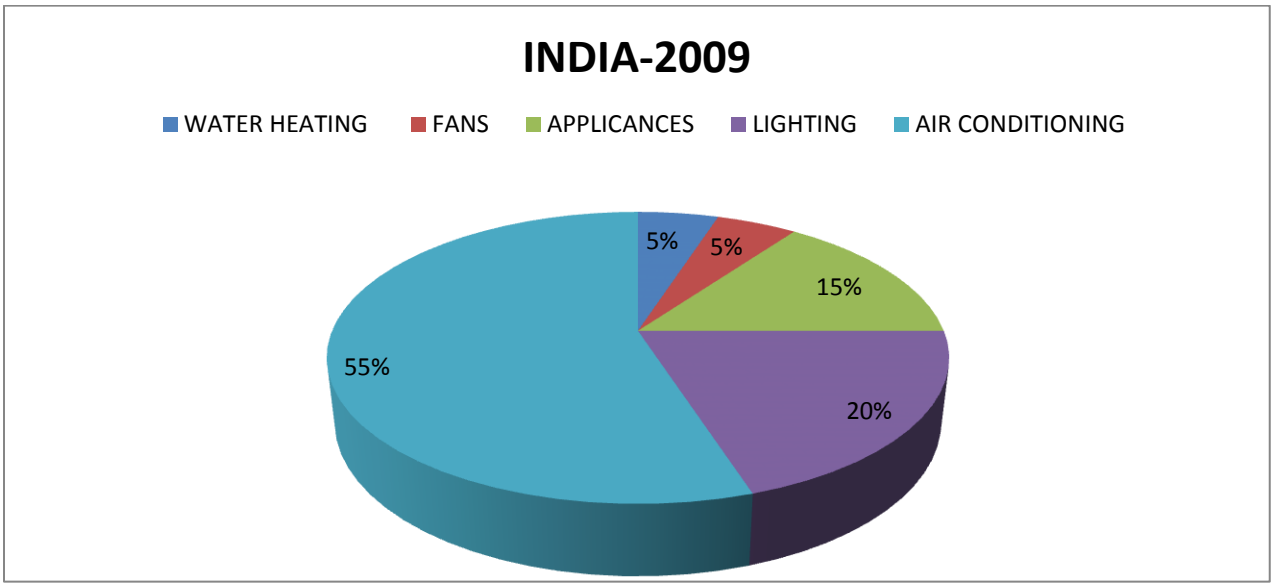


Fig 1.4 Residential energy consumption in 2009 [DOE, US DEPARTMENT OF ENERGY]

According to **India Energy Outlook Report 2015** its energy demand per capita in 2040 would still be 40% below the world average. Electricity demand will be increased and 600 million new electricity consumer will be there. Oil demand will reach to 10 million barrels per day by 2040. However India is the world's 2nd largest market for solar PV. Energy efficiency has increased from 1% in 2005 to more than 15% today and is set to increase to more than 40% by 2040. Incurring of the solar and wind energy solves the drastic energy demands for the future. **[IEA]**

Energy efficiency is a way to lower emissions and reduce energy use and costs. Adopting the policies and procedures stated by the working organization, taking the advice of senior consultants is an individual approach which is much needed .

Whole building design approach is useful in achieving the energy efficiency in the new construction . visiting the site, gathering the data about regional climate , buying appliances and

home electronics with A+ energy saving, providing inner and outer insulation and air sealing, Optimum lighting and day lighting measures , minimum space heating and cooling loads, Installing Water heating system, solar PV cells on the rooftop, altering the thermal and mechanical properties of the material used in the windows, doors, floors and skylights.

Due to the increased pollution and depletion of fossil fuel resources world has to find the alternate sustainable solutions such as renewable energy sources such as wind power energy, solar PV , bio power, geothermal ,CSP and ocean power. Figure below shows the renewable energy potential of the countries (2013) **[RENI21, P.S., Renewables 2014: Global Status Report. 2014: Secretariat Renewable Energy Policy Network for the 21st Century (REN21) Paris].** Report shows the Germany's highest potential of generating power from the Solar PV. INDIA comes in the category of middle income group country and a developing nation, though it has ranking in renewable energy sources compared to other developing Asian countries which is a step forward approach.

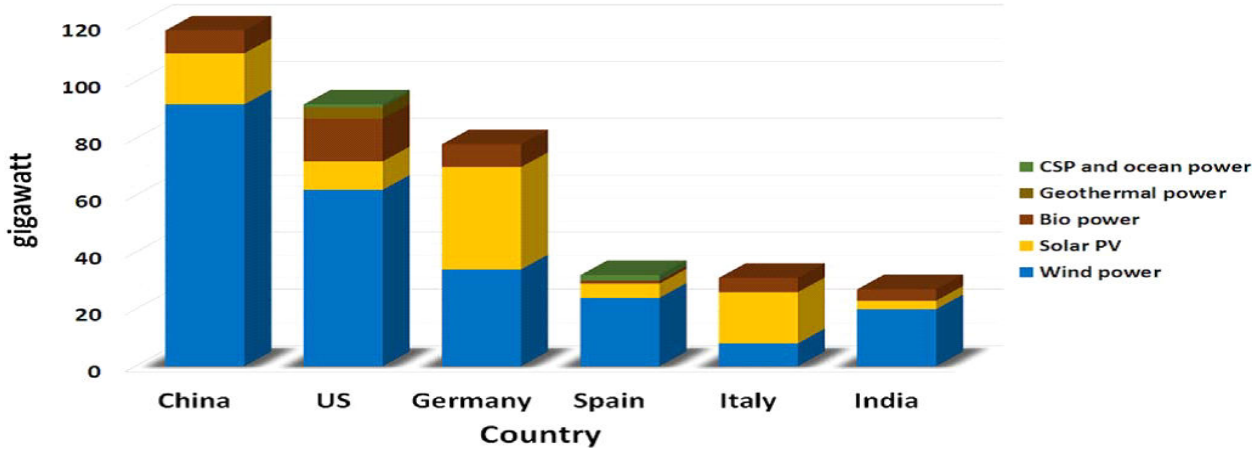


Fig. 1.5 Renewable power capacities in world [REN21, Global Status Report (2014)]

INDIA is a non-member country but still it has ranked 2nd in the wind power energy and 6th in the solar PV applications.

1.2 Energy efficient green building

Green construction, net zero energy houses, energy efficient buildings, sustainable construction, high performance buildings, intelligent building, low embodied energy houses are some of the

terms defining the green buildings. Green building is the construction to increase the efficiency of the construction using the material, methods, water and energy by reducing the negative impact on the living beings, their health and environment. Green building uses innovative and technological sound methods to achieve the overall efficiency in the buildings.

Green construction has various benefits over the conventional construction such as cost effective , though it has high initial cost but the maintenance cost is less as compared with the conventional buildings, saving the loads on the non-renewable resources, building in a way to have lesser impact on the end users and surrounding environment, expanding the interest of developers, real estate stakeholders, owners in the market ,reducing the stakeholders risk by increasing the resale value of the green products.

1.3 Working organizations and rating system

Globally recognized organizations which are working with the green construction are ASHRAE, UNEP, USGBC, EPA, EIA, ENERGY STAR.

LEED is the rating system developed by the USGBC in 1994 for the green and sustainable construction. It gives the rating and certification level as follows

Table 1.1 Certification level of LEED [Source: USGBC (1993)]

Certification	Certified	Silver	Gold	Platinum
Points	40-49	50-59	60-79	80 And Above

Energy conservation building code (ECBC) of India has some has some committees which are working toward the more progressive environment[**BEE INDIA(https://beeindia.gov.in/sites/default/files/selection%20(1).pdf)]**

Table 1.2 ECBC committees

Source [(https://beeindia.gov.in/sites/default/files/selection%20(1).pdf)]

Government organizations	**NGO's**	**Bilateral and Multilateral Agencies**
1. Ministry of New and Renewable Energy (MNRE) 2. Ministry of Urban Development (MOUD)/ TCPO/ CPWD 3. All State Designated Agencies (SDAs) 4. Bureau of Indian Standards (BIS) 5. Central Building Research Institute (CBRI) 6. Building Material and Technology Promotion Council (BMTPC)	1. GRIHA Council 2. Indian Green Building Council (IGBC) 3. Centre for Science and Environment (CSE) 4. Alliance to Save Energy (ASE) 5. Natural Resources Defense Council (NRDC)	1. Swiss Agency for Development and Cooperation (SDC) 2. French Development Agency - Agence Française de Dévelopement (AFD) 3. Gesellschaft für Internationale Zusammenarbeit (GIZ) 4. Kreditanstalt fur Wiederaufbau (KFW) 5. Shakti Sustainable Energy Foundation (SSEF) 6. Indo- EU 7. United Nations Environment Programme (UNEP) 8. United Nations Development Programme (UNDP)

1.4 Need of study

Green construction acts as connector in balancing the relationships between environmental, social, and economic health. While my focus in this report may seem to be limit on some of techniques used in the green building construction used .Because a planned and well-built techniques provides many social, economic and environmental benefits. Green building is based on an integrative perspective of the relationship between our natural and built environments. The green building design and construction using methods and materials that are resource efficient, will not compromise the health of the environment or the associated health and well-being of the building's occupants, construction workers, the general public, or future generations. The growth and development of our communities has a large impact on our natural environment. The manufacturing, design, construction, and operation of the buildings in which we live and work are responsible for the consumption of many of our natural resources.

1.5 Objective

1. Study on green buildings to identify different techniques for the construction of Green Buildings.
2. Preparing green building models in Autodesk Revit (2016) by considering cold/cloudy and composite climatic zones.
3. Energy analysis of green building models and comparison with the conventional building models.
4. Construction Cost comparison of green building models with the conventional building.

1.6 Scope

Various studies and techniques have been implemented for the modeling of green building through various soft-wares to conduct energy analysis to minimize the heating and ventilating loads on the structure. The modeling will differ with different climatic zones. These climatic zones depend upon various factors i.e. sun path pattern, terrain, intensity of rainfall, climatic conditions of the place etc. The study of the work will be to identify different modeling techniques for the different climatic zones to model green buildings in a way so that it can give maximum inner comfort level as compared to the outside environment.

1.7 Limitation

1. All the thermal analysis is worked out for steady heat flow.
2. Models are strictly architectural structure built for two different climatic regions.

CHAPTER-2

LITERATURE REVIEW

2.1 Reviews of authors

Chaturvedi, S. (2008) The study concluded the remarks on the adoption of efficient energy innovations. With the increase in energy consumption, degradation of the environment is also increasing which is urgings the demand for green and energy built design. The construction of more energy required buildings results in destruction of natural habitats and bio-diversity, air and water pollution, more water consumption, waste generation and decreased user productivity. It is recommended that the cost of energy efficient structure is 10-15% of the overall cost of the house. Integral active cooperation of engineers, architects, builders and policy makers, more energysaving techniques can be implied.

Chunduri, S., Yimin, Z., and Bayraktar, M. E. (2011) This study performed a controlled experiment on 23 graduate-level students in construction management and obtained some initial results related to the impact of customizing material presentation according to learning styles when teaching green building concepts. The results of the experiment showed that addressing a student's learning style improved results in learning of green building concepts. Learning style was based on the concept maps mind maps, ontology. Other factors such as thinking styles, gender, and IQ may also affect learning styles.

Denzer, A. and Heimbuck, K. (2011) Based on the work , author concluded that making a robust freshman course for architects and engineers that would consist of kinesthetic and inductive learning activities, leading to fundamental theory, on a variety of Green Building topics. In such a scenario, sophomore (or even second-semester) instructors could anticipate these fundamentals as prerequisite knowledge, and move on to higher-order concepts and problems.

Gibler, M. R. (2015) Green roof represent the environmental, social and economic benefit along with sustainability. The authors findings present the fully quantify and directly link evaporative

cooling potential of green roofs, capable of projecting the urban cooling benefits of green roofs, when incorporated into a climate-based model. Using a local typical meteorological year , evapotranspiration can be projected on a daily basis, coupled with designed field capacity to forecast storm water retention performance. This forecasting can be applied to project large-scale benefits of green roof projects before they are constructed. Such modeling can be used as a predictive tool to design green roofs for use in watershed management and urban planning.

Ionescu, C., et al. (2015) Historical evolution of the energy efficient building is found out about 5500 BC in Romania (Carpathian region) where houses were totally constructed in the ground so that it can keep a constant indoor temperature during the year. From that era onwards evolution has only increased till now and today's world is adapting more prominent ideas continuingly.

Sajjadian, S. M., et al. (2015) In different climatic regions low and high thermal mass do not contribute in thermal balance. He performed simulations in existing buildings in LONDON and MANCHESTER using DESIGN BUILT SOFTWARE(calculation engine ENERGY PLUS) taking the weather data of 2020,2050,2080 with five high performance construction and concluded that climatic change solely do not alter the decision of choosing among construction.

Sorell, S. (2015) Complex economic system, increased energy demand with the increased economic growth, not considering the feasible solutions to climatic changes are some emerging issues as a barrier for reducing energy demands which can be encountered by accepting new energy efficient technologies and growing literature on sociotechnical transitions.

Sun, S., et al.(2015) Building industrialization has changed the worlds perspective toward the improvement in building components to achieve the optimum energy efficiency. Study included the HS-EPS core column structure system, The GaoGe Composite Wall Panel of Husk Mortar and straw board construction. For the construction in the cold area, building industrialization can save 40% of the working time, 50% saving in labor as compared to the traditional construction. For the pre fabricatred components building industrialization can save 7% of concrete, 2% of Steel, 40% of water consumption, 70% of plasterer materials..

Chan, A. P. C.,et al. (2016) The study aims to examine the criticality of various barriers which are preventing the adoption of green building technologies. Author categorized the barriers from the Factor analysis results that are technological risks and difficulties; stakeholders'

attitudes, knowledge limitations; market limitations; and higher cost and information. To improve the barrier there is much need of integrated designs and strategies.

Charalambides, J., and Wright, J. (2016) Author concluded the effect of building orientation which isadvantageous for solar gain and building heat losses and gains, it allows designer to optimize the building orientation to an extent. He considered the building shape and a limited range of Uvalues , he further observed that optimal orientation of a building is significantly affected by the latitude and climate of the particular region. Colder climates benefit from morning solar gain during winter more than they suffer from the solar gain during summer. As such, building orientation needs to be optimized to capture morning solar gain. On the other hand warmer climates and lower latitudes, the building be has to be oriented to minimize solar gain.

Chokor, A. and Asmar, M. E. (2016) Study investigates the impact of LEED certification on the buildings energy consumption. The study include the novel LEED performance assessment method through the case study of 18 research buildings located in climate zone 2B,which is developed after the predictive models of the energy consumption for the investigated buildings. Author measured heating/cooling and electricity energy consumption in 15 min increments over a 7-year period and aim at a specific type of facilities in one geographical location in order to limit the variation in the dataset. In the results of this paper it shows the superiority of the Gradient Boosting Regression over other regression models in predicting energy consumption for this dataset of research buildings. The study shows the differences between the benchmark addressed in the literature and the one proposed in this study in order to assess the performance of LEED buildings.

Kannan, N., et al.(2016) The applications of solar energy is widespread and are used in various field areas including heating and cooling of building, roof mounted PV systems, solar energy for drying and green houses, food refrigeration, electrical fencing, lighting, water pumping, charging electronic devices, salinity removal, wastewater treatment, space application.

Kolokotroni, M., et al.(2016) Green roofs shows reductions for heating and cooling energy loads , whereas the cool roofs shows reductions only for the cooling energy loads because of higher surface reflectance which reject the significant amount of solar heat gains.

Nguyen, H.T., Gray, M. (2016) Various middle income countries are adopting the idea of green building. Increased energy demand and scarce resources (Increasing @5.5% p.a. till 2025), demand for buildings due to growing population (90.7 M- 108.7 M till 2049) and urbanization , harmful climatic changes are hindering the sustainable development in Vietnam and green building could be beneficiary benefit to the country.

Wong, N., H. (2016) Concluded that naturally ventilated buildings in tropical climates have low thermal comfort and better indoor air quality . to rectify the shortcomings thermal comfort assessment method for naturally ventilated industrial buildings was applied. He further recommend that thermal comfort assessment of industrial buildings shall be based on PMV equation. The recommended PMV level as the minimum passing criteria is PMV -1 to 1. PMV 0.8 is proposed for the higher level's passing criteria. Consultants can adopt innovative methods to lower the DBT without any additional energy consumption.

2.2 Summary of literature review

From the finding of various researchers and evolution of new techniques in construction industry, synchronization has been set up between the more integrated, equipped and organized pre planning programs before the execution process which has taken the demand and fulfillment to the next level by implementing innovative ways in modeling and designs which has led the world to adopt greener technologies. Net zero buildings, eco-friendly buildings, green buildings and energy efficient buildings in construction industry are the example of the innovative ideas and evolution of technology from the past era till present time. Need of it has urged due to fast depleting energy resources, scarcity of the energy resources, conventional technologies and materials which are not up to mark and increasing environmental pollution. There is need of rectifying the issues and intervention of the designers for effective methodologies and chosen materials to minimize the energy usage, ecological degradation that is directly harming the environment. Generally the energy efficiency in buildings is achieved by the minimization of load by the incorporation of the solar passive techniques, taking grip on eco- friendly designs, using the renewable energy sources and the low embodied material and methods. Moreover by spreading awareness between the end users and common people about the green and efficient technologies can help a lot in real scenario to see the world which is worth to live in.

2.3 Energy efficient building design concepts

Table 2.1 Design features of Energy Efficient Green building

Commonly adopted design elements	**Design features**	
(A)Design	Design of the structure taking in account the thermal phenomena including the heat produced by the residing elements and the thermal body itself and internal heat gains.[Ionescu,C.,et al.(2015).	
(B)Building form	S/V(surface to volume ratio is a parameter which is defined by the building form. Compactness of the shape of building is correlated with the volume of the space inside a building. For a given building more compact the shape, more effectiveness of it toward hear gain and loss. It also determines the airflow pattern, and depth of the building for ventilation and need of artificial lighting. [Majumdar,M. (2001)]	
(C) Positioning	Positioning of the building in a way for venting the summer heat and reducing winter winds in all climatic regions. Trees can be act as entrapper to warm winds and giving a cooling effect.[Ionescu,C.,et al.(2015)	
(D) Presence of water bodies	Modifying the microclimate, water acts as good modifier. It soaks heat within giving the cooling effect. Effective in the hot-dry climates and should be avoided in the purely humid regions as it can increase humidity.[Majumdar,M. (2001)]	
(E) Shading	(a)Active shading	For the large building having large glazing areas , active shading devices are effective to control the lighting and solar radiations.[Ionescu,C.,et al.(2015)]

	(b)Passive shading	Some of the devices such as overhangs, balconies ,blind curtains, decks etc. acts as passive shading devices..[Ionescu,C.,et al.(2015)]	
	(c)Natural shading	Landscaping is a way of natural shading. It prevents solar radiations directly striking and heating up the building surfaces in the summer. It creates pressure differences between the warm and cool winds and alter the airflow pattern. Shade created by the trees and vegetation reduces air tempretuer. [Majumdar,M. (2001)]	
(F) Orientation	Solar orientations have incorporated to have the heat gain in the winter and expulsion of it in the summer[Ionescu,C.,et al.(2015)]. Orientating the building to the S-W having S and N facing walls 1.5-2 times the E and W facing walls completes the goal of optimum energy efficiency in the building [Chaturvedi,S.,(2008)]. In the cold regions 15 degree east of south orientation is preferred for the maximum use of sun during the mornings hours. [Majumdar,M. (2001)]		
(G)Designing building envelope and fenetration	(a)walls	Designing wall thickness, material, finishes considering the heat storage capacity and the heat conduction property are the key features for the thermal comfort conditions . Thermal insulations and air cavities reduce the heat transmission into the building when combined within the wall system. Thickness of the cavity more than 20mm have seen constant effect on the heat flow [Chaturvedi,S.,(2008)].	
	(b)windows (fenestration and shading)	Windows acts as solar heat collector , ventilators and light guiding devices .	
		(1) N facing windows	1/3 to 1/2 of the N face should be glazed, so that solar radiation in the winter can be entrapped and properly designed eaves can contribute in shading. Some of the shading devices such as

			pergolas, eaves and landscaping provides effectiveness to the elements. [Chaturvedi,S.,(2008)]
		(2) E facing windows	E facing windows are critical factored element. These windows add warmth in the winter but they are unstoppable being overheated during the summer because altitude angle is high with the horizontal (~ 86˚) in the morning hours(E side) and in the late afternoon hours(W side) and only placement of vertical screening can obstruct the sun rays at these angles. [Chaturvedi,S.,(2008)]
		(3) W facing windows	W facing windows are also critical factored element. These windows add warmth in the winter but they are unstoppable being overheated during the summer because altitude angle is high with the horizontal (~ 86˚) in the morning hours(E side) and in the late afternoon hours(W side) and only placement of vertical screening can obstruct the sun rays at these angles. [Chaturvedi,S.,(2008)]
		(4) S facing windows	S facing windows do not receive direct sun rays in the winter but receive morning and afternoon sun for few hours. So these windows gain excessive heat in the summer and lose heat in the winter. As the winter sun is low in the sky so direct heat radiations falls on the façade placing

			S , to prevent it vertical elements(external screening, landscaping) are combined with internal blinds for most effective shading.[Chaturvedi,S.,(2008)]
		(5) Internal windows	Internal windows placements are important for the heat loss reduction in the winter. As windows in the winter can lose heat 5-10 times than the wall surface area. This loss can be minimized by placing closed curtains including pelmet made from the heavy fabric having insulating backing.[Chaturvedi,S.,(2008)]
		(6) skylight	Skylight is designed to meet the daylight needs. For the overheating and under heating problems in the summer and winter respectively fit the special glazing that reduces heat transfer and can be closed at night time.[Chaturvedi,S.,(2008)]
		(7) Reflective Films and tinted glass	Reflective films reflect heat and tinted glass absorb heat keeping the space cool and warm. For their applications they are placed in E and W facing large areas where glazing is eliminated due to design specifications.
		(8) Double - glazing	Cost effective where high heating demands are to be fulfilled. 10mm space between the two panes of glass reduces the winter heat also the conductive summer heat gain. But still it allows significant heat transfer when exposed to direct sun, which creates requirement for the shading .
	(c)Room	According to the climatic regions specifications changes	

	layout	accordingly. In hot regions most bedrooms are placed toward the due N having some shading provisions. In the cold regions the living, bedrooms are placed due S as the sun is low in winter with proper vertical shading devices. Kitchen, laundry and washrooms are placed in series to minimize the need for the long hot pipes which will ultimately reduce the heat loss from the pipes reducing the hot water demand.[Chaturvedi,S.,(2008)]
	(d)Roof	Most of the solar radiations are received by the roof top throughout the year in any climatic regions. This reason increases the demand of the insulation provided for the roof. Planting of deciduous trees provides evaporative cooling, insulation in the form of inverted earthen pots or providing vermiculite concrete, for the day lighting and ventilating purposes vents and skylights are provided.
	(e) Floor	Floors also play important role in the heat gain or loss. Glossy and shiny surface of the floor reflect back the incident radiations whereas the dark colored and concrete floors absorb some of the incident radiations. Timber floors require insulation underneath to protect the heat loss as the thermal mass of the timber floor is less as compared to the concrete floor.[Chaturvedi,S.,(2008)]
(H)Material properties and effective construction	(a)Low embodied energy material	Low embodied energy material reduces the strain on the conventional energy sources improving structural design and transportation energy.
	(b)Insulation	Insulation reduces the demand of the mechanical heating and cooling loads for the space. Thickness and placing of the insulation plays important role for its effective usage. In hot

		zones insulation is provide in the outer side beneath the wall.
	(c) Drought proofing	Drought excluders and sealing strips on the bottom of the door and around windows greatly saves energy bills.
	(d) Moisture proofing	Material used in the construction should have high vapor resisting capabilities. Use of vapor diffusion retarder minimizes the transmission rate of vapors and controls the moisture of the thermal envelope.
	(e) External finishes	Light color and smooth surfaces tend to reflect more amounts of light and heat than the darker one. As the emissivity of the light color surface is high, one can take advantage of it in selecting the external wall and roofing material. But if the proper insulation is provided in the walls, floors and roofs , this factor becomes less important.
Modern passive heating techniques	Adopted in the cold regions for better thermal comfort.	
(A) Direct gain system	It works on the passive solar principles. Sunlight directly enters the interior space by the windows and glazing. Windows are double or triple glazed with low emissivity (E) to obstruct the solar radiation from outside warm air to the inside of the cooler air. Window pane space in between is filled by the gases like Argon, Krypton or mixture of it or remained vacuumed. 60-75% of the solar energy is gained through the direct gain system. Clerestories and skylight windows are specially designed for the heating and day lighting purposes.	
(B) Indirect gain system	Construction with the thermal mass. Thermal mass is placed between the direct sun and the interior space. It uses 30-45% of the sun's energy incident on the glass.	

	(a) Trombe wall	Trombe wall is the conjunction of the construction material with the glazing system. Common materials such as concrete, masonry and adobe acts as construction material which are placed as thermal mass of the S side of the building in the northern hemisphere and glazing system is placed on the outer covering to it providing a gap between it. Vents provided in the trombe wall during daytime provide the transport mechanism to the warm air from the incident solar light which has been stored as a sensible heat by the wall. Air space between the glazing and the wall gets heated up and enters the inner space by the convection through the vents.
	(b) Water wall	Water wall also works on the same principle like trombe wall. Only the difference is that it uses water as the thermal storage medium. Drums of water is placed behind the glazing to absorb heat. Heat is transferred at a much faster rate than the trombe wall. Departmental buildings which work on the daytime could get benefit from the water wall construction as it delivers hear at faster rate. Some shading devices are coupled with it in the summer to reduce over heating effect.
(C) Roof – based air heating system	For heating the interior spaces solar radiation is entrapped by the roof. It consists of north sloping insulated surface and inclined south facing glazing creating air space between the north and south sloping roof.	
(D) Solarium	Solarium or the sunspace is the combination of the direct or indirect gain system. Solar radiations heats up the solarium glazing and heat absorbed through it is conveyed through convection and conduction to the inner spaces.	
Modern passive cooling	It uses heat sinks to remove the heat from the internal spaces. Cooling is provided without using any electrical appliances and introduction of the convective and evaporative cooling.[Majumdar,M. (2001)]	

<table>
<tr><td>techniques</td><td colspan="3"></td></tr>
<tr><td>(A) IAQ</td><td colspan="3">Internal air quality is directly related to the ventilation techniques.</td></tr>
<tr><td></td><td colspan="2">Cross ventilation</td><td>Stack ventilation</td></tr>
<tr><td></td><td colspan="2">Works on the air pressure difference when openings are placed opposite to each other. When outside air is cooler than the inside air of the building. Inside air is at low pressure which rises and expands with more heat induction. outside air is at high pressure as it is denser with cold. Due to pressure difference, the hot air flows toward outside and cool air replaces the hot air providing the cooling effect. This ventilation is needed to remove the stagnated air which has moisture, mold and bad smells.</td><td>It uses air temperature difference due to height of pull. Warm air rises through the stack because it is at the low pressure replaced by the cool air. Technique is adopted in the temperate / cold region where there is high temperature difference between indoor and outdoor air which induces high air flow.</td></tr>
<tr><td></td><td>(a) Wind tower</td><td colspan="2">Works efficiently in the hot and dry regions and for the individual units. Works on the ventilation principle. Due to air exchange throughout the day, wind tower becomes warm in the evening. Which is overcome by the contact of cooler ambient air temperature to the bottom tower of the during the night .</td></tr>
<tr><td>(B) Courtyard effect</td><td colspan="3">As the solar radiations fall in the courtyard, warm air starts rising and cool air from the ground level replaces it by producing air flow pattern. If the orientation of the roof surface is sloped toward the courtyard , the cooled air sinks into the courtyard through the openings placed at the low rising level and warm air rises up and goes out through the openings placed at the higher level.</td></tr>
</table>

(C) Earth air tunnels	As we know that the temperature below the 4m from the earth surface remains constant and acquires the same temperature of the surroundings .Due to this reason a tunnel can be built in the form of pipe which cool the air in summer and warm the air in winter .RETREAT building in Guru gram has adopted this technology.		
(D) Evaporative cooling	Evaporative cooling is best suited for the hot and dry climate where atmospheric humidity is low. Water is evaporated by the sensible heat of air for the cooling of air which ultimately cools the inner space of the buildings.		
Others	(A)Electric appliances and devices	(B)Energy load	(C)Economic aspects
	To reduce the energy consumption in the buildings ,it is necessary to use electric appliances with the A+ energy efficiency. Use of florescent bulbs or LED lamps lowers the energy consumption and increase the life span of the devices	Designing the house in a way to reduce the 8-15 times lower heating and cooling loads for the buildings.	Payback period for the recovery of energy efficient house is about 15-30 years. Generally, extra cost incurred is 5-15% of the total house cost . [Ionescu,C.,et al.(2015)]

2.4 Case studies

2.4.1 Case studies for cold and cloudy climate:

a) Case study 1

Location: Shimla

Building type: Office building

Climate: Cold and cloudy

Architects: ArvindKrishan and KunalJain

Owner /client: H.P energy developement agencyYear of completion: 1997

Built-up area: 635 m^2

Building: Himurja office building, shimla

Design strategies: Air heating panels, Double glazed windows, Insulated diaphragm walls,Solar chimney, Solarium, Light shelves, Solar water heating system, Solar photovoltaic system

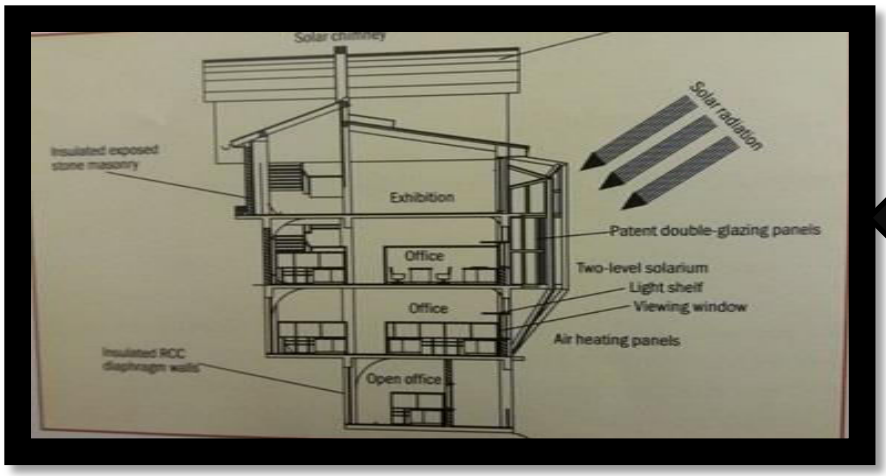
Cost: 7million+1.3million(incorporation of solar systems) , 18.6% increase in cost due to incorporation of the solar system

User feedback: Excellent thermal conditions in winter, except the overheating in summer

Outcomes: Incorporation of designing day lighting, heating, insulation strategies and renewable energy systems increase the building performance

A south-west view of the office building showing specially designed sunspaces for maximizing solar gains in winter

A view of curved ceiling with glass blocks to contribute daylight and roof -mounted solar water heating system



Section through the building showing solar access through specially designed solarium and air heating panels

References:…Majumdar (2002) Fig. 2.1 (a) (b) (c) Various views(S, N) of building

b) Case study 2

Location: Mall road, 23 onven, H.P.

Building type: Office building

Climate: Cold and cloudy

Architect: Ashok B Lall

Client/owner: H.P. Cooperative bank

Year of completion: (1995-1998)

Built-up area: 1650 m^2

Buildings: H.P. state cooperative bank, Shimla

Design strategies: Sunspaces, Heat collector wall(solar walls), Roof top solar collector, Artificial illumination

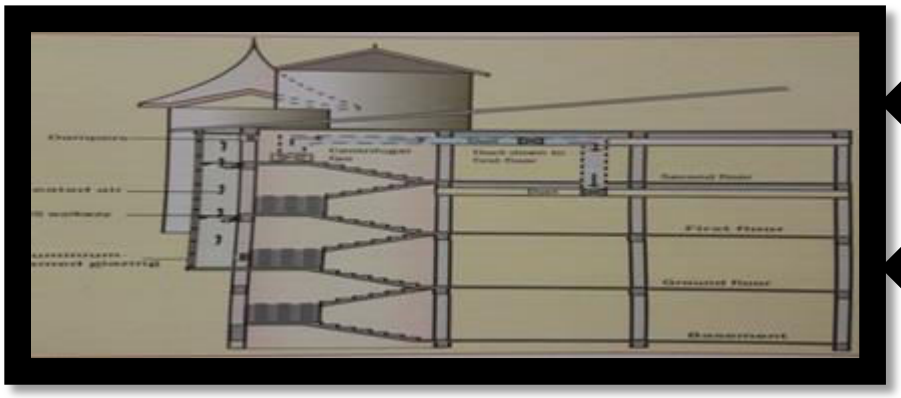
Cost: Total cost(22 million) ,5.6% increase in cost

User feedback: Reduction in electricity bills and thermal comfort (maintaining 5-10˚C)during winter

Outcomes: Adoption of energy saving techniques provides saving in electricity and eliminating the need of conventional heating and ventilating system and providing thermal comfort.

Roof based air heating systems

South-facing heat collector trombe wall.



Section of the building with heat collector wall. The heated air from the surface of this trombe wall is drawn out at the top

References: …Majumdar (2002) **Fig. 2.2 (d) (e) Rooftop solar PV**

c) Case study 3

Location: Bhowali, Nainital, U.p

Project type: Post-retirement cottage

Climate: Cold and cloudy

Architect: Sanjay Prakash

Client/owner: Mohini Mullick

Project period: 1991-1995

Construction type: load bearing

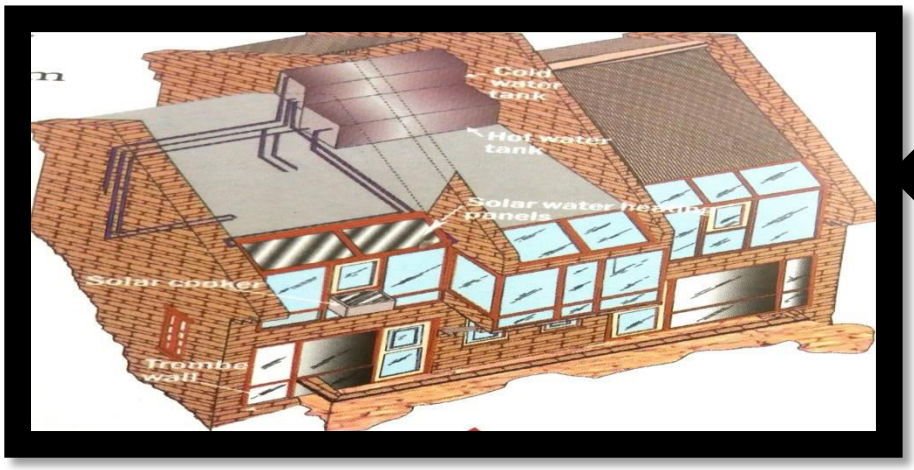
Residence: MohiniMullick, Bhowali, Nainital

Design strategies: Inclined south glazing, Trombe wall, Earth berming, Entry from the north, Entry through air lock ,Min. opening on the east and west and no opening on the north Solar hot water system and solar food cooker

User feedback: Providing thermal comfort

Outcomes: Keeping in mind not to disturb the hill ecology by compact form construction, Use of locally available, material reduces transportation cost, Skilled manpower

A view inside the living spaces showing glazing for direct solar gains



View of the house showing south glazing and integrated solar water heater on roof and wall integrated solar wood warmer

References:…Majumdar (2002) **Fig. 2.3 (f) (g) Views of south glazing**

2.5.2 Case studies for composite climates:

a) Case study 1

Location: Panchkula

Project description: Residence house

Architects: Anant Mann and Siddhartha Wig

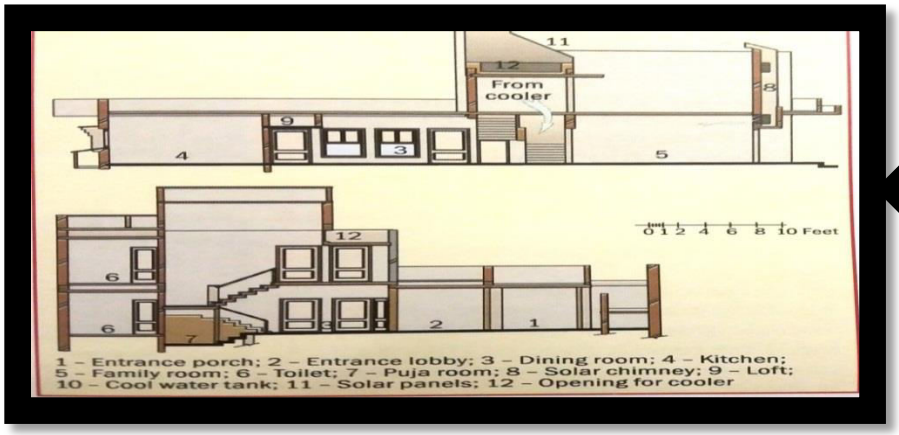
Project period: 1999

Buildings: Residence for madhu and anirudh, panchkula

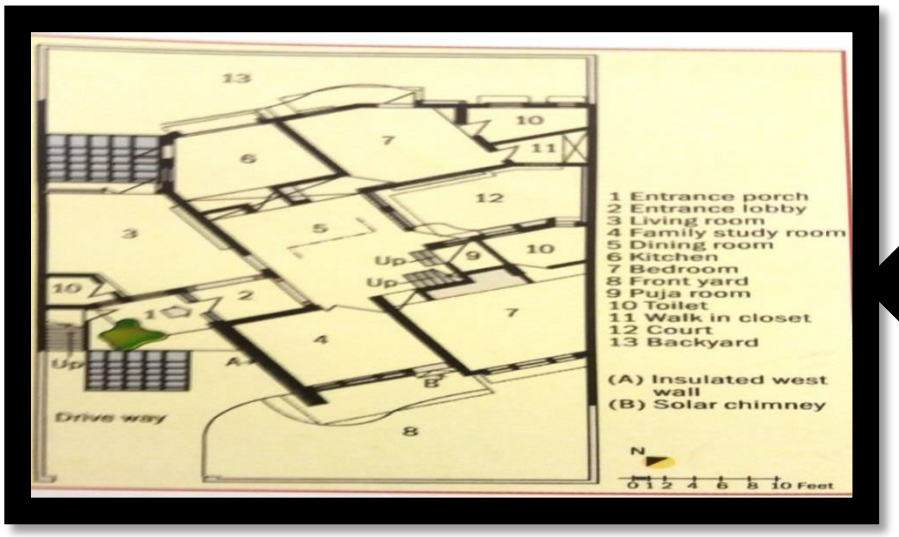
Design strategies: Orientation (s-w facing), Shading and daylighting (louvre, lighting shelves),Ventilation(solar chimney),Insulation on west wall,Evaporative cooling

Outcomes: Use of cost effective interventions for achieving energy efficiency techniques at the design stage to reduce the electricity bills in nature

Building is oriented due south. Insulated west wall clad in slate, black solar chimney and light shelves on the south windows are shown.



Section of the building showing centralized evaporative cooling systems for the rooms. The air movement is assisted by the solar chimney.



Building plan showing angular design of the house in order to give southern exposure to most of the rooms

Reference: …Majumdar (2002) **Fig. 2.4 (h) (i) (j) Plan and elevational view**

b) Case study 2

Location: Rajpur , Dehradun, U.P

Building type: Institutional

Climate: Composite

Architect: Ashok B Lall

Year of completion: 1997-1999

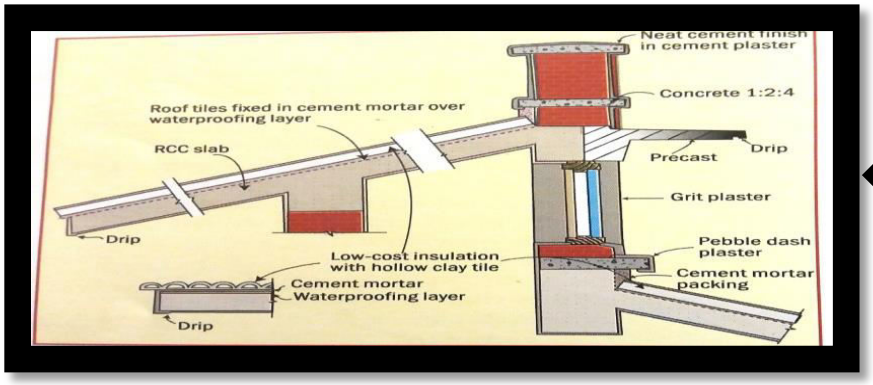
Buildings: SOS Tibetan children's village, rajpur , Dehradun

Design strategies: Outdoor spaces (landscaping /plantation, open spaces),Building plan(south sloped terrain and clerestory windows),Building fabric(RCC roof slab+ terracotta tiles

Cost: Rs.45.8 million

Outcomes: simple construction techniques also provides insulation at a minimal cost and minimal maintenance

Site has a slope toward south, allows orientation of the cottages



External roof insulation with hollow terracotta tiles to improve thermal dampening characteristics of the roof

References: ...Majumdar (2002) **Fig. 2.5 (k) (l) (m) Showing the outdoor spaces**

c) Case study 3

Location: Gurgaon

Project description : Country house for a couple with two children

Climate: Composite

Architects: GernotMinke and Sanjay Prakash

Project period : 1992-1996

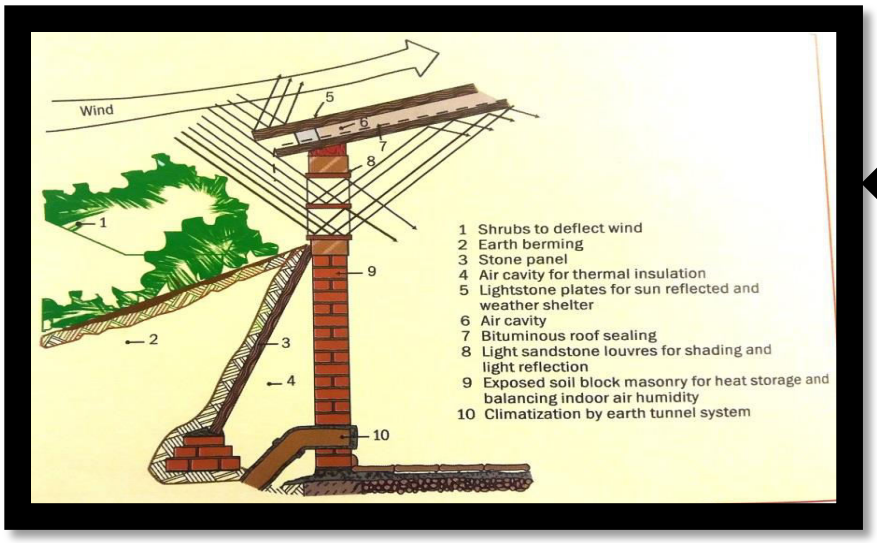
Building: Dilwarabagh, country house for Reena and Ravinath, Gurgaon

Design strategies: Plantation (earth berms, shrubs, fruit trees),Adobe walls, Stone louvers in all windows, Lake formation

Outcomes: Use of traditional method and material and adoption of passive architectural principles eliminate the need of energy intensive space conditioning techniques

A south view of the house with windows for winter gain . The roof overhangs provide shading for overcoming

The building opens up to the south for winter gain. Northern face is partially earth bermed for optimum day lighting.



Wall section showing earth berming and earth air tunnel

References: … Majumdar (2002) **Fig. 2.6 (n) (o) (p) Various views**

CHAPTER-3

RESEARCH METHODOLOGY

3.1 Introduction:

Work on the thesis includes green building solar passive design techniques to build two buildings on different climatic locations namely cold and cloudy in Shimla and Chandigarh in composite climate. Main purpose of the building is to design it in a way to provide the maximum thermal comfort within the building without using or minimal use of thermal control devices for providing comfortable environment within the building. This strategy uses some of the designs features aided by organizations working with green environment to achieve the optimum certification level . Cold and cloudy region uses passive heating concepts and composite region uses passive cooling concepts . Maximum use of sun for the heating purpose, orientation of the walls and windows with respect to the sun , adopting shading techniques improved the thermal comfort in these locations.

3.2 Work plan:

3.2.1 Work plan for the 3rd semester:

(a) Designing of green building modals considering different climatic locations respectively for cold and cloudy and composite climates

(b) Design of modals adopting solar passive techniques for both the locations

(c) Adopting green materials for the construction of the buildings

(d) Calculation of the wall thickness, U-values of the walls and windows , dimensions of the rooms, walls ,windows to know the heat flow in the building or out of it (Qc, Qv ,Qi) .

(e) By incorporating the thermal design for steady heat flow in the buildings obtaining the Δt values in the buildings

3.2.2 Work plan for the 4th semester:

a) Energy analysis of the building models using Revit 2016 software

b) Comparison of the energy analysis of the green buildings with the normal buildings in respective locations.

3.2.3 Work plan flow chart for 3rd semester :

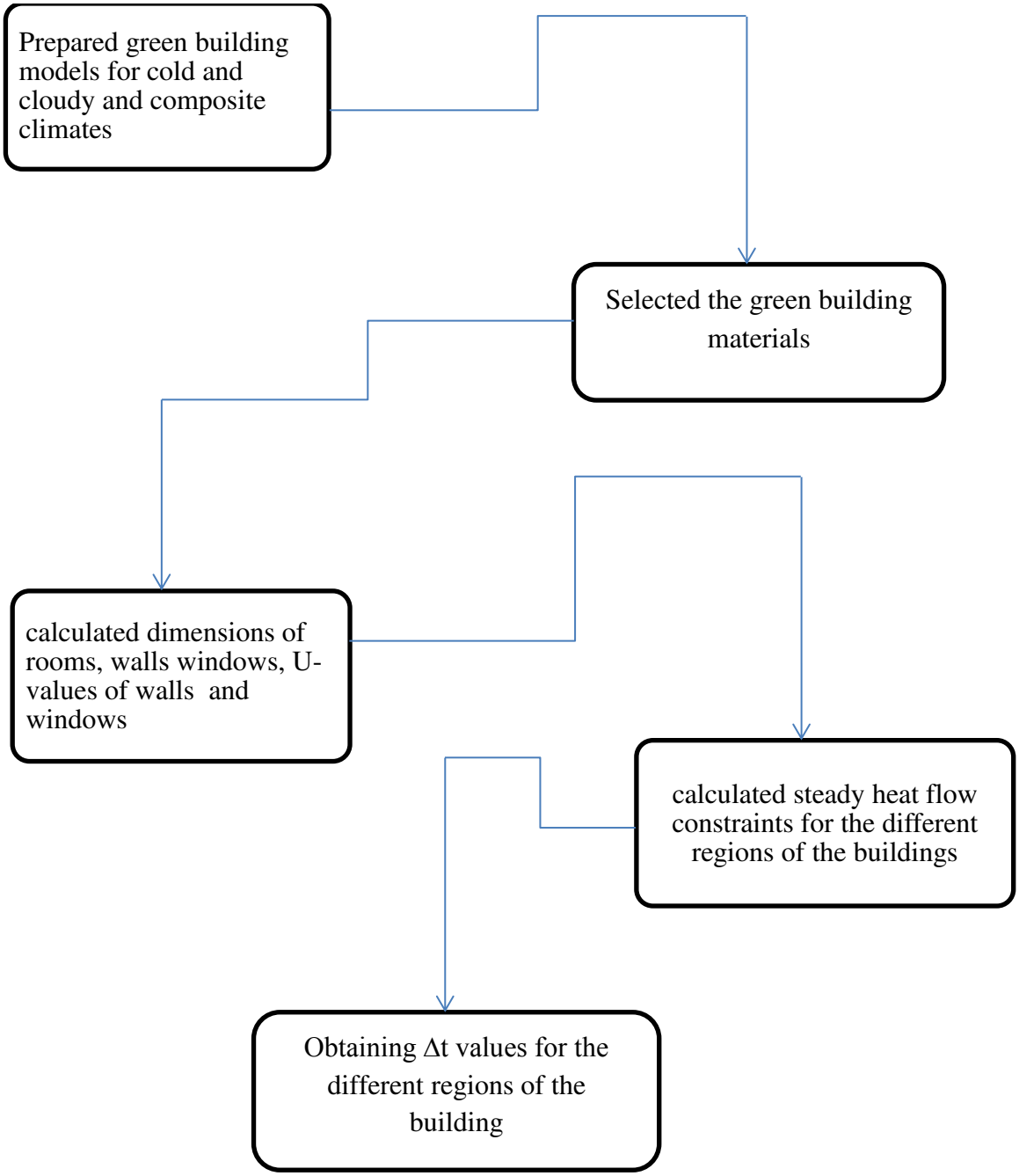


Fig. 3.1 Work plan flow chart for 3rd semester

3.2.4 Work plan flow chart for 4th semester :

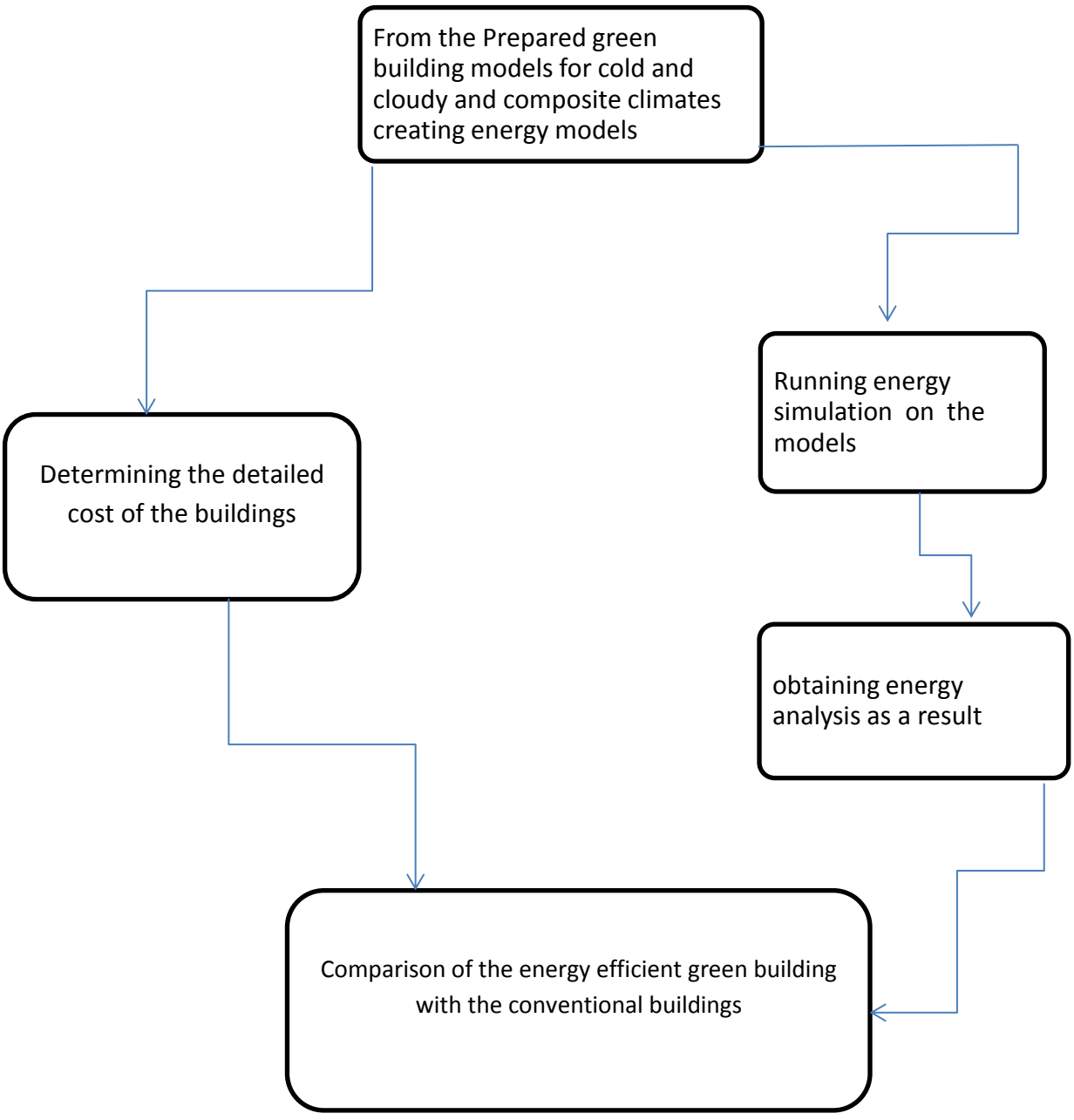


Fig 3.2 Work plan flow chart for 4th semester

3.3 Project methodology:

3.3.1 project methodology flow chart:

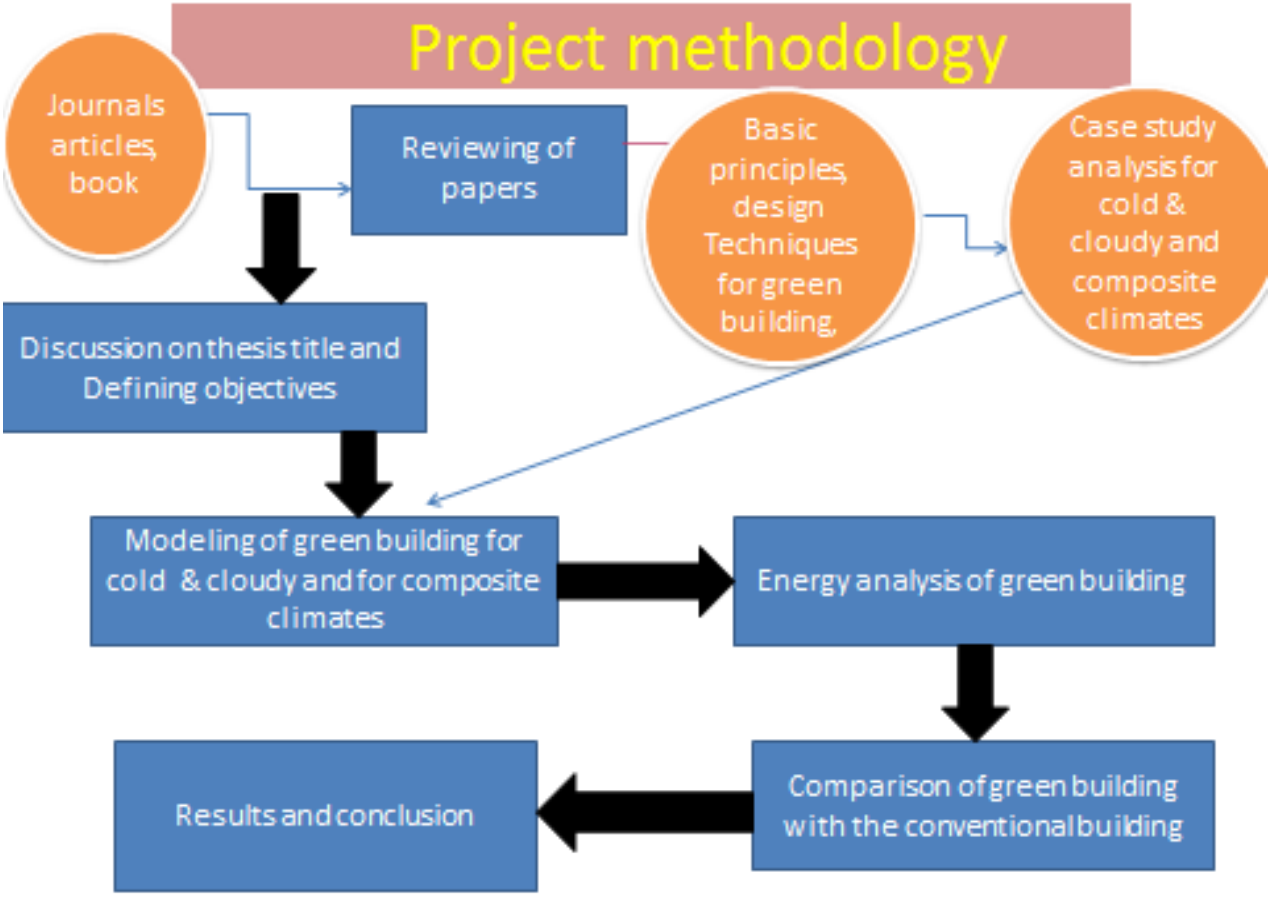


Fig 3.3 Project methodology flow chart

3.3.1 Design techniques

Incorporation of the solar passive techniques in this Project's building design is to minimize the heating, ventilating, cooling and lighting loads on the buildings. Passive system provides

thermal and visual comfort by natural energy sources and sinks by incorporating the solar radiations, outside air, sky, wet surfaces, vegetation and internal gain.

Design techniques for green building

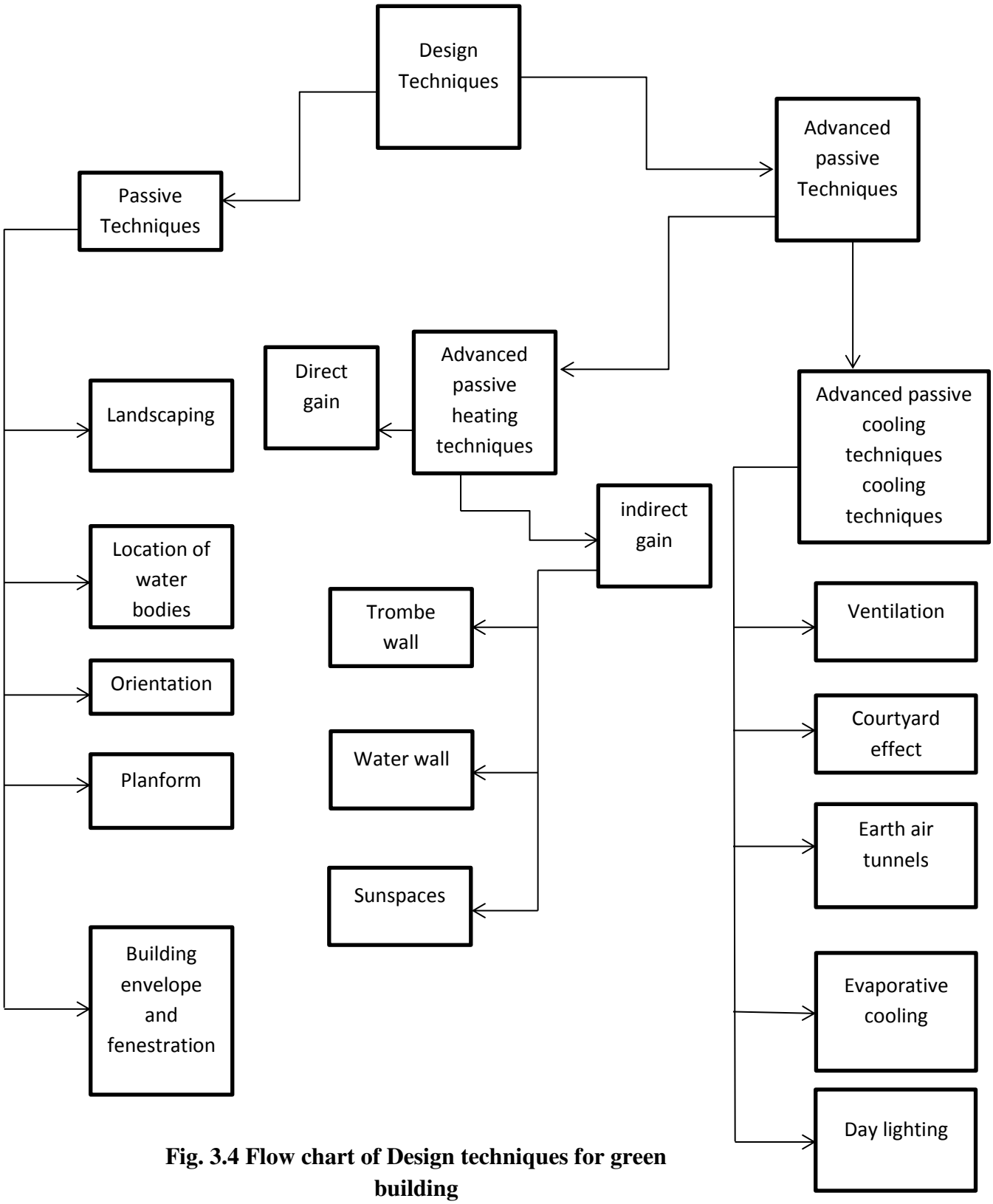


Fig. 3.4 Flow chart of Design techniques for green building

3.3.2 Material selection :

Material opted for the construction of building modals were thoroughly identified on the basis of their thermal properties i.e. conductance, transmittance , resistance etc. which have been included in the selection procedure before building the modals. Materials with low embodied energy and the materials providing better thermal insulation were chosen for the floors, walls, ceiling and roofing .

3.3.3 Autodesk Revit 2016:

Revit 2016 is used to design the sustainable green building modals in order to retrieve the architectural and structural drawings of the project so that a realistic view of the project can be obtained**. Green Building Studio** linked with this software helps in running simulation program.

3.3.4 Calculation:

Calculations are done on the MS-Excel 2010 to obtain the following parameters:

(a) Dimensions of rooms, walls, windows , ceiling, floor, roof
(b) k, Rc, b/k, $1/f_{o}$,1/fi , u- values
(c) Qm, Qc , Qi
(d) Δt

3.3.5 Modeling:

Modeling of the green building is done using the **Revit 2016 software**. This includes some structural and some architectural components such as foundations, slabs, columns, roofing , walls, floors, windows etc. Some special components i.e. skylights, light shelves, louvers, solar shading devices, composite walls, certain walls, trombe walls , PV solar cells, solar water heaters etc. are placed to make building more energy efficient .
Energy model is created after the whole building is created in Revit.
Simulation of the energy models are done on **Green Building Studio** of each set of buildings**.**

3.3.6 Detailed cost and abstract formation:

Detailed cost for the whole buildings is worked out and abstract formation is done using **DSR 2016 rates.** Estimator is used for the detailed construction cost estimation.

3.3.7 Comparison:

After working out on the modeling and construction costing of the project, comparison is done between the green and conventional buildings. Comparison of both the buildings are done under header named Results and discussions.

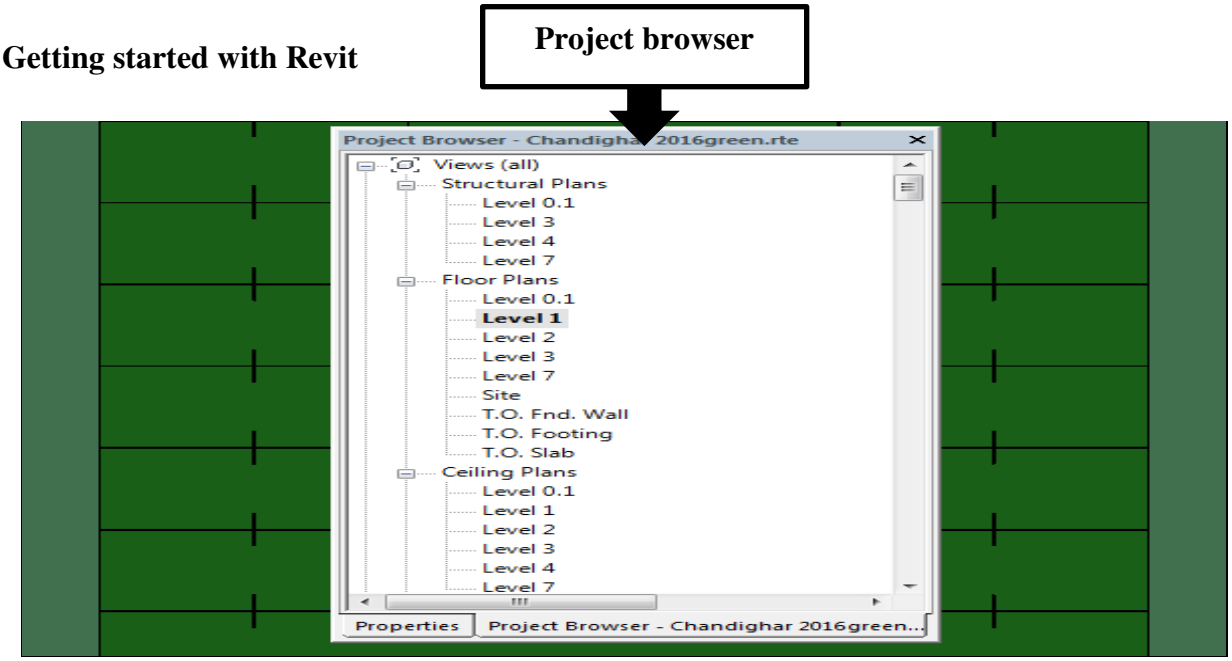
CHAPTER-4

GREEN BUILDING MODELING

4.1 Introduction

The green building model that shall be concluded from the findings below will give us an idea about the sustainable designing approach to build it in different climatic locations. The sustainability of the building comes from the fact that it can satisfy self-sufficient heating and cooling needs and electric supply for its daily use .The solar power panels and photovoltaic panels that are put to use have a capacity to supply 1.5 kWh of electric supply and also a solar water heater with a 200 liter/day capacity is also installed to provide continuous hot water supply for the winters. Also the rain water harvest system shall introduce in the composite climates that has high efficiency thus providing ample storage chances and a substantial storage to overcome the shortcoming of the water .Following description is the design of both the climatic locations adopting green building techniques certified by LEED and ASHRAE. Thermal comfort of the buildings is expressed on the basis of maintaining indoor room temperature by incorporating the green design techniques.

Getting started with Revit



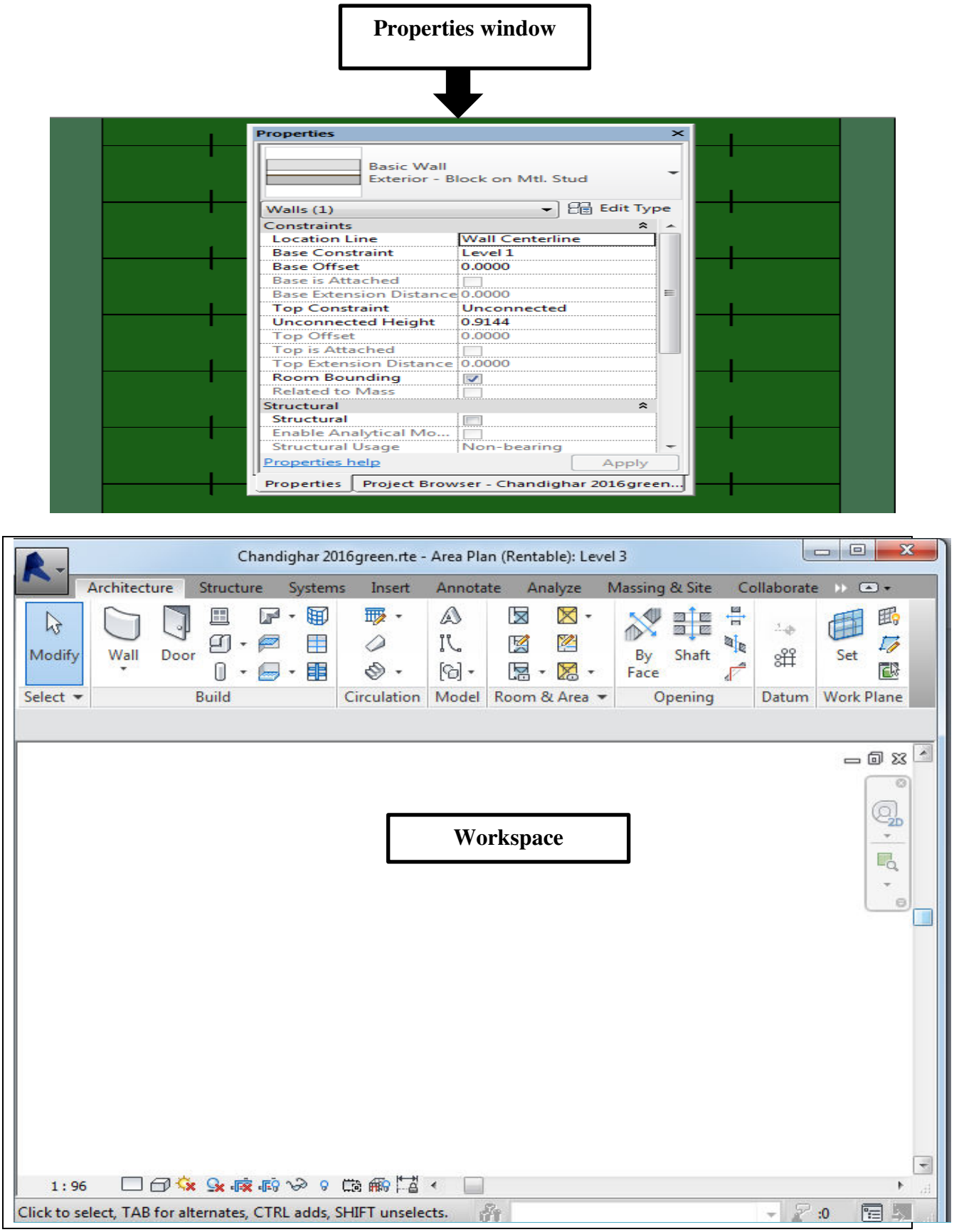


Fig. 4.1 Getting started with Revit

4.2 Design model for the cold and cloudy climate

Shimla(MSL 2206m, 31.1048° N, 77.1734° E) lying in the cold and cloudy climatic zone, has a fairly long winter from October to February end with a severe cold spell of about two months and minimum DBT about -3˚C with short wet periods in winter. While summer(May and June) is pleasant with a maximum DBT OF 28-30˚C. Monsoon period(July and August) has a high level of precipitation with high humidity about 85%. So the climatic design requires buildings to be heated almost throughout the year. **[Majumdar. M.(2001)]**

4.2.1 Design strategies

Design of the building is done in the way to maximize the solar exposure through orienting it to the true south. True south gives the maximum solar exposure for the whole day. Main entry is from the south side of the house. Minimum openings are placed on the east and very few openings on west because the solar gain directly interact with the warm air temperature increasing the discomfort level in the inner spaces. Thermal mass and shading mechanism is placed in the form of walls, roofs, floors to counteract the overheating and day lighting to this side. As the north side of the building hardly contribute in solar gain for the longer session throughout the day, though it has capacity to absorb the maximum intensified solar radiation in the early mornings but due to prevailing northerly winds , insulation on the walls were provided on this side with minute detailing. Major openings are placed in the south and south-west orientation of the house with the longer walls facing south and north.

Roofs and walls are constructed with the high thermal mass in the east and west direction , as the function of the thermal mass is to (1) limit the amount of solar gain in the hot summers and (2) re-emit the sensible heat stored during the night in the winters.

Material choice becomes prominent as it should be minimum in cost, eco-friendly, energy efficient or industrialized to have minimum wastage of the it. (1) Better thermally and mechanically improved material (2) white, shiny, glossy texture of material used for the summer region (3) darker shade material in the winter. For the cold regions color of external finishing and surface treatment is opted as it absorbs the maximum possible heat. ISO specified material is taken as the higher altitude faces the higher intensity of solar radiations which in turn decays the material.

Properly arranged setup reduces the overall cost for the shading devices with ultimate ease to the end users.

4.2.2 Building plans and elevation

Below is given the some views of the house

1st Floor plan

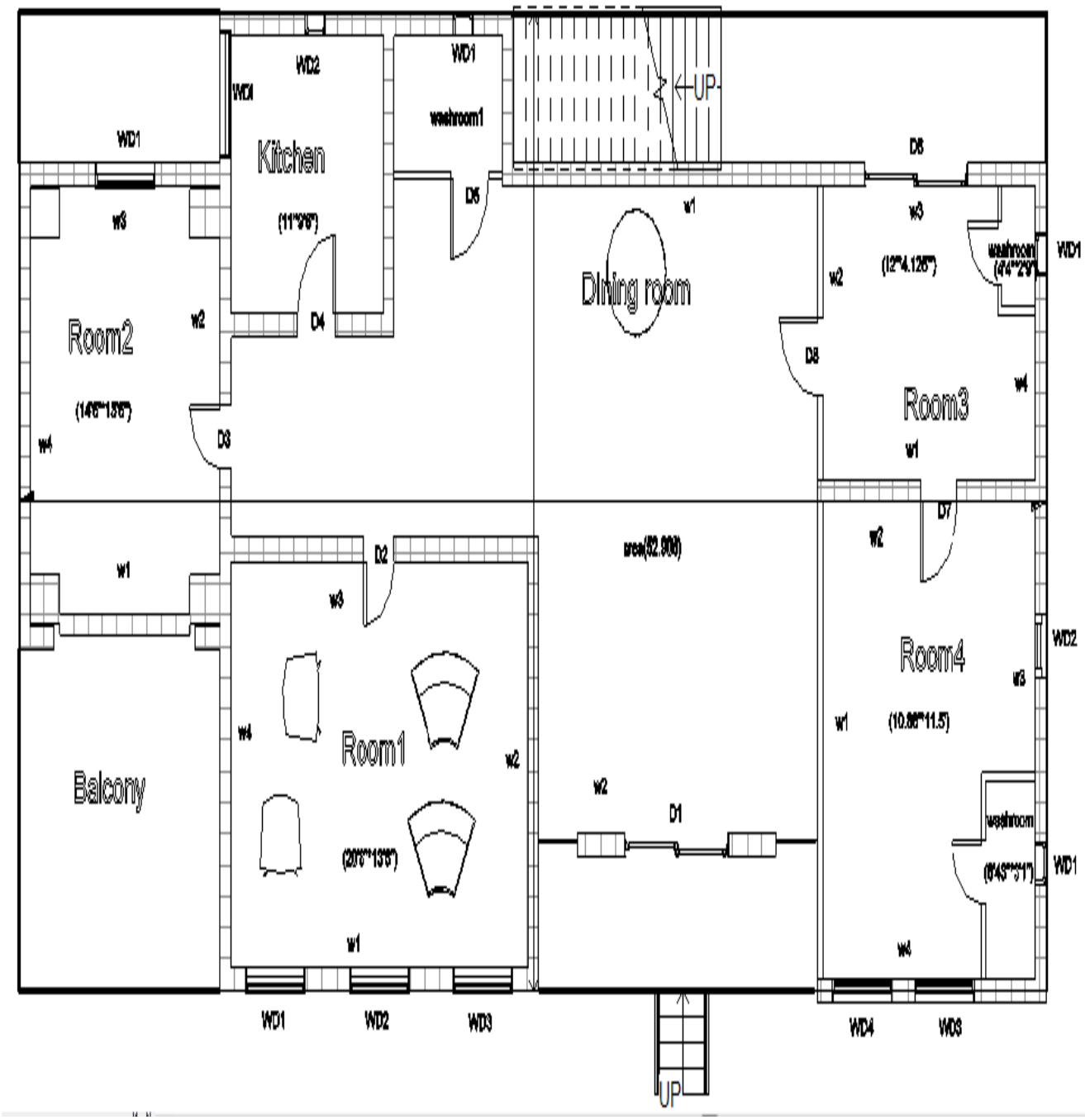


Fig. 4.2 Plan view 1st floor

2nd Floor Plan

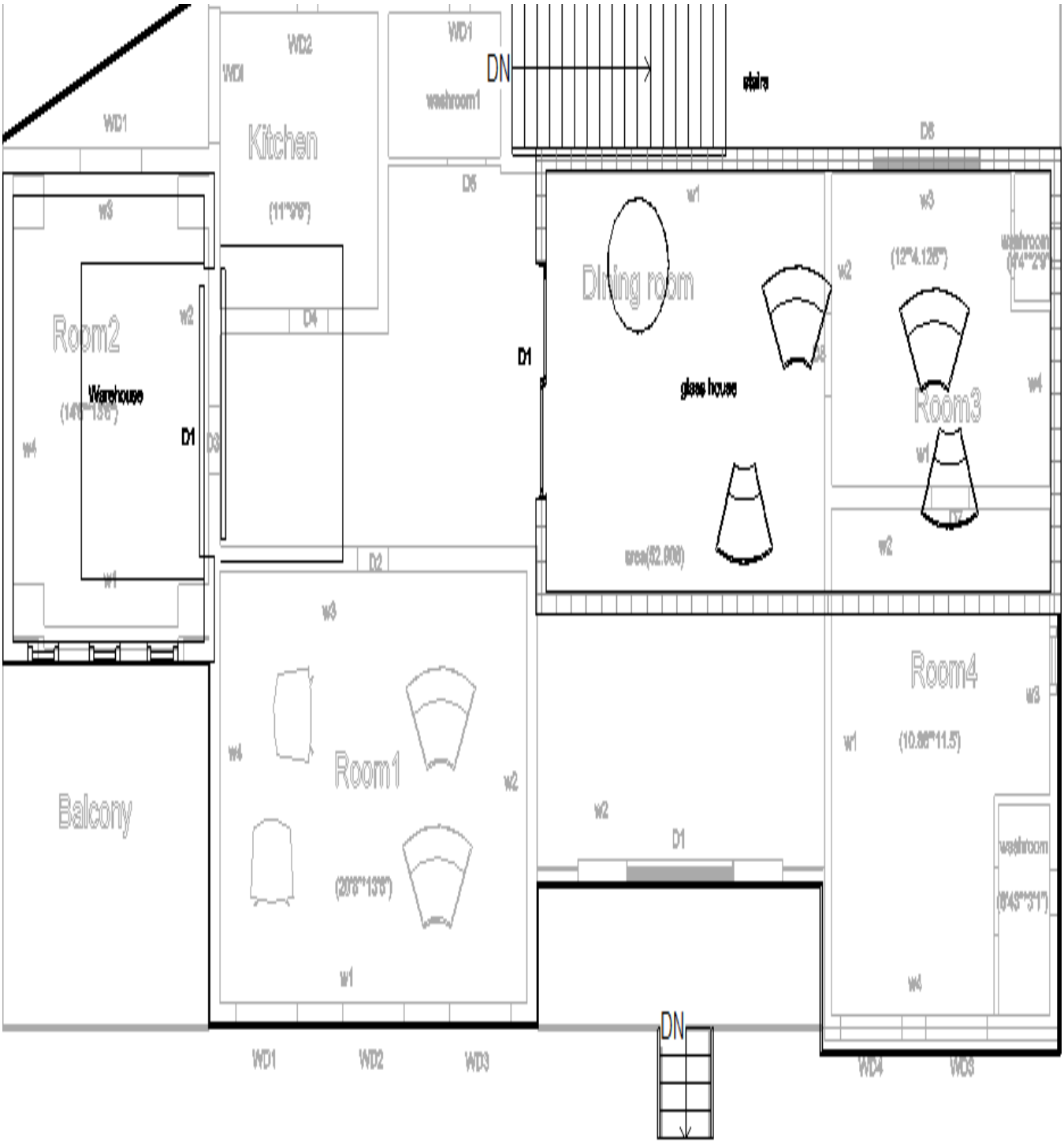


Fig. 4.3 Plan view 2st floor

East view of the building

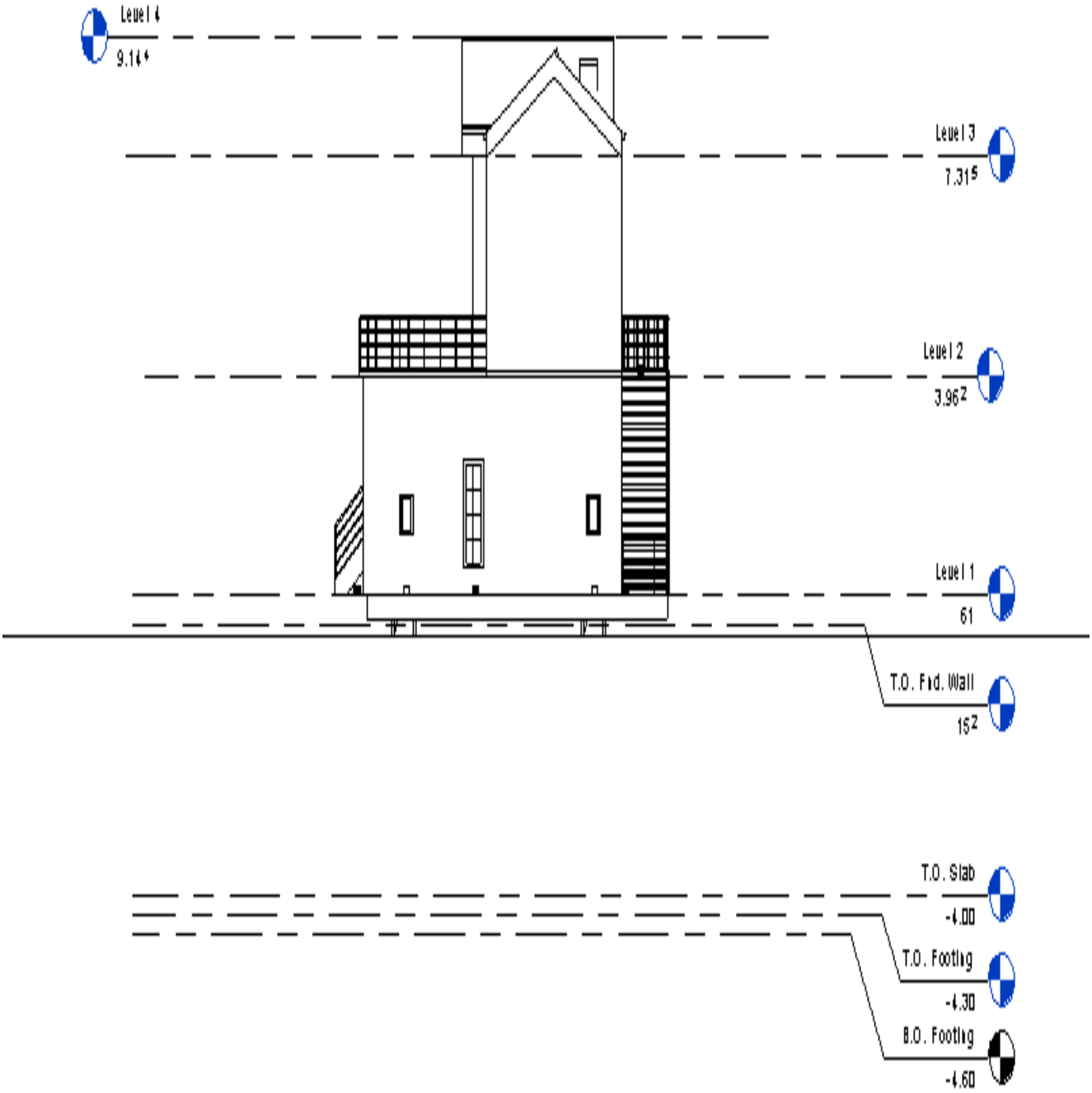


Fig. 4.4 East view

North view of the building

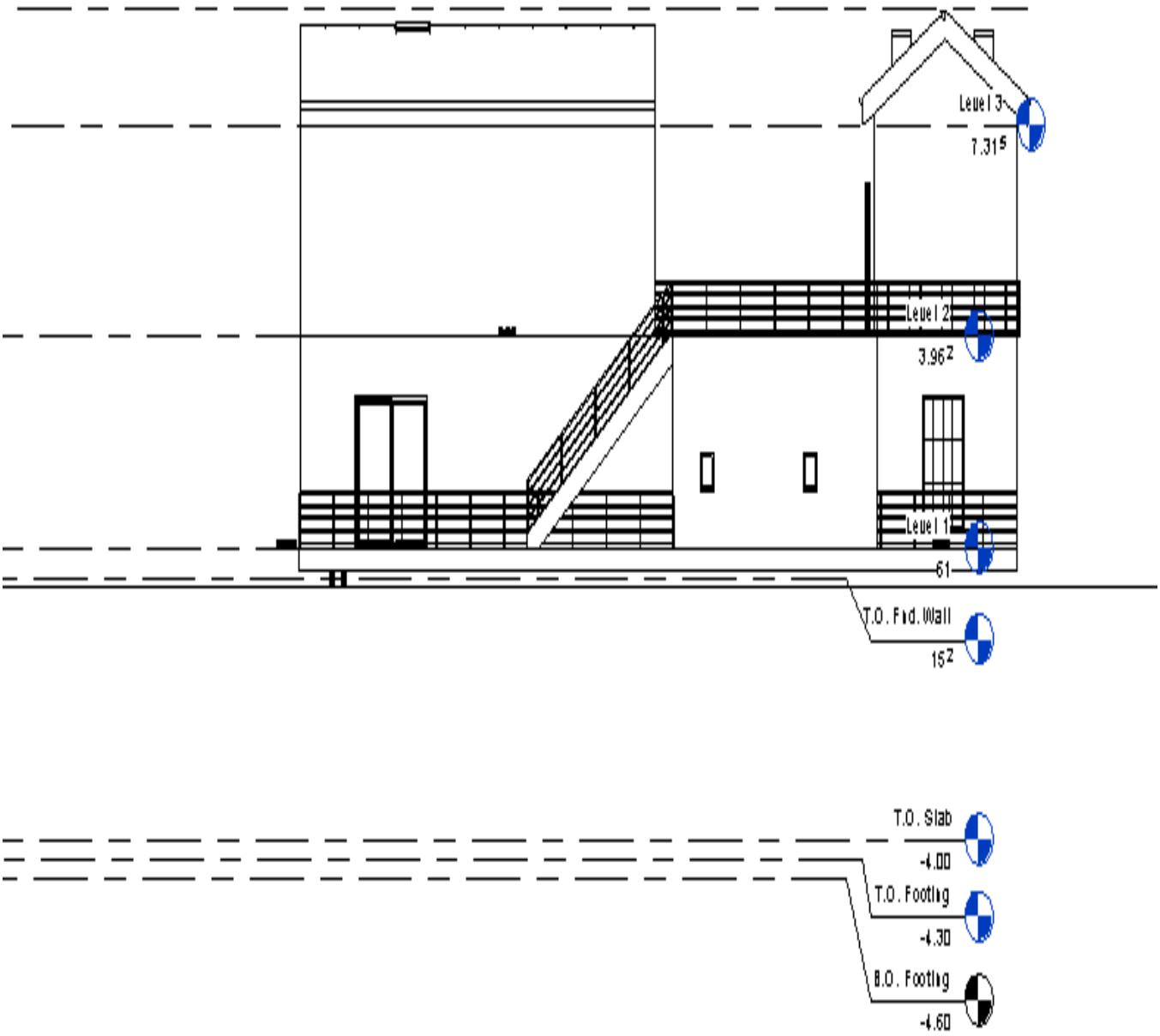


Fig. 4.5 North view

South view of the building

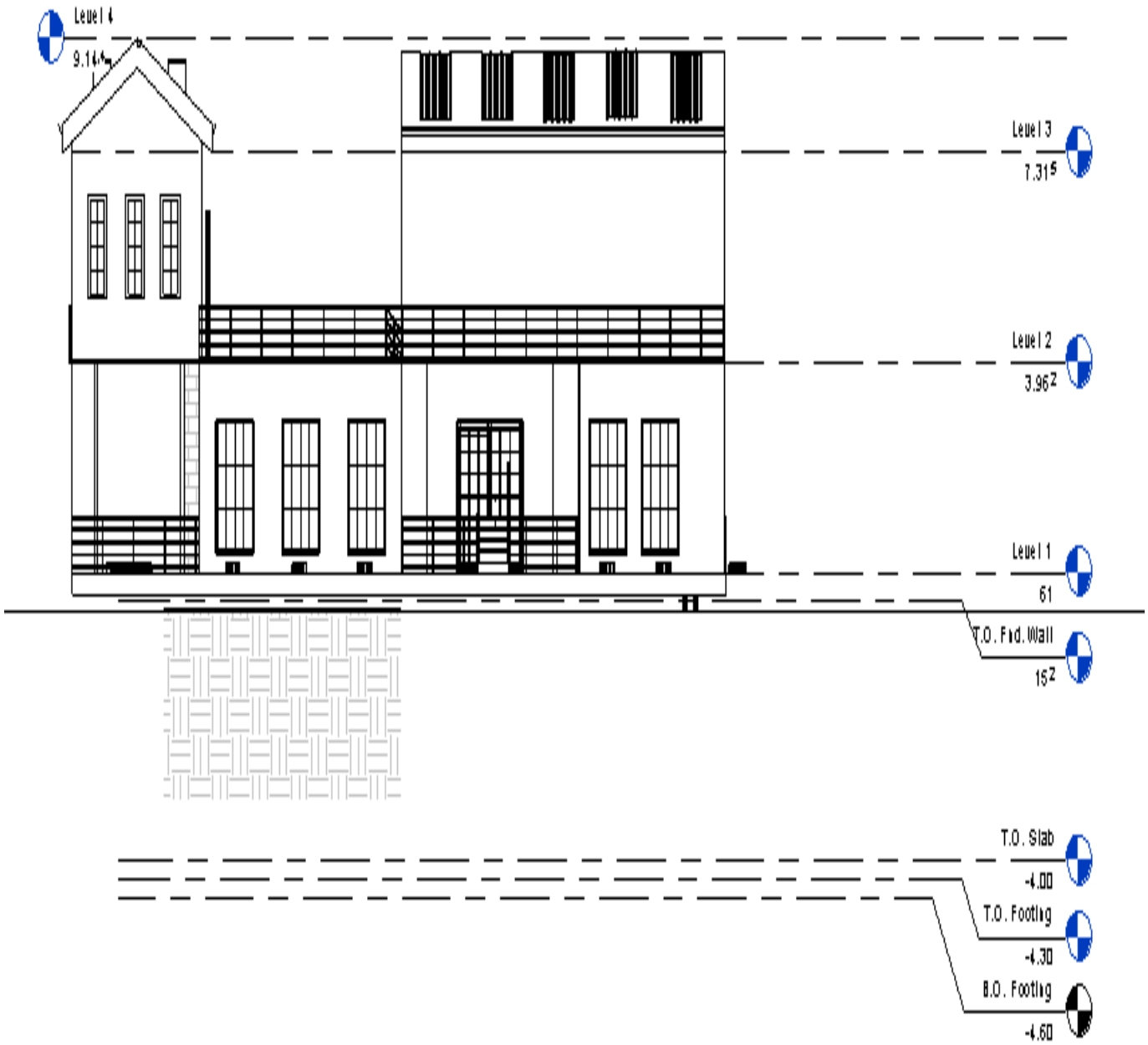


Fig. 4.6 South view

West view of the building

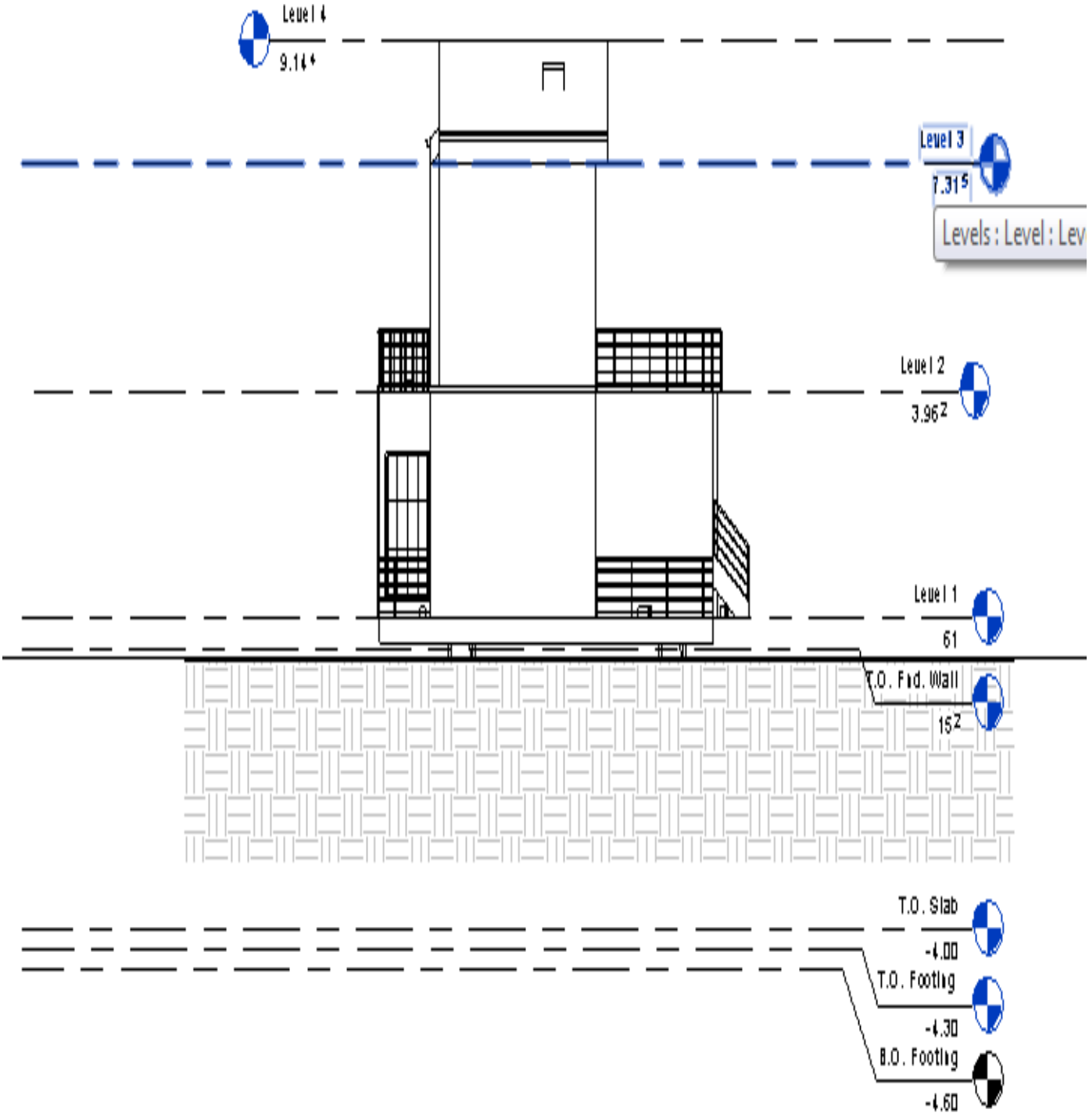


Fig. 4.7 West view

3-D Views of the house

Front side view

Fig. 4.8 Front side view

Back side view

Fig. 4.9 Back side view

Fig. 4.10 Consistent color views

Consistent color views

S-W side views showing the maximum glazing placed to this side for the direct gain to facilitate the internal heating of the rooms. As the sun's position in winter is low(altitude angle with the reference plane is less as compared to the summer), which adds the longer duration of heat gain for the colder region in the winter season. Trombe wall is built for the heating purpose. On the above story glass house is made for the internal gain to the lower story indirectly.

Realistic views

Front side (S) and back side(N) views of the house showing the skylights , solar PV panels on the rooftop and minimum fenestration to the N side respectively . Day lighting demand gets fulfilled by the tubular guiding devices such as skylights and light shelves. On the other hand electricity demand is compensated by the installation of the PV panels to the S in the summer as well as winter. Kitchen is oriented due N as the intensity of solar radiations are high in the morning rays and it kills all the microorganism such as germs, molds and harmful bacteria. Minimum openings are placed to the N side to prevent the living rooms from the northerly winds .

Fig. 4.11 Realistic views

Inner views

Glass house made with the tinted blue (double glazed) glass showing the S, W, E orientation which absorbs the maximum amount of heat during the day and redirect the heat to the thermal mass walls, floors during the night.

Fig. 4.12 Inner views

4.2.3 Thermally analyzed data

From the above modeling , heat loss from inside of the house is find out so that the thermal comfort within the house is find out on the basis of maintaining the indoor temperature more than the ambient air temperature outside of the house.

Table 4.1 Calculation of Qc,Qv,Qi

	Qc	Qv=(1300*V*ΔT)				Qi=(n_1*W_1)+(n_2*W_2)			
	Qc	1300	V=(N*room volume)/3600	Qv	No. of persons (n_1)	Heat produced (W_1)	No. of electrical source(n_2)	Heat produced (W_2)	Qi
R1	37.541	1300	0.0725	94.288	4	180	5	100	1220
R2	15.280	1300	0.0508	66.054	2	130	2	100	460
R3	11.877	1300	0.0384	50.032			2	80	160
R4	22.526	1300	0.0605	78.682	3	130	2	120	630
R5	23.577	1300	0.1478	192.14	3	150	7	120	1290
K1	21.347	1300	0.0271	35.262	2	160	2	120	560
WR1	4.1266	1300	0.0096	12.597	2	150	1	80	380
WR2	0.8508	1300	0.0031	4.1070	1	150	1	80	230
WR2	1.6077	1300	0.0063	8.3180	1	150	1	80	230

Assumption: all the calculations are worked out for the steady state heat flow.

Heat flow equation: (Qi-Qc-Qv-Qm-Qe+Qs) = 0, Qs and Qm are neglected because there is no mechanical installation in the building. If the sum of the equation (Qi-Qc-Qv-Qm-Qe+Qs) > 0 , then the building is heating itself and if the sum of the equation is (Qi-Qc-Qv-Qm-Qe+Qs) < 0 , then the building is cooling itself. Executing this the U-value of the walls and windows are calculated and all the dimensions of walls, rooms, windows are calculated [Refer Annexure-A]

(a) $Qc=(A*U*\Delta T)$

(b) $Qv=(1300*V*\Delta T)$

(c) $Qi=(n_1+W_1)+(n_2+W_2)$

Refer Annexure – A(1,2,3.4,5) for the calculations

4.2.4 Energy analysis

After modeling the building, next phase is to obtain the energy model for the respective climate and to run the energy simulation on the model. Analytical spaces and surfaces are defined for the simulation. Once the energy analysis is done on the models , comparison is done with the conventional building depending on the different factors which are building performance factors, life cycle energy use, monthly cooling and heating load, monthly electricity consumption, temperature fluctuations etc. below is the energy model showing the analytical surfaces.

4.2.4.1 Energy analysis model

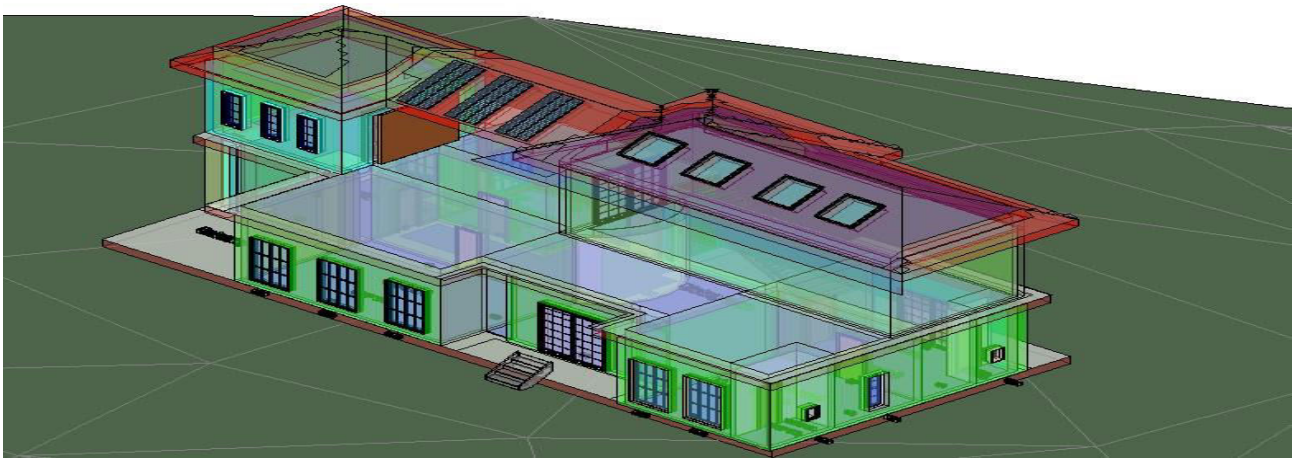


Fig. 4.13 Energy model for the cold and cloudy climate

4.2.5 Abstract of construction cost for the conventional building Shimla

Table 4.2 Details of measurement for the conventional building Shilma

S.No.	Description	Quantity	Unit	Rate	Amount
	GROUND FLOOR				
	EARTH WORKS				
1	**EARTH WORKS EXACAVATION:** Earth work excavation for foundation trenches in all classes of soil and depositing on bank with initial lead upto 50 mt. and lift upto 1.5m including and sectioning of spoil bank etc. complete.	113.93	Cu.M	220.00	25064.60
2.	**EARTH WORKS FILLING FOUNDATION:** Filling the foundation trenches with the cut earth available at site in layers not exceeding 20 cms in depth consolidating each deposited layers by ramming and watering . Measurements will be taken only the filled and compacted earth.	34.18	Cu.M	110.00	3759.80
3.	**EARTH WORKS FILLING PLINTH USING EARTH FROM SITE:** Filling the plinth and side of the foundation with the cut earth available at site in layers not exceeding 20 cms in depth consolidating each deposited layers by ramming and watering. Measurement will be taken only the filled and compacted earth.	142.89	Cu.M	110.00	15717
					44542.30
	PCC				
4.	**PCC FLOORING 1:2:4 CuM:** Providing and laying P.C.C 1:2:4 using 40 mm nominal size broken stone well consolidated 100 mm thick including	14.95	Cu.M	5,157.00	77097.15
5.	**BRICK WORKS CM 1:4**: First class brick work masonary in C.M.1:4 (1 cement 4 course sand) with approved good quality country burnt bricks of compressive strength 35	91.50	Cu.M	4,970.00	454755.00

	kg/m^2 of standard size of on super structure of all thickness. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work.				
6	**BRICK WORKS CM 1:6**: First class brick work masonary in C.M.1:6 (1 cement 6 course sand) with approved good quality country burnt bricks of compressive strength 35 kg/m^2 of standard size of on super structure of all thickness. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work.	86.76	Cu.M	5,582.00	484294.32
					939049.32
	FLOOR AND WALL FINISHES				
7	**FLOOR FINISHING MARBLE TILES:** Supplying and fixing 20 mm thick marble slabs size 80cm X 150cm fixed into the floors.	149.45	Sq.M	3,035.00	453580.75
					453580.75
	DOORS AND WINDOWS				
8	**FRAMES WOOD:** Supplying and fixing of doors and windows frames using good quality wood including M.S.clamps and fittings, fixing complete including a coat of tar at the contact surface of the frame.	0.70	Cu.M	85386.00	59770.20
9	**SHUTTERS WOOD PANELLED:** Supplying and fixing of shutters of good quality paneled wood	8.13	Sq.M	2,689.00	21861.98
10	**SHUTTERS WOOD GLAZED:** Supplying and fixing of fully glazed shutters of good quality wood	28.49	Sq.M	2,293.00	65327.57
					146959.75
	PAINTING				
11	**PAINTING WALLS PLASTIC EMULSION:** Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty	852.39	Sq.M	48.00	40914.72
16	**PAINTING WALLS INT. DISTEMPER:** Distempering two	1,066.72	Sq.M	48.00	51202.56

	coats to the wall including smoothening with sand paper				
					92117.28
	Total for Ground floor				1753346.55
	FIRST FLOOR				
	FLOOR AND WALL FINISHES				
1	**FLOOR FINISHING MARBLE TILES:** Supplying and fixing 20 mm thick marble slabs size 80cm X 150cm fixed into the floors	110.64	Sq.M	3035.00	335792.40
					335805.32
	DOORS AND WINDOWS				
2	**FRAMES WOOD:** Supplying and fixing of doors and windows frames using good quality wood including M.S. clamps and fittings, fixing complete including a coat of tar at the contact surface of the frame.	0.04	Cu.M	85386.00	3415.44
4	**SHUTTERS WOOD PANELLED:** Supplying and fixing of shutters of good quality paneled wood	0.00	Sq.M	1,963.92	0.00
5	**SHUTTERS WOOD GLAZED:** Supplying and fixing of fully glazed shutters of good quality wood	0.47	Sq.M	1,387.92	652.32
					34215.96
	PAINTING				
6	**PAINTING WALLS PLASTIC EMULSION:** Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty	72.55	Sq.M	52.44	3804.52
					3804.52
	Total for first floor				343677.61
	Total				2097024.15
Net amount					2097024.15

4.2.6 Abstract of construction cost for the green building Shimla

Table 4.3 Details of measurement for green building Shilma

S.No.	Description	Quantity	Unit	Rate	Amount
	GROUND FLOOR				
	EARTH WORKS				
1	**EARTH WORKS EXACAVATION:** Earth work excavation for foundation trenches in all classes of soil and depositing on bank with initial lead upto 50 mt. and lift upto 1.5m including and sectioning of spoil bank etc. complete.	84.21	Cu.M	220.00	18526.20
2	**EARTH WORKS FILLING PLINTH USING EARTH FROM SITE:** Filling the plinth and side of the foundation with the cut earth available at site in layers not exceeding 20 cms in depth consolidating each deposited layers by ramming and watering. Measurement will be taken only the filled and compacted earth.	185.11	Cu.M	110.00	20362.10
3	**ANTI-TERMITE TREATMENT:** Anti-termite treatment by providing and injecting chemical emulsion/aldrin/heptachlor emulsible concentrates 0.50% and clilossdance emusifiable concentrate for pre contractional treatment and creating a chemical barrier as per IS:6313(part 2) 1951 in wall trench foundation top surface of plinth filling junction of wall and floor along the external perimeter of the building complete.(area of buiding shall be measured).	195.40	Sq. M	200.00	39080.00
					77968.30
	PCC				
4	**PCC FOUNDATION 1:4:8:** Providing and laying PCC 1:4:8 using 40 mm nominal size broken stone well consolidated including curing etc. complete for foundation	36.03	Cu.M	4478.00	161342.34
5	**DAMP PROOF COURSE 1:2:4:** Providing 4 cm thick PCC as a damp proof course with broken stone chips and approved water proofing compound beneath the wall as per IS: 2645-1964	26.82	Sq. M	314.85	844.28
6	**PCC FLOORING 1:2:4 Cu.M:** Providing and laying PCC 1:2:4 using 40 mm nominal	19.55	Cu.M	5175.00	101171.25

	size broken stone well consolidated 100 including				
					270957.87
	BRICK WORKS				
7	**BRICK WORKS CM 1:6**: First class brick work masonary in C.M.1:6 (1 cement 6 course sand) with approved good quality country burnt bricks of compressive strength 35 kg/m^2 of standard size of on super structure of all thickness. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work.	71.47	Cu.M	5582.00	398945.54
					398945.54
	FLOOR AND WALL FINISHES				
8	**FLOOR FINISHING MARBLE TILES:** Supplying and fixing 20 mm thick marble slabs size 80cm X 150cm fixed into the floors.	195.40	Sq. M	3035.00	593039.00
9	**SKIRTING AND GRANITE TILES IN M:** supplying and fixing pre polished black granite slab 20mm thick over 1:3,12mm thick using necessary cement grout including closing the joints with pigment of the color to match including washing, cleaning, polishing the edges etc complete for skirting.	150.47	m	456.00	68614.32
10	**SKIRTING MARBLE TILES IN Sq. M:** Skirting using marble tiles	16.83	Sq M	600.00	10098.00
					671751.32
	DOORS AND WINDOWS				
11	**FRAMES WOOD:** Supplying and fixing of doors and windows frames using good quality wood including M.S.clamps and fittings, fixing complete including a coat of tar at the contact surface of the frame.	0.71	Cu.M	85386.00	60624.06
12	**SHUTTERS WOOD PANELLED:** Supplying and fixing of shutters of good quality paneled wood	19.68	Sq. M	2689.00	52919.52
13	**SHUTTERS WOOD GLAZED:** Supplying and fixing of fully glazed shutters of good quality wood	30.94	Sq. M	2293.00	70945.42
					184489.00
	PLASTERING AND POINTING				
14	**PLASTERING WALLS CM 1:2 12MM:** Plastering with cement mortar to walls,				

	columns and other structural architectural features at all heights, floated hard and trowelled get smooth finish. the rate shall include provision of grooves scaffolding at any height curing etc. complete as directed by the engineer.	735.41	Sq. M	201.95	148516.05
					148516.05
	PAINTING				
15	**PAINTING WALLS PLASTIC EMULSION:** Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty	735.41	Sq. M	48.00	35299.68
16	**PAINTING WALLS INT. DISTEMPER:** Distempering two coats to the wall including smoothening with sand paper	735.98	Sq. M	49.65	36541.41
					71841.09
	Total for Ground floor				1824469.16
	FIRST FLOOR				
	BRICK WORKS				
1	**BRICK WORKS CM 1:6:** First class brick work masonry in C.M. 1:6 (1 cement 6 course sand with approved good quality country burnt bricks of compressive strength 35 kg/m^2 of standard size of on super structure of all thickness. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work	0.99	Cu.M	5582.00	5526.18
					5526.18
	FLOOR AND WALL FINISHES				
2	**FLOOR FINISHING MARBLE TILES:** Supplying and fixing 20 mm thick marble slabs size 80cm X 150cm fixed into the floors	110.64	Sq. M	3035.00	335792.40
					335792.40
	DOORS AND WINDOWS				
3	**FRAMES WOOD:** Supplying and fixing of doors and windows frames using good quality wood including M.S. clamps and fittings, fixing complete including a coat of tar at the contact surface of the frame.	0.15	Cu.M	85386.00	12807.90
4	**SHUTTERS WOOD PANELLED:** Supplying and fixing of shutters of good quality paneled wood	1.31	Sq. M	2689.05	3522.66

5	**SHUTTERS WOOD GLAZED:** Supplying and fixing of fully glazed shutters of good quality wood	7.80	Sq. M	2293.00	17885.40
					34215.96
	PAINTING				
6	**PAINTING WOOD POLISH:** Polishing wood including preparing and smoothening the surface	16.52	Sq. M	81.70	1349.68
7	**PAINTING WALLS PLASTIC EMULSION:** Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty	14.25	Sq. M	52.44	747.27
					2096.95
	Total for first floor				377631.49
	Total				2202100.65
	Unforeseen works				7899.0
	Net amount				2210000.00

Adding the solar PV 100Kw plant and the 200ltr. solar water heater which costs Rs.119518 and adding the composite wall panels is Rs. 268193.68 which increases the totasl cost to Rs. 2597711.68.

4.3 Design model for the composite climate

Chandighar (MSL 304-365m, 30.7333° N, 76.7794° E) lying in the composite climatic zone, experiences wide climatic swings over the year, i.e. very hot and dry period of almost two and half months when DBT reaches 44˚C and quite cold period of a shorter duration, minimum DBT 3˚C . The hot dry period is followed by a hot humid monsoon period of about two months reaching the maximum relative humidity 90%. So the climatic design requires buildings to be cooled most of the months in year.

4.3.1 Design strategies

Design of the house is done in a way to maximize the solar exposure through orienting it to the due south for the winters and minimizing sun's effect during the summer . True south gives the maximum solar exposure for the whole day. Entry for the house is from the north side to overshadow the heating effect. Maximum openings are placed on the north and east and very few openings on south –west side to utilize the cooling effect and preventing it from overheating in the summer. As the south-west side of the building does not contribute in heat loss so insulation on the walls are provided on this side with minute detailing.

Solid construction of the roofs and walls having good insulation properties with longer time lags for heat transmission ensures the lower temperature in the summer and maintaining higher temperature in the winter as compared to the outside ambient temperature.

Shiny and glossy textured finishing are placed to the sides which experience the hottest days of summer . For indoor thermal comfort in winters north and south walls are made from the highly heat absorptive materials.

Composite climate as mostly faces the ventilation problem and growing moisture in the rainy seasons when it is not exposed to the sun, so for the better air circulation cross ventilation scheme is adopted and the moisture and water absorptive layer is placed for maximum absorption of the moisture due to condensation. Landscaping and planting is done due south-west direction for the fresh/cooled air circulation and shading

Open spaces in the form of verandah and courtyard are leaved unoccupied with the high thermal mass constructed wall for the space heating and cooling .

4.3.2 Building plans

Below is given the some views and elevation of the house

1st floor plan

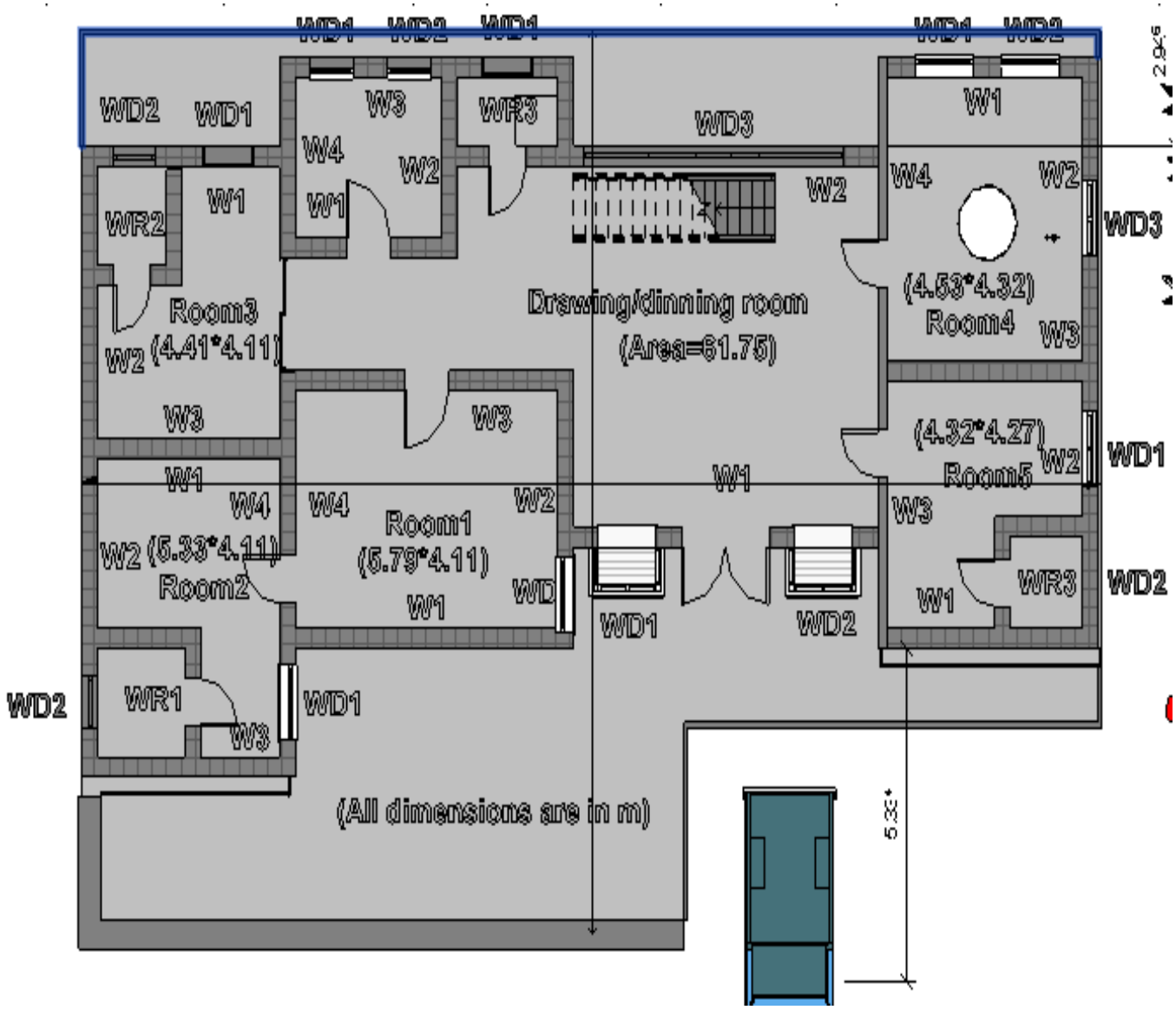


Fig. 4.14 1st floor plan

2nd floor plan

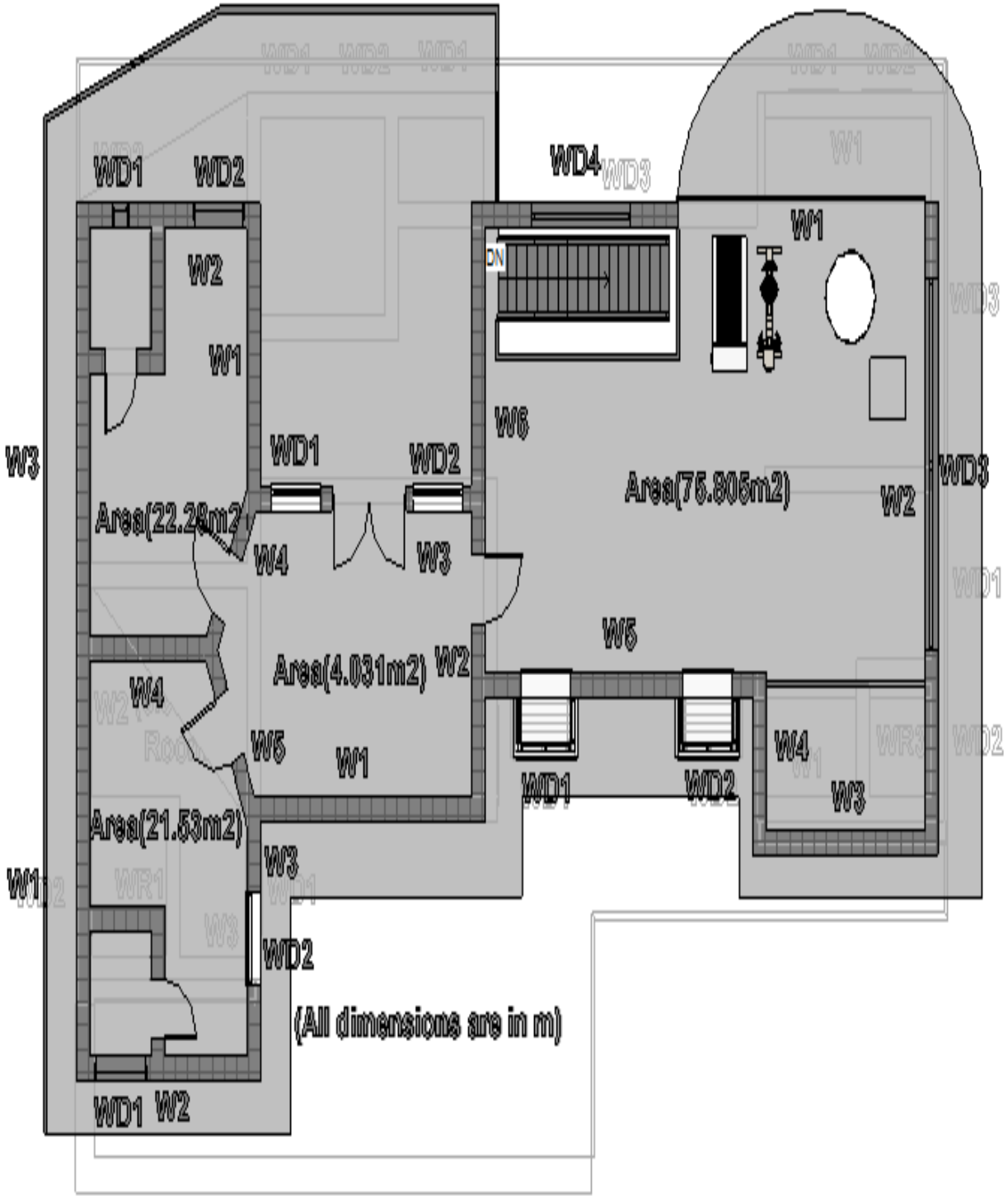


Fig. 4.15 Plan of 2nd floor

East view of the house

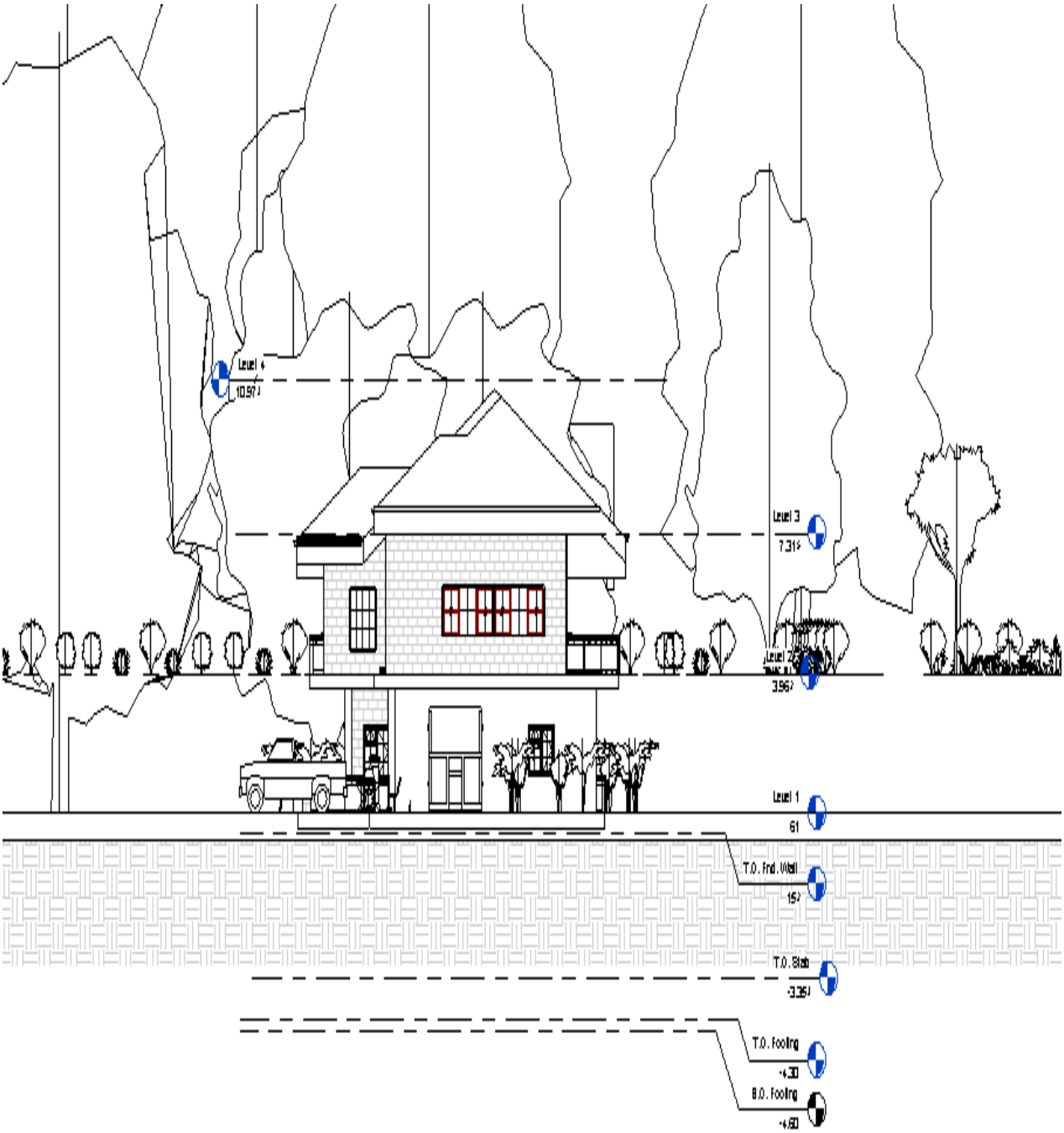


Fig. 4.16 East View

North view of the house

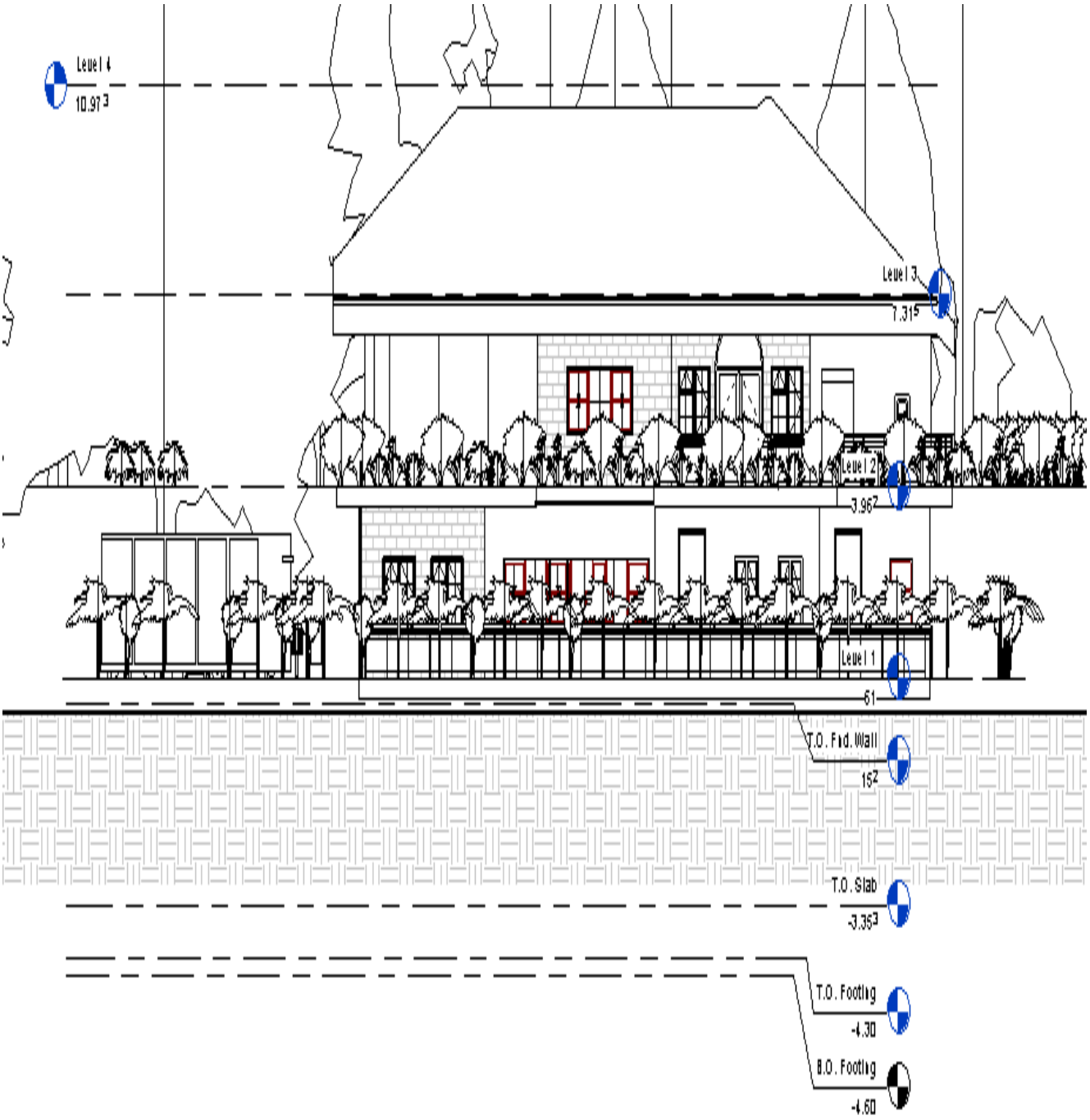


Fig. 4.17 North view

South view of the house

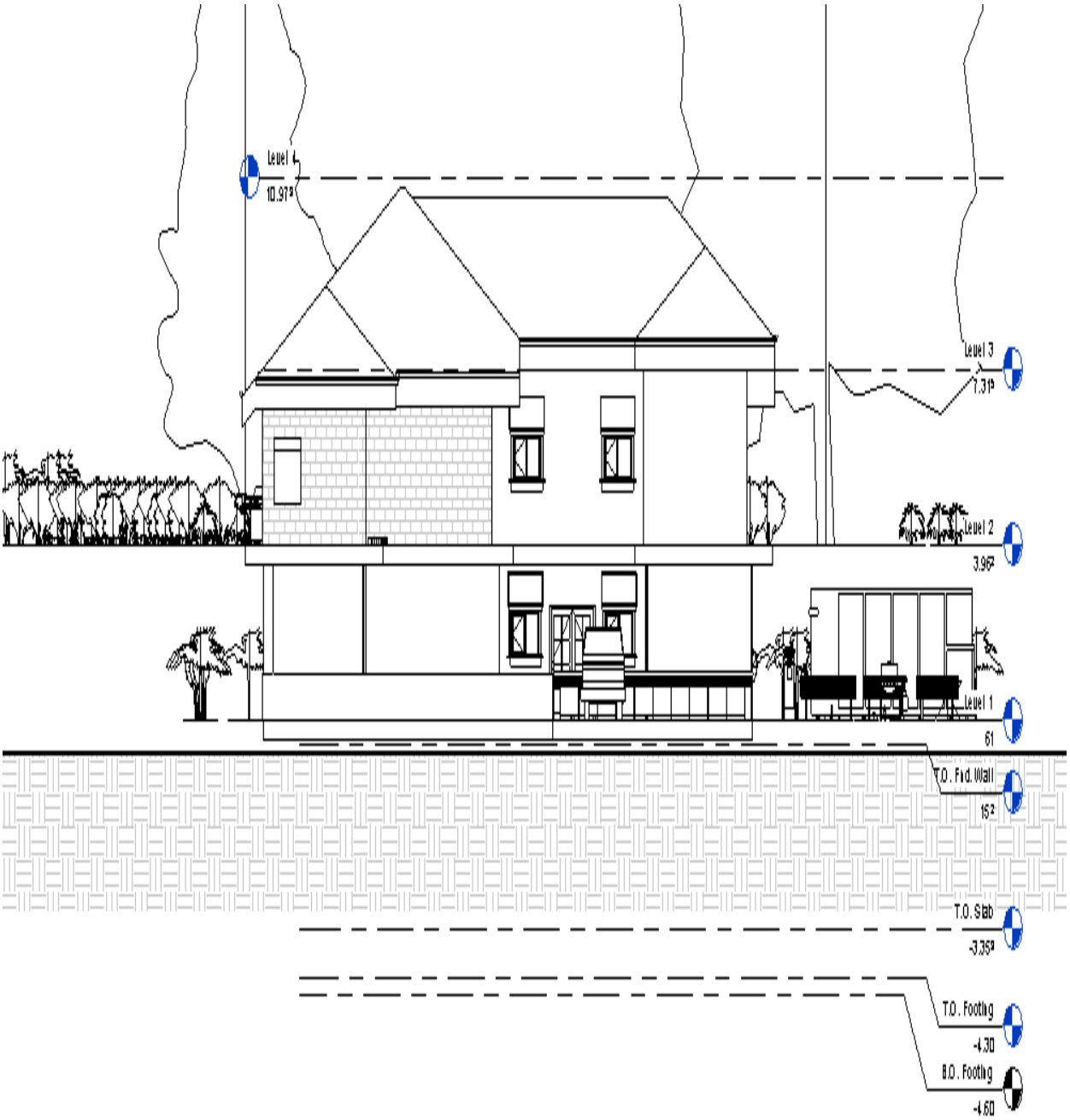


Fig. 4.18 North view

West view of the house

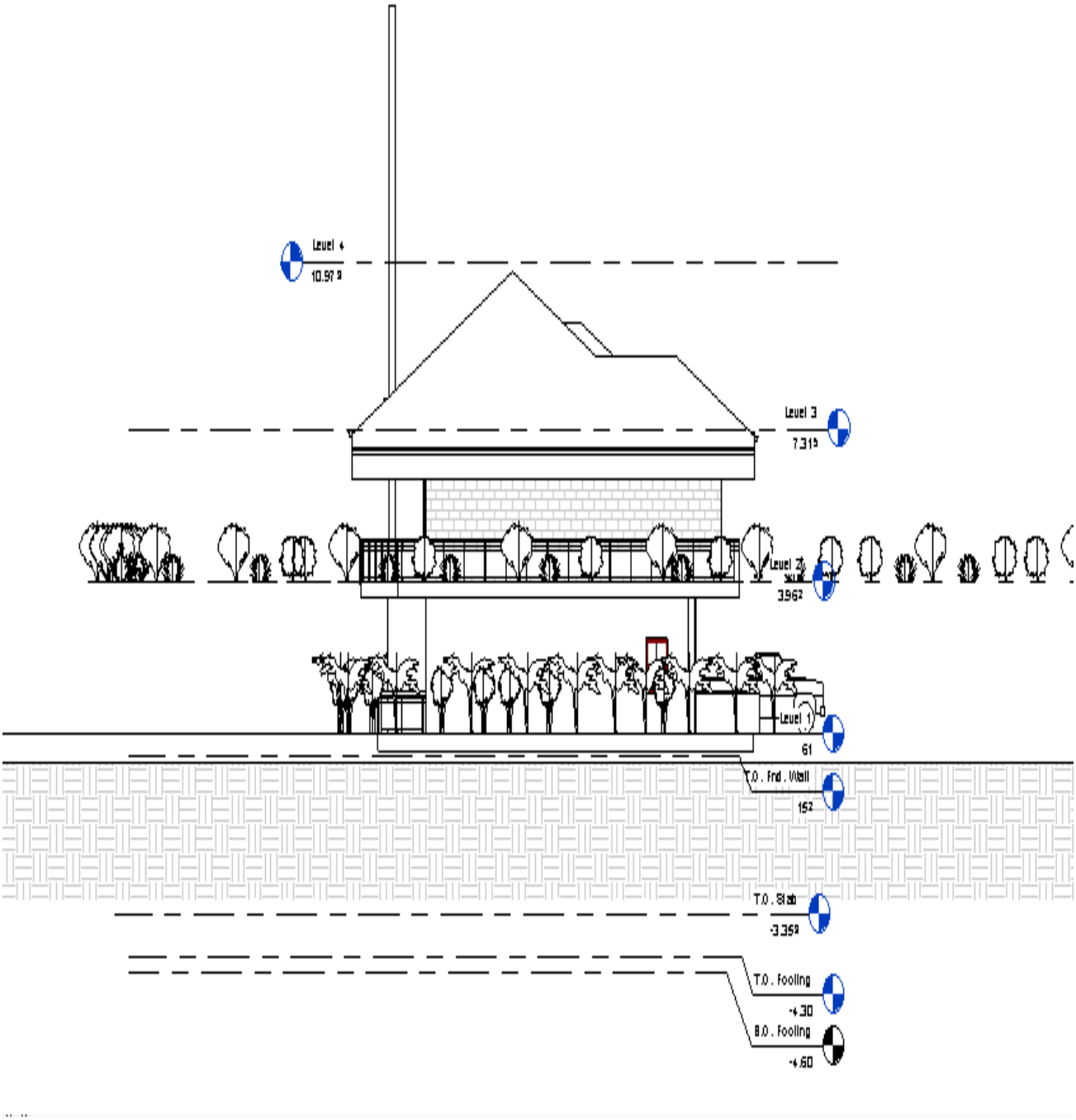


Fig. 4.19 West view

3-D views of the house

Fig. 4.20 3-D views

Ray trace views of the house

Fig. 4.21 Ray trace view

N-W side view of the house having plantation and extended floor and roof to prevent overheating in the summer . windows are double glazed with the air gap between them. composite walls provide better insulation and decrease in the total heating and cooling loads for the house.

2nd back side view

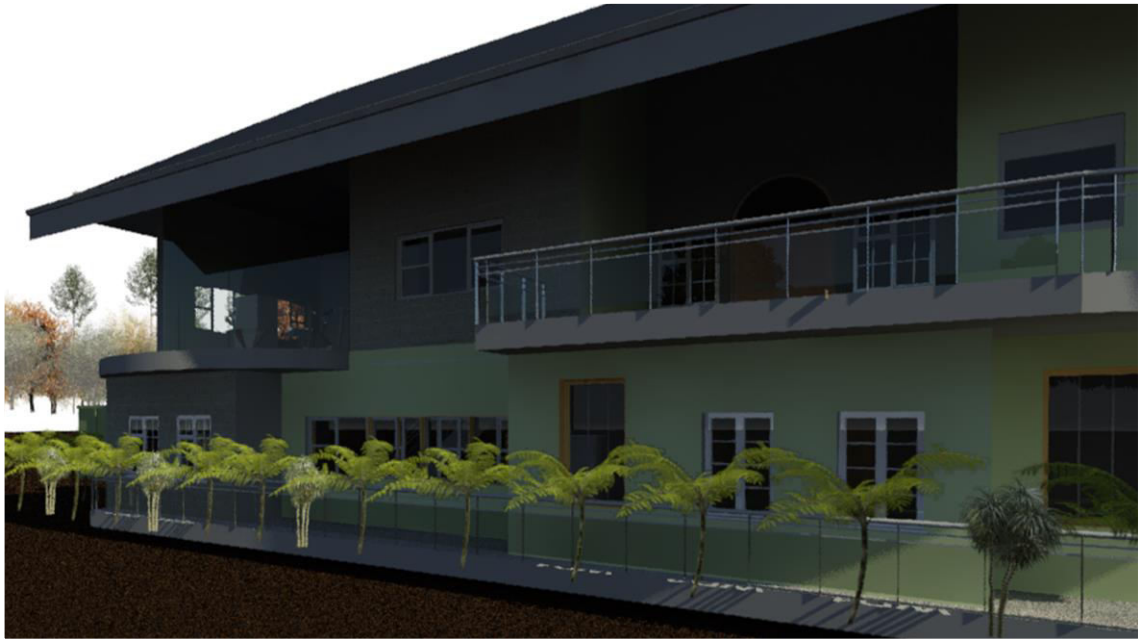
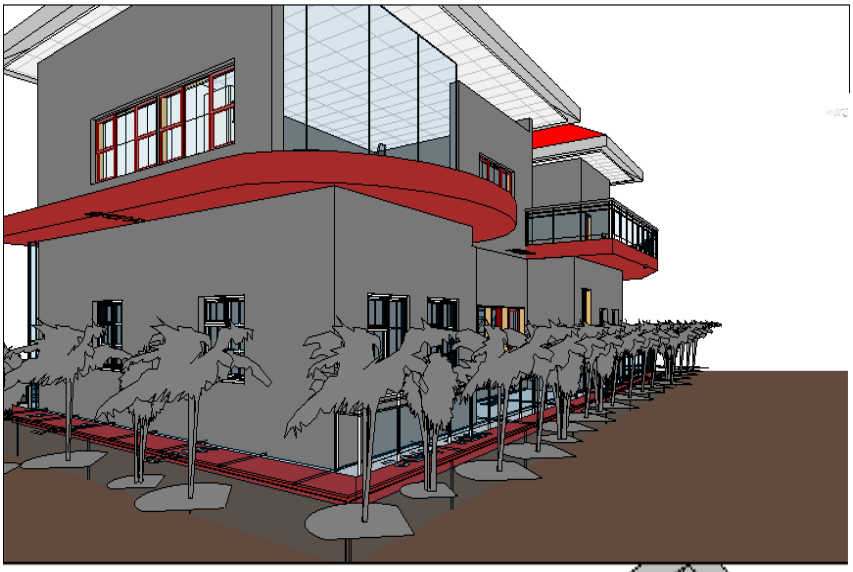


Fig. 4.22 NVIDIA rendered view



Consistent color views

View of the house showing the curtain wall having double glazing and compound ceiling above which the cold roof is placed with good insulation, waterproofing and moisture proofing membrane for the diffusing of the vapor accumulated below the top layer of the roof surface.

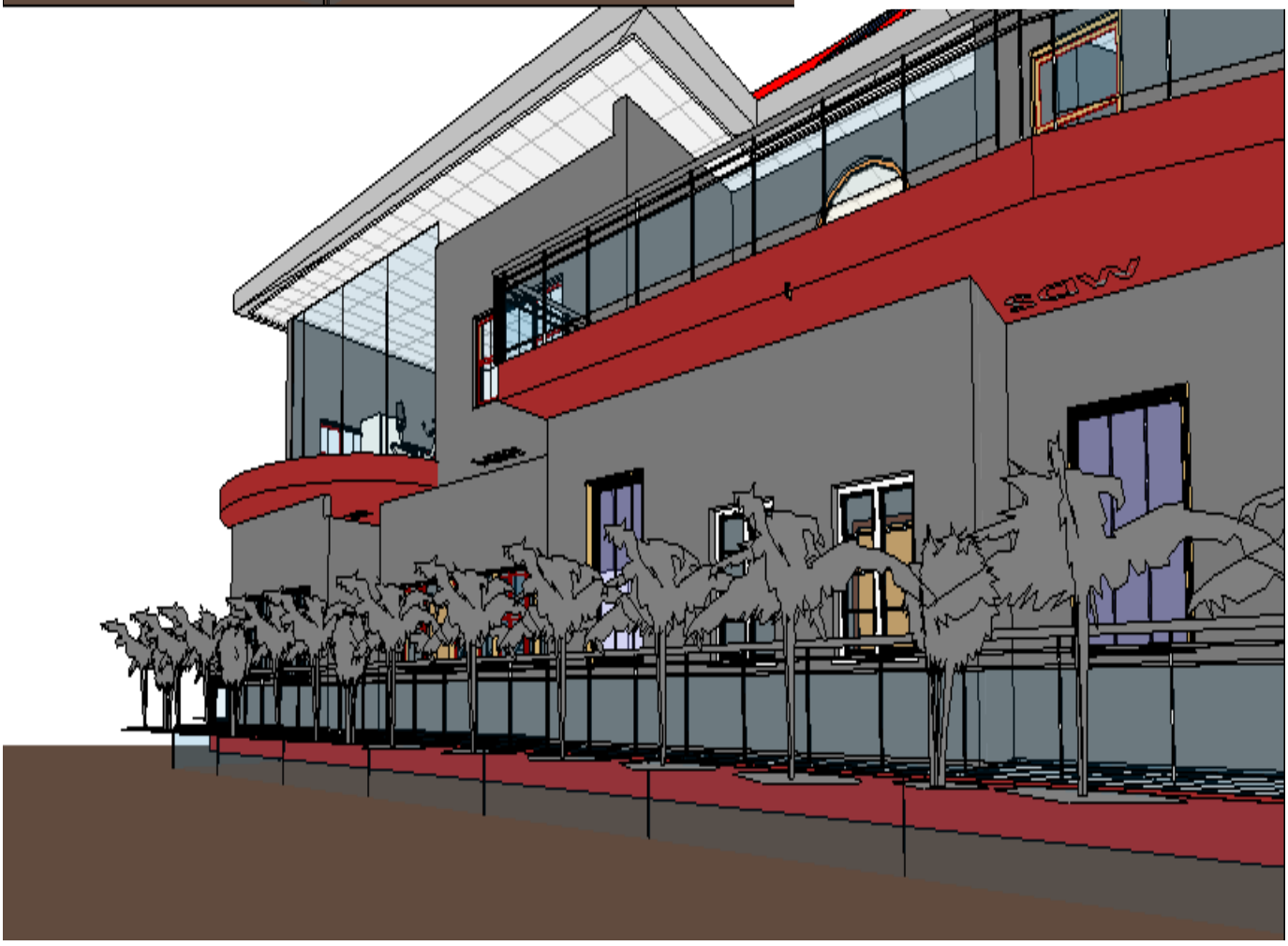


Fig. 4.23 Consistent color views

Inner views

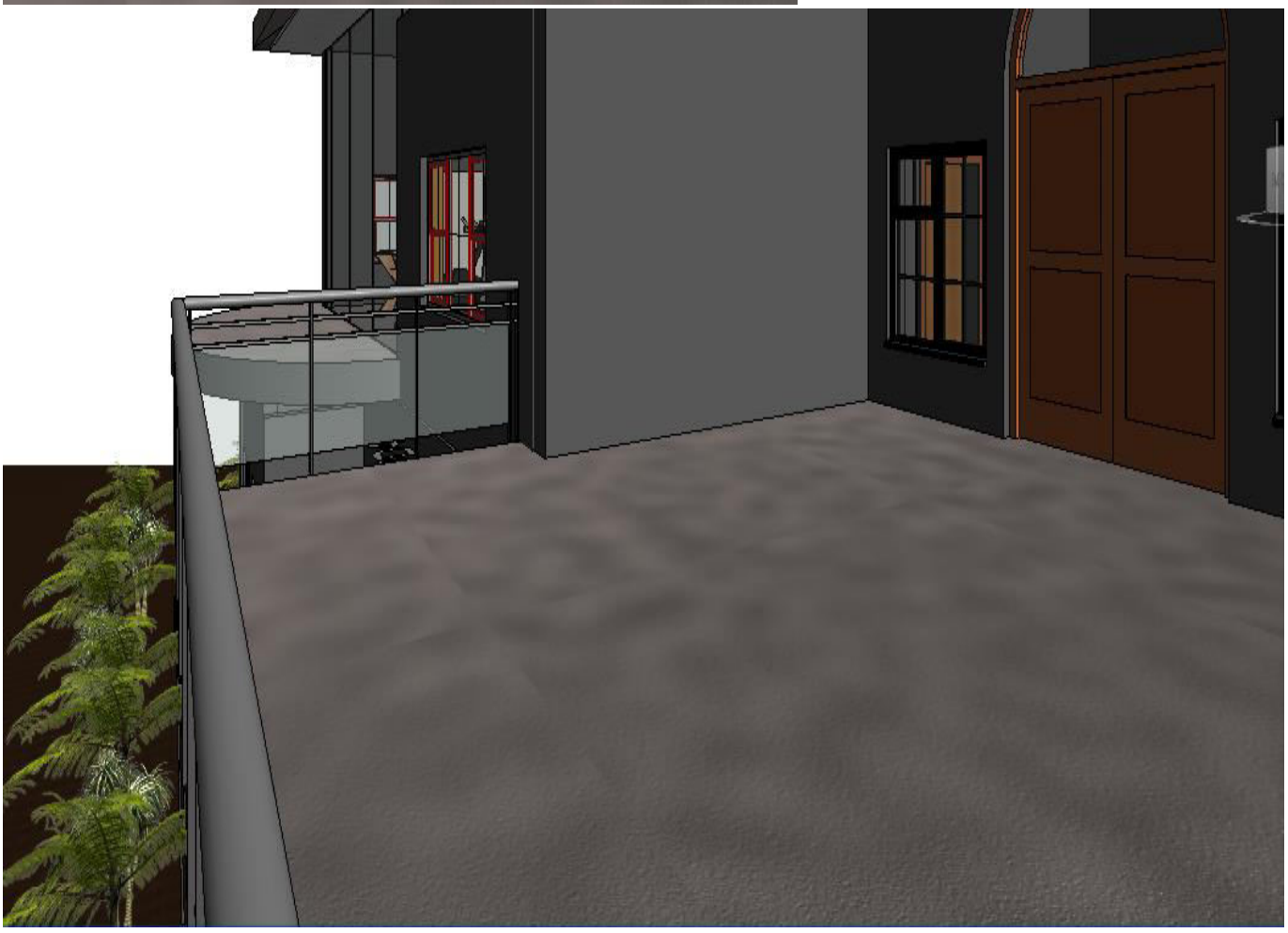


Fig 4.24 Inner views

Ray trace interactive views

E and S View of the house showing the minimum fenestration with shading devices in the hot summer. Bay windows are placed at the S side of the house. For the ventilation purpose double glazed windows are placed at the E side. Spaces are open in front of the house to have the courtyard effect from the sloping roof. Deciduous trees are planted in the SW orientation , 5m from the W side wall to have the better air circulation and cut the direct solar heat gain in the winter when sun is low in the sky . A food waste collector dump yard is placed outside of the house

Fig 4.25 Ray trace interactive views

4.3.3 Calculated data

From the above modeling , heat loss from inside of the house is find out so that the thermal comfort within the house is find out on the basis of maintaining the indoor temperature more than the ambient air temperature outside of the house.

Assumption : All the calculations are worked out for the steady heat flow.

Heat flow equation: **(Qi+Qc+Qv+Qm+Qs) =0,** Qs and Qm are neglected because there is no mechanical installation in the building. If the sum of the equation **(Qi-Qc-Qv-Qm+Qs)>0** , then the building is heating itself and if the sum of the equation is **(Qi-Qc-Qv-Qm+Qs)<0** , then the building is cooling itself. Executing this the U-value of the walls and windows are calculated and all the dimensions of walls, rooms, windows are calculated [Refer Annexure-A]

a) Qc=(A*U*ΔT)
b) Qv=(1300*V*ΔT)c)
c) Qi=(n1+W1)+(n2+W2)

Refer Annexure – B(1,2,3.4,5) for the calculations

Table 4.4 Calculation of Qc,Qv,Qi

	Qc= (A*U*ΔT)	Qv=(1300*V*ΔT)			Qi=(n_1*W_1)+(n2*W2)				
	Qc	1300	V=(N*room volume) / 3600	Qv	No.of persons (n_1)	Heat produced (W_1)	No. of electrical source (n_2)	Heat produced (W_2)	Qi
R1	16.383008	1300	0.06658	86.553	2	150	3	100	600
R2	12.808639	1300	0.061324	79.720	2	130	3	100	560
R3	18.234210	1300	0.050811	66.054			2	80	160

R4	27.73565	1300	0.054863	71.321	1	80	2	80	240
R5	11.548046	1300	0.051724	67.241	1	100	2	100	300
DR	9.4419349	1300	0.17253	224.28	3	130	6	100	990
K	16.532456	1300	0.027125	35.262	2	160	2	100	520
WR1	6.4307336	1300	0.00942	12.246	2	130	1	80	340
WR2	2.7459719	1300	0.009133	11.872			1	80	80
WR3	3.126354436	1300	0.012337	16.038	2	130	2	100	460
W4	4.825315759	1300	0.00826	10.737	2	150	2	100	500
Floor2									
R1	12.980969	1300	0.017947	23.331	2	160	3	100	620
R2	14.191469	1300	0.018572	24.143	2	160	3	100	620
R3	19.355734	1300	0.020197	26.255	2	160	3	100	620
R4	35.658777	1300	0.063171	82.122	4	250	6	120	1600
WR1	2.8015334	1300	0.009571	12.442	1	150	1	80	230
WR2	2.7940762	1300	0.009844	12.797	1	150	1	80	230

4.3.4 Energy analysis:

After modeling the building ,next phase is to obtain the energy model for the respective climate and to run the energy simulation on the model . Analytical spaces and surfaces are defined for the simulation. Once the energy analysis is done on the models , comparison is done with the conventional building depending on the different factors which are building performance factors, life cycle energy use, monthly cooling and heating load, monthly electricity consumption, temperature fluctuations etc. below is the energy model showing the analytical surfaces.

4.3.4.1 Energy model:

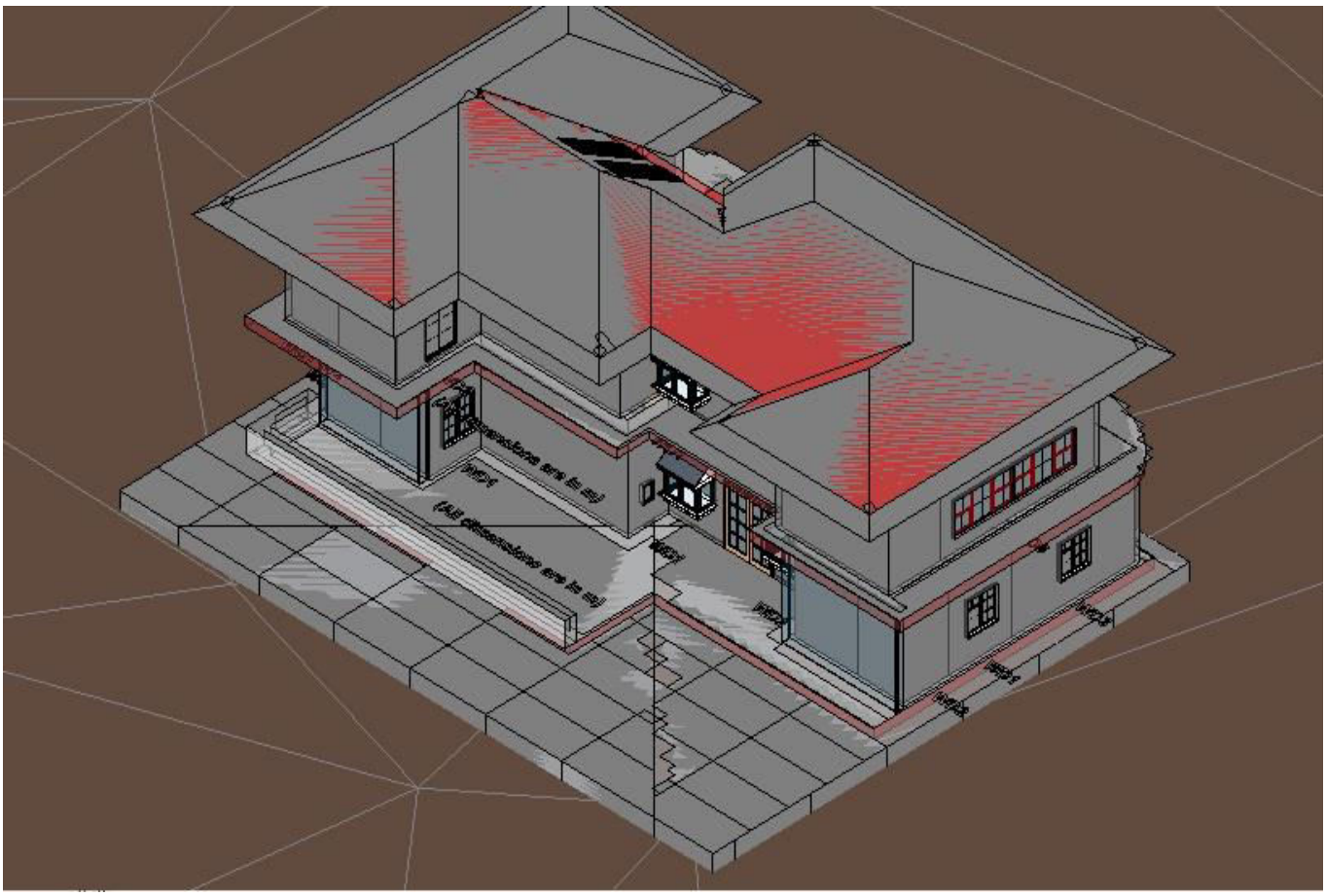


Fig. 4.26 Energy model

4.3.5 Abstract of construction cost for the conventional building Chandighar

Table 4.5 Details of measurement for the conventional building Chandighar

S.No.	Description	Quantity	Unit	Rate	Amount
	GROUND FLOOR				
	EARTH WORKS				
1	**EARTH WORKS EXACAVATION:** Earth work excavation for foundation trenches in all classes of soil and depositing on bank with initial lead upto 50 mt. and lift upto 1.5m including breaking clods,watering ramming and sectioning of spoil bank etc. complete.	119.03	Cu.M	220.00	26186.60
2	**EARTH WORKS FILLING PLINTH USING EARTH FROM SITE:** Filling the plinth and side of the foundation with the cut earth available at site in layers not exceeding 20 cms in depth consolidating each deposited layers by ramming and watering. Measurement will be taken only the filled and compacted earth.	575.99	Cu.M	110.00	63358.90
					89545.50
	PCC				
3	**PCC FOUNDATION 1:4:8:** Providing and laying PCC 1:4:8 using 40 mm nominal size broken stone well consolidated including curing etc. complete for foundation	35.71	Cu.M	4478.00	159909.38
4	**DAMP PROOF COURSE 1:2:4:** Providing 4 cm thick PCC as a damp proof course with broken stone chips and approved water proofing compound beneath the wall as per IS: 2645-1964	54.91	Sq. M	257.80	14155.80
5	**PCC FLOORING 1:2:4 CuM:** Providing and laying PCC 1:2:4 using 40 mm nominal size broken stone well consolidated 100 including	18.00	Cu.M	6778.20	122007.60
					296072.78
	BRICK WORKS				
6	**BRICK WORKS CM 1:4**: First class brick work masonary in C.M.1:4 (1 cement 4 course sand) with approved good quality country burnt bricks of compressive	78.92	Cu.M	4970.00	392232.40

	strength 35 kg/m^2 of standard size of on super structure of all thickness. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work.				
7	**BRICK WORKS CM 1:6**: First class brick work masonary in C.M.1:4 (1 cement 6 course sand) with approved good quality country burnt bricks of compressive strength 35 kg/m^2 of standard size of on super structure of all thickness. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work	99.79	Cu.M	5582.00	557027.78
					949260.18
	FLOOR AND WALL FINISHES				
8	**FLOOR FINISHING MARBLE TILES:** Supplying and fixing 20 mm thick marble slabs size 80cm X 150cm fixed into the floors.	9.71	Sq. M	3035.00	29469.85
9	**SKIRTING AND GRANITE TILES:** Supplying and fixing pre polished black granite slab 20mm thick over 1:3,12mm thick using necessary cement grout including closing the joints with pigment of the color to match including washing, cleaning, polishing the edges etc complete as per pavior.	165.93	Sq. M	3907.00	648288.51
					677758.36
	DOORS AND WINDOWS				
10	**FRAMES WOOD:** Supplying and fixing of doors and windows frames using good quality wood including M.S.clamps and fittings, fixing complete including a coat of tar at the contact surface of the frame.	0.38	Cu.M	85386.00	32446.68
11	**SHUTTERS WOOD PANELLED:** Supplying and fixing of shutters of good quality paneled wood.	14.87	Sq. M	1731.05	25740.71
12	**SHUTTERS WOOD GLAZED:** Supplying and fixing of fully glazed shutters of good quality wood.	8.64	Sq. M	2293.00	19811.52
					77998.91
					148516.05
	PAINTING				
13	**PAINTING WALLS DISTEMPER:** Distempering two coats to the wall	909.61	Sq. M	49.65	45162.14

	including smoothening with sand paper				
					45162.14
	Total for Ground floor				2135797.87
	FIRST FLOOR				
	BRICK WORKS				
1	**BRICK WORKS CM 1:6:** First class brick work masonry in C.M. 1:6 (1 cement 6 course sand with approved good quality country burnt bricks of compressive strength 35 kg/m^2 of standard size of on super structure of all thickness. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work.	101.37	Cu.M	2338.90	237094.29
					237094.29
	FLOOR AND WALL FINISHES				
2	**FLOOR FINISHING MARBLE TILES:** Supplying and fixing 20 mm thick marble slabs size 80cm X 150cm fixed into the floors.	142.47	Sq. M	732.94	104421.96
					104421.96
	DOORS AND WINDOWS				
3	**FRAMES WOOD:** Supplying and fixing of doors and windows frames using good quality wood including M.S. clamps and fittings, fixing complete including a coat of tar at the contact surface of the frame.	0.41	Cu.M	85386.00	35008.26
4	**SHUTTERS WOOD PANELLED:** Supplying and fixing of shutters of good quality paneled wood.	12.61	Sq. M	2689.05	33908.92
5	**SHUTTERS WOOD GLAZED:** Supplying and fixing of fully glazed shutters of good quality wood.	8.64	Sq. M	2293.00	19819.47
					88736.65
	PAINTING				
6	**PAINTING WALLS PLASTIC EMULSION:** Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty	901.08	Sq. M	52.44	47252.64
					47252.64
	Total for first floor				477505.54
	Total				2613303.41
	Net amount				2613303.00

4.3.6 Abstract of construction cost for the green building Chandighar

Table 4.6 Details of measurement for the green building Chandighar

S.No.	Description	Quantity	Unit	Rate	Amount
	GROUND FLOOR				
	EARTH WORKS				
1	**EARTH WORKS EXACAVATION:** Earth work excavation for foundation trenches in all classes of soil and depositing on bank with initial lead upto 50 mt. and lift upto 1.5m including and sectioning of spoil bank etc. complete.	113.59	Cu.M	220.00	24989.80
2	**EARTH WORKS FILLING PLINTH USING EARTH FROM SITE:** Filling the plinth and side of the foundation with the cut earth available at site in layers not exceeding 20 cms in depth consolidating each deposited layers by ramming and watering. Measurement will be taken only the filled and compacted earth.	101.24	Cu.M	110.00	11136.40
3	**ANTI-TERMITE TREATMENT:** Anti-termite treatment by providing and injecting chemical emulsion/aldrin/heptachlor emulsible concentrates 0.50% and clilossdance emusifiable concentrate for pre contractional treatment and creating a chemical barrier as per IS:6313(part 2) 1951 in wall trench foundation top surface of plinth filling junction of wall and floor along the external perimeter of the building complete.(area of buiding shall be measured).	176.84	Sq. M	200	35368.00
					71494.20
	PCC				
4	**PCC FOUNDATION 1:4:8:** Providing and laying PCC 1:4:8 using 40 mm nominal size broken stone well consolidated including curing etc. complete for foundation	37.17	Cu.M	4,478.00	166447.26
5	**DAMP PROOF COURSE 1:2:4:** Providing 4 cm thick PCC as a damp proof course with broken stone chips and approved water proofing compound beneath the wall as per IS: 2645-1964	56.51	Sq.M	314.85	17792.17
6	**PCC FLOORING 1:2:4 Cu.M:** Providing and laying PCC 1:2:4 using 40 mm nominal size broken stone well consolidated 100	17.69	Cu.M	3,233.00	5719.77

	including				
	BRICK WORKS				241431.20
7	**BRICK WORKS CM 1:4**: First class brick work masonary in C.M.1:4 (1 cement 4 course sand) with approved good quality country burnt bricks of compressive strength 35 kg/m^2 of standard size of on super structure of all thickness. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work.	81.60	Cu.M	4970.00	405552.00
8	**BRICK WORKS CM 1:6**: First class brick work masonary in C.M.1:6 (1 cement 6 course sand) with approved good quality country burnt bricks of compressive strength 35 kg/m^2 of standard size of on super structure of all thickness. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work.	67.60	Cu.M	5,582.00	377343.20
	FLOOR AND WALL FINISHES				782895.20
8	**FLOOR FINISHING MARBLE TILES:** Supplying and fixing 20 mm thick marble slabs size 80cm X 150cm fixed into the floors.	176.84	Sq.M	3035.00	536709.00
9	**SKIRTING MARBLE TILES:** supplying and fixing 20mm thick marble slabs size 80 cm X 150 cm fixed into the floors.	150.47	M	456.00	68614.32
10	**SKIRTING MARBLE TILES IN Sq. M:** Skirting using marble tiles	16.29	Sq M	2937.00	47843.73
	DOORS AND WINDOWS				584553.13
11	**FRAMES WOOD:** Supplying and fixing of doors and windows frames using good quality wood including M.S.clamps and fittings, fixing complete including a coat of tar at the contact surface of the frame.	0.88	Cu.M	85386.00	75139.68
12	**SHUTTERS WOOD PANELLED:** Supplying and fixing of shutters of good quality paneled wood	15.24	Sq M	2689.00	40981.12
13	**SHUTTERS WOOD GLAZED:** Supplying	27.42	Sq M	2293.00	62874.06

	and fixing of fully glazed shutters of good quality wood				
					178994.86
	PLASTERING AND POINTING				
14	**PLASTERING WALLS CM 1:2 12MM:** Plastering with cement mortar to walls, columns and other structural architectural features at all heights, floated hard and trowelled get smooth finish. the rate shall include provision of grooves scaffolding at any height curing etc. complete as directed by the engineer.	655.80	Sq M	201.95	132438.81
					132438.81
	PAINTING				
15	**PAINTING WALLS PLASTIC EMULSION:** Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty	655.80	Sq M	48.00	31478.40
16	**PAINTING WALLS INT. PLASTIC EMULSION:** Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty.	655.80	Sq M	48.00	31478.40
					62956.80
	Total for Ground floor				2054764.21
	FIRST FLOOR				
	BRICK WORKS				
1	**BRICK WORKS CM 1:6:** First class brick work masonry in C.M. 1:6 (1 cement 6 course sand with approved good quality country burnt bricks of compressive strength 35 kg/m^2 of standard size of on super structure of all thickness. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work	77.15	Cu M	5583.00	430728.45
					430728.45
	FLOOR AND WALL FINISHES				
2	**FLOOR FINISHING GRANITE TILES:** Supplying and fixing pre polished black granite slab 20 mm thick over 1:3, 12 mm	155.84	Sq. M	2,937.00	457702.08

	thick using necessary cement grout including closing the joints with pigment of the colour to match including washing, cleaning, polishing the edges etc. complete as per pavior.				
3	**SKIRTING GRANITE TILES IN M:** Supplying and fixing pre polished black granite slab 20 mm thick over 1:3, 12 mm thick using necessary cement grout including closing the joints with pigment of the colour to match including washing, cleaning, polishing the edges etc. complete as per pavior.	93.86	m	358.00	33601.88
					491303.96
	DOORS AND WINDOWS				
4	**FRAMES WOOD:** Supplying and fixing of doors and windows frames using good quality wood including M.S. clamps and fittings, fixing complete including a coat of tar at the contact surface of the frame.	0.41	Cu.M	85,386.00	35008.26
5	**SHUTTERS WOOD PANELLED:** Supplying and fixing of shutters of good quality paneled wood	9.46	Sq.M	2689.05	25438.41
6	**SHUTTERS WOOD GLAZED:** Supplying and fixing of fully glazed shutters of good quality wood	10.51	Sq.M	2293.00	24099.43
					84546.10
					2096.95
	Total for first floor				3061343.00
	Total				3061343.00

Adding the solar PV 100 Kw plant and the 200ltr. solar water heater which costs Rs.1,19,518 and adding the composite wall panels is Rs. 287193.76 which increases the totasl cost to Rs. 34,68,054

CHAPTER-5

RESULTS AND DISCUSSION

From the above discussed heat balance equation which has been opted for thermal design of building, calculation are made for maintaining comfortable inner room temperature throughout the year comparatively to the ambient outside air temperature for both the climatic design. Below is given the calculated temperature difference for various parts of the building , from which the room temperature is find out

.5.1 Results for the Cold and Cloudy climate

5.1.1 Obtaining internal temperature for the different spaces

Table 5.1 Calculation of ΔT, T_i, T_0 for cold and cloudy

	ΔT	T_o	T_i
R1	9.25	-3	6.25
R2	6.14	-3	3.14
R3	7.75	-3	4.75
R4	6.22	-3	3.22
DR	7.83	-3	4.83
K	9.89	-3	6.89
WR1	16.74	-3	13.74
WR2	16.13	-3	13.13
WR3	8.0598	-3	5.05

5.1.2 Obtaining energy analysis for the building

obtaining the comfortable situation inside the spaces by theoretical means , it is needed to do whole energy analysis of the building for the real situation , which is done with the help of Autodesk Revit 2016. Energy analysis is done by the software and results are presented in the following sheets.

5.2 Discussion of results

From the climatic design perspective when temperature is taken into account we can see that the room1 has the most comfortable situations and room 2 has the least amongst all. Increase in the temperature is due to the use of low embodied energy material which are environment friendly and we can say that green material which have a very few or negligible harmful effects on the living beings and the surrounding environment. Other fulfilling reasons are adopting solar passive design techniques for the construction.

On the other hand, comparison of the green building for the cold and cloudy climate has shown improved results than the conventional building .This was made possible because of the improved design strategies adopted for the modeling . It is made clear from the results that green building improved building performance, lower life cycle energy cost, lower monthly heating and cooling loads, lower monthly electricity consumption. As the results are precise and valid , we can say that green buildings are way beyond than the conventional ones and it has effectiveness , weather it has been built in any climate . following is the comparison of the monthly temperature fluctuation for the respective models.

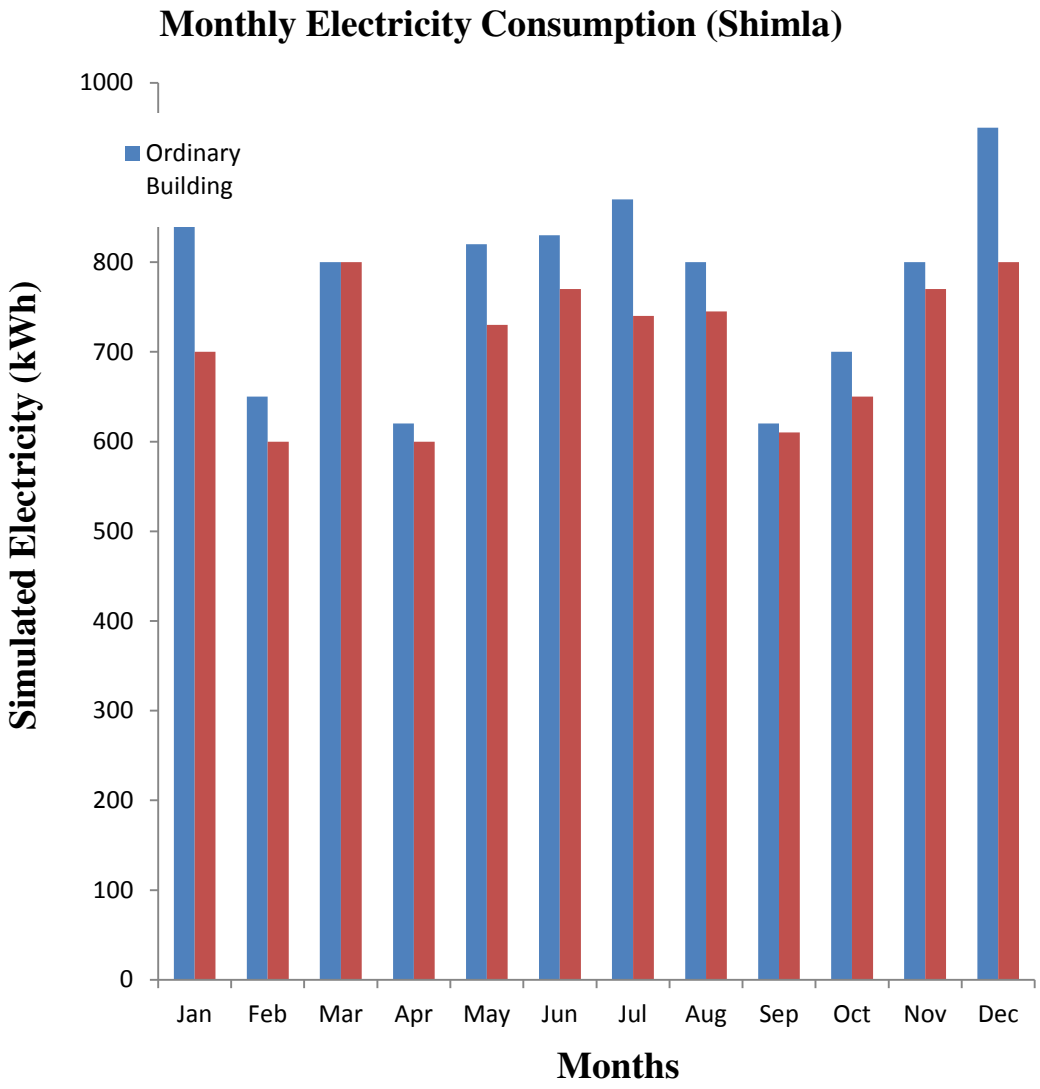


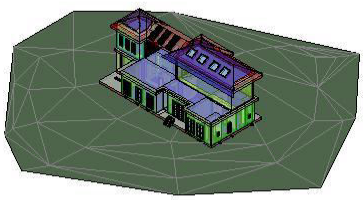
Fig. 5.1 comparison of the monthly electricity consumption

AUTODESK.

(5.3) ENERGY ANALYSIS RESULT FOR COLD AND CLOUDY CLIMATE (green) SHIMLA GREEN BUILDING 2016

Analyzed at 3/26/2017 5:51:43 PM
Version 2017.1.7.39(DOE-2.2-48r)

Energy Analysis Result



Building Performance Factors

Location:	Shimla , India
Weather Station:	431091
Outdoor Temperature:	Max: 32°C/Min: 0°C
Floor Area:	182 m²
Exterior Wall Area:	340 m²
Average Lighting Power:	4.84 W / m²
People:	2 people
Exterior Window Ratio:	0.08
Electrical Cost:	$0.05 / kWh
Fuel Cost:	$0.14 / Therm

Energy Use Intensity

Electricity EUI:	53 kWh / sm / yr
Fuel EUI:	666 MJ / sm / yr
Total EUI:	857 MJ / sm / yr

Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	288,836 kWh
Life Cycle Fuel Use:	3,626,850 MJ
Life Cycle Energy Cost:	$8,425

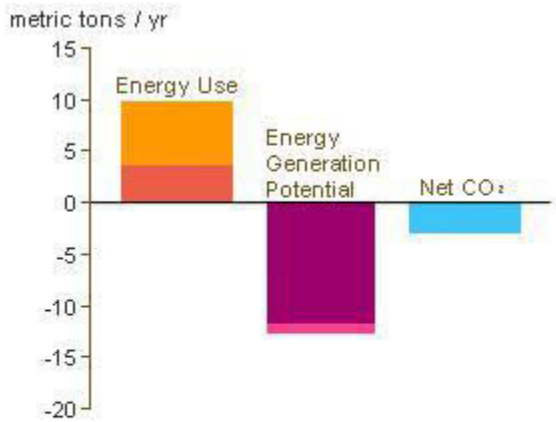
*30-year life and 6.1% discount rate for costs

Renewable Energy Potential

Roof Mounted PV System (Low efficiency):	10,257 kWh / yr
Roof Mounted PV System (Medium efficiency):	20,513 kWh / yr
Roof Mounted PV System (High efficiency):	30,770 kWh / yr
Single 15' Wind Turbine Potential:	2,245 kWh / yr

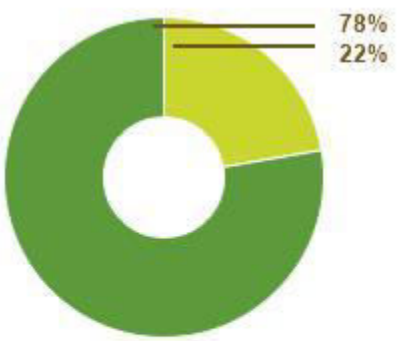
*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

Annual Carbon Emissions



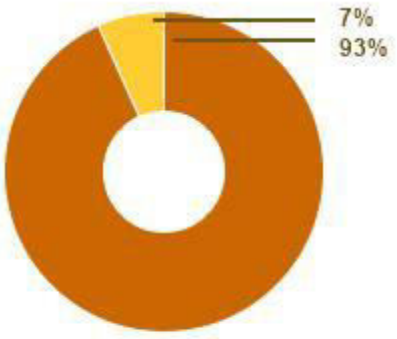
	(metric tons / yr)
Electricity Consumption	3
Fuel Consumption	6
Roof PV Potential (High Efficiency)	-11
Single 15' Wind Turbine Potential	0
Net CO2	-2

Annual Energy Use/Cost



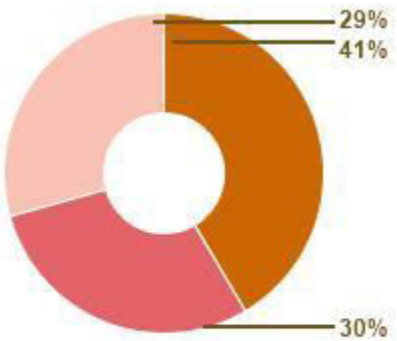
Electricity	22%	$453	9,627	kWh
Fuel	78%	$166	120,895	MJ
		$619		

Energy Use: Fuel



			(MJ)
HVAC	93%	$154	112,735
Domestic Hot Water	7%	$11	8,159
		$165	120,894

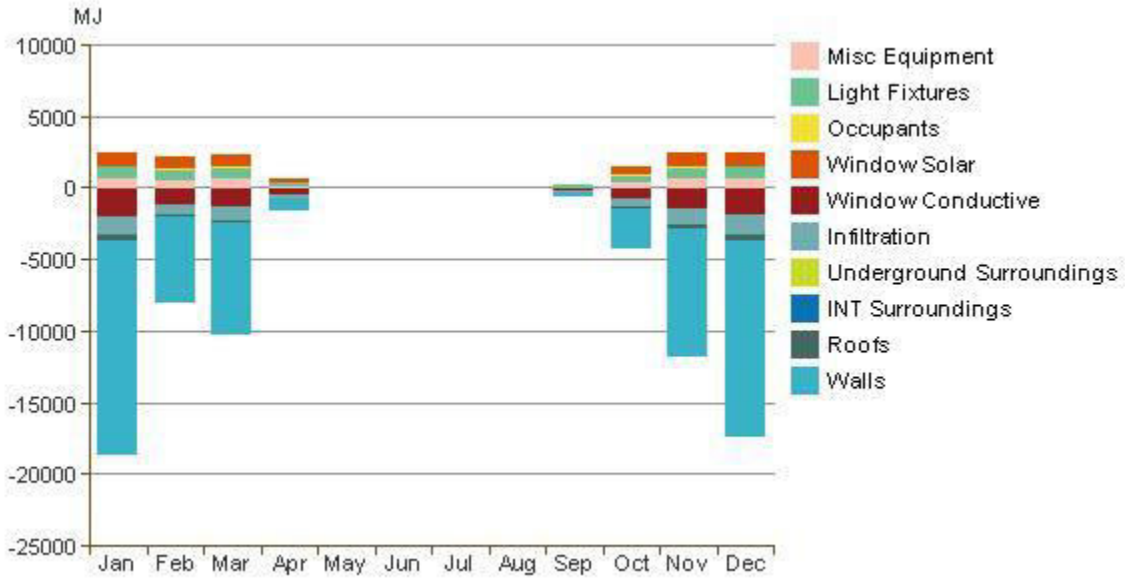
Energy Use: Electricity



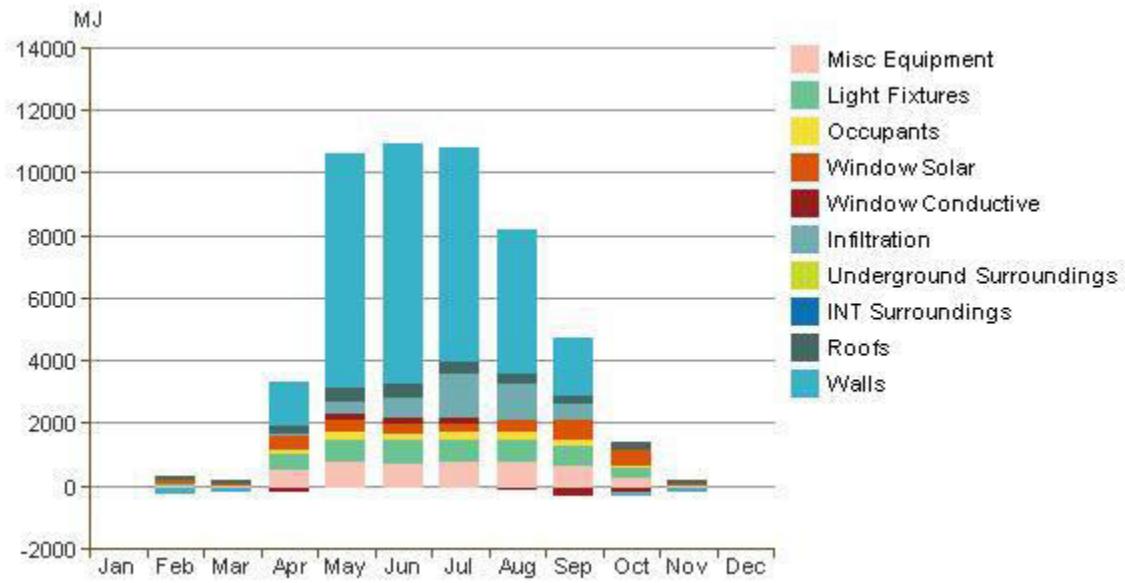
			(kWh)
HVAC	41%	$187	3,994
Lighting	30%	$131	2,808
Misc Equipment	29%	$132	2,825
		$450	9,627

Monthly Heating Load

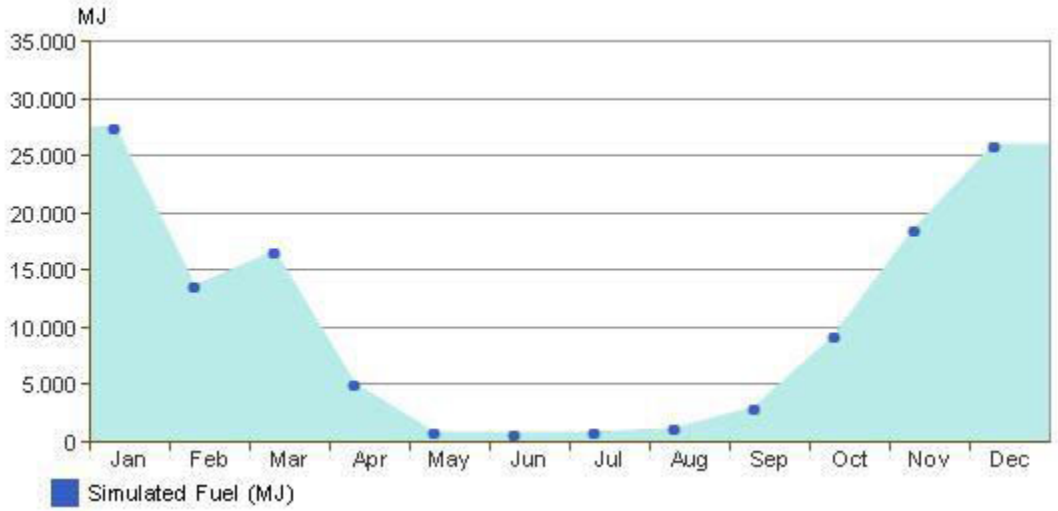
Monthly Heating Load



Monthly Cooling Load

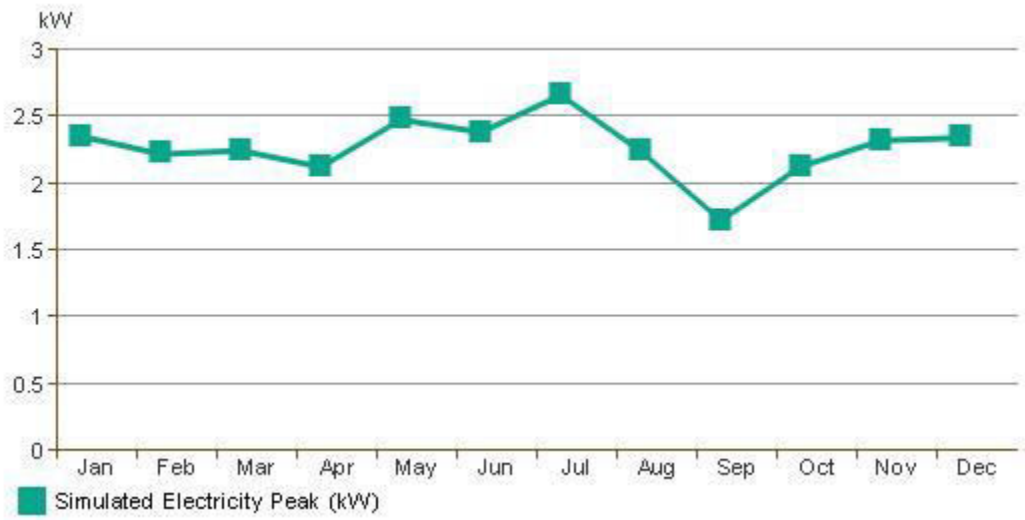


Monthly Fuel Consumption

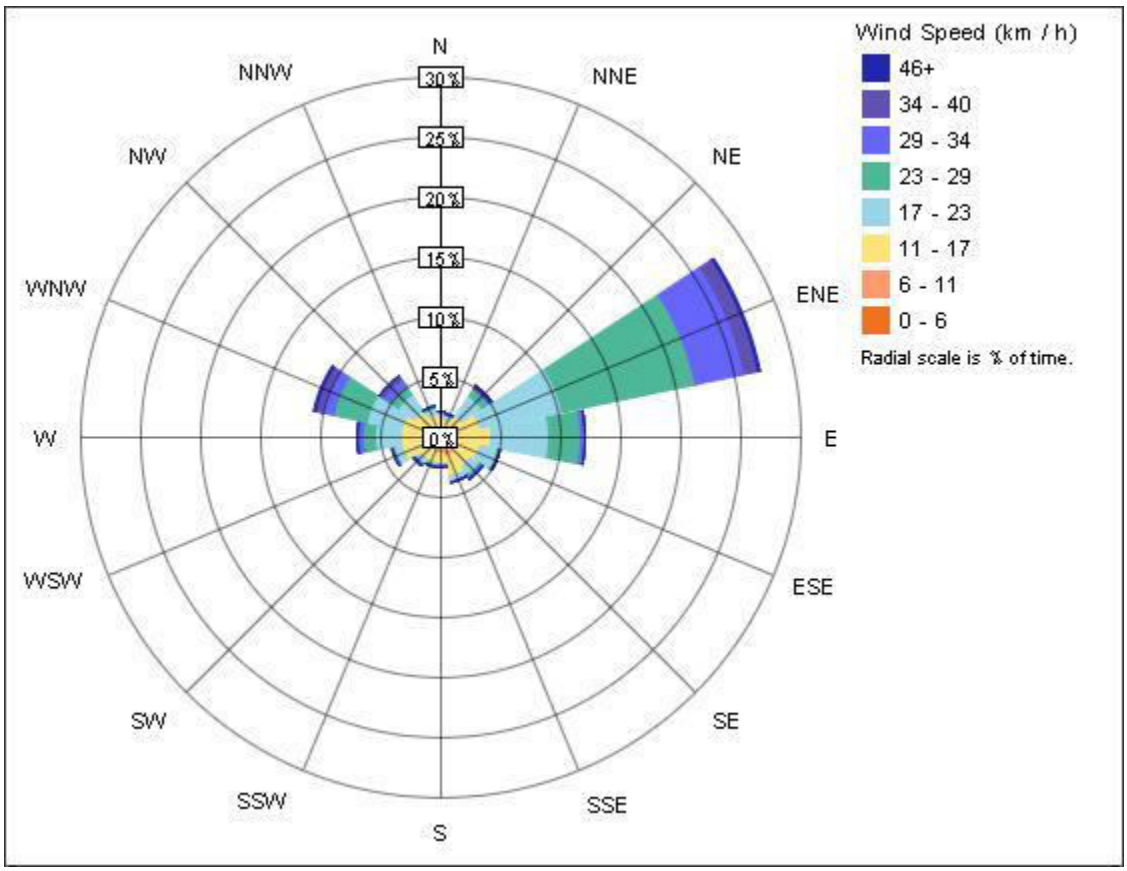


Monthly Electricity Consumption

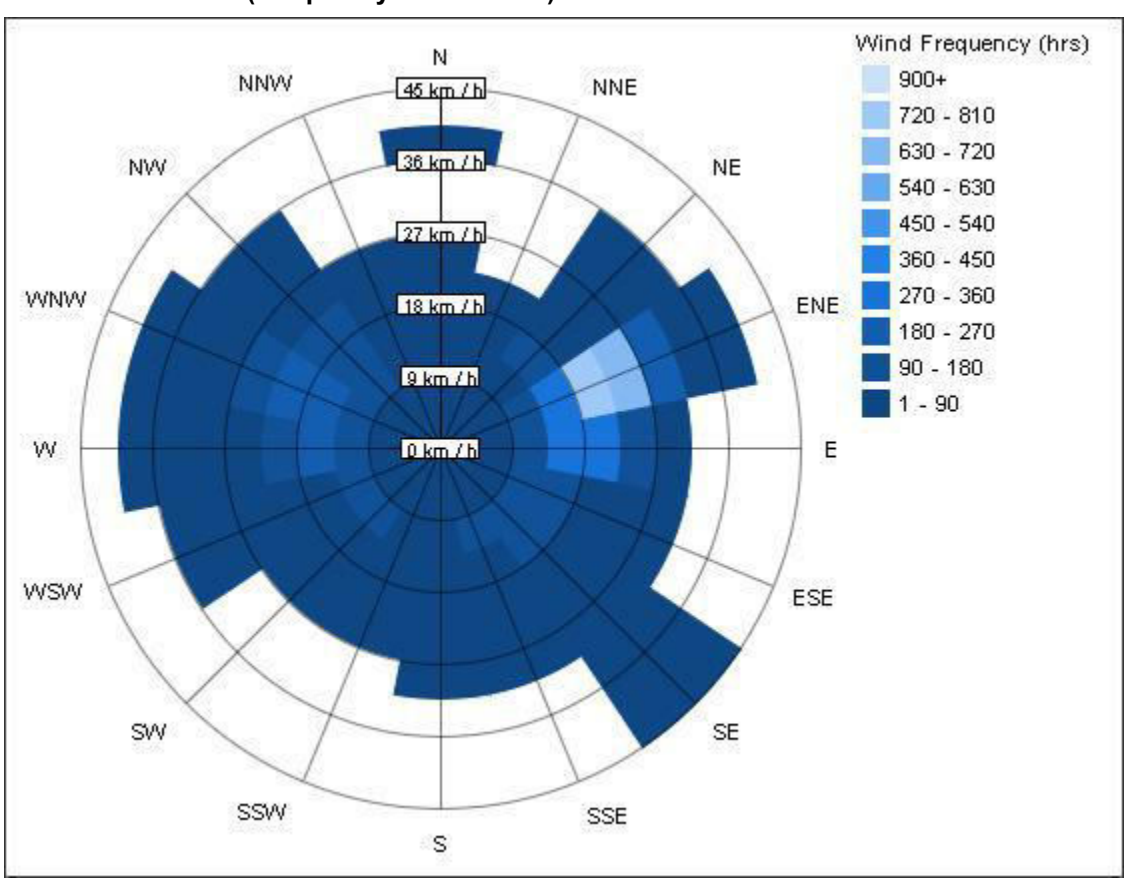
Monthly Peak Demand



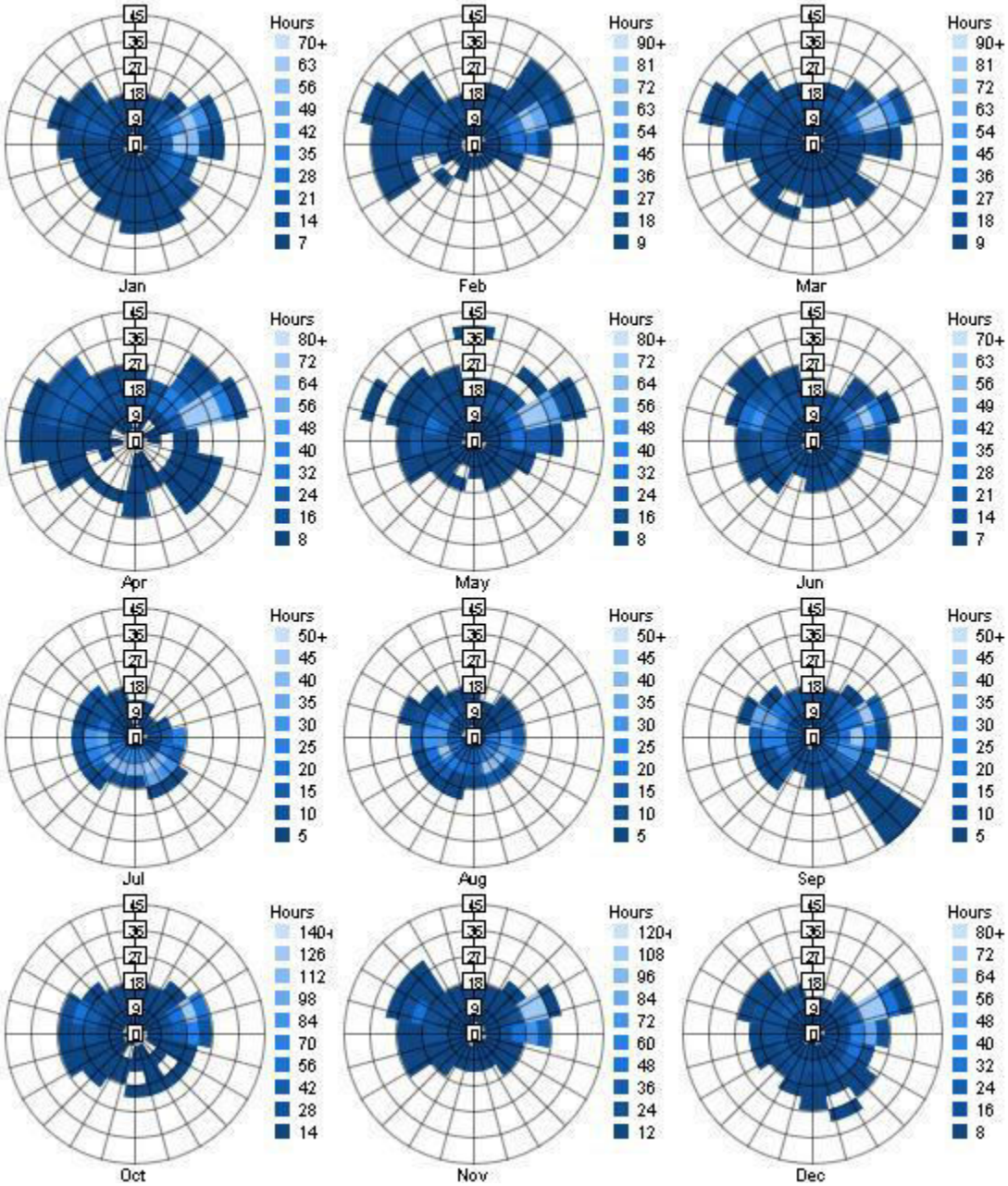
Annual Wind Rose (Speed Distribution)



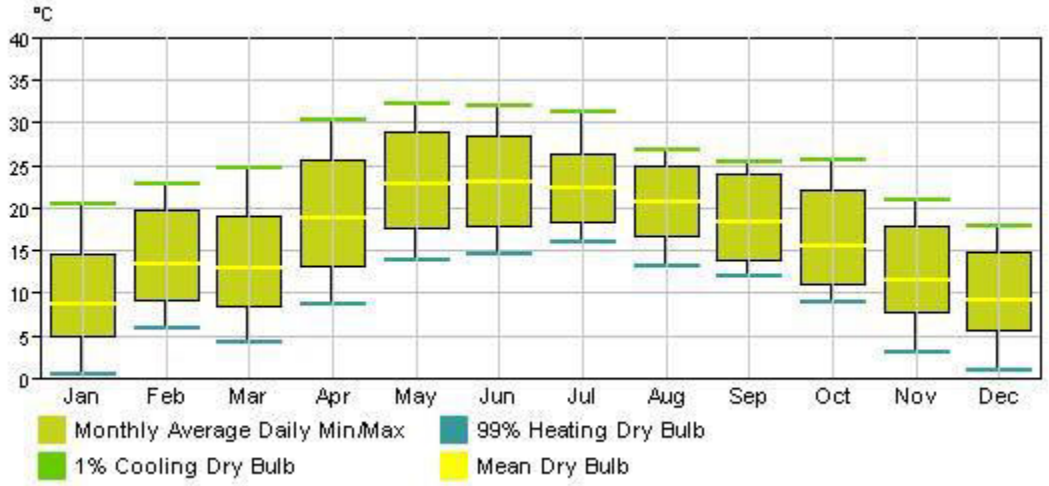
Annual Wind Rose (Frequency Distribution)



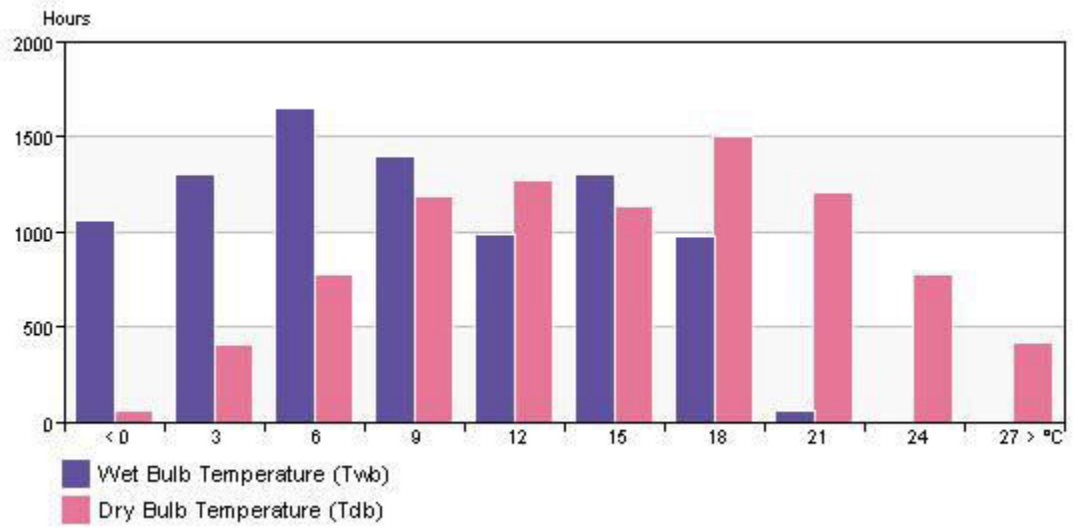
Monthly Wind Roses



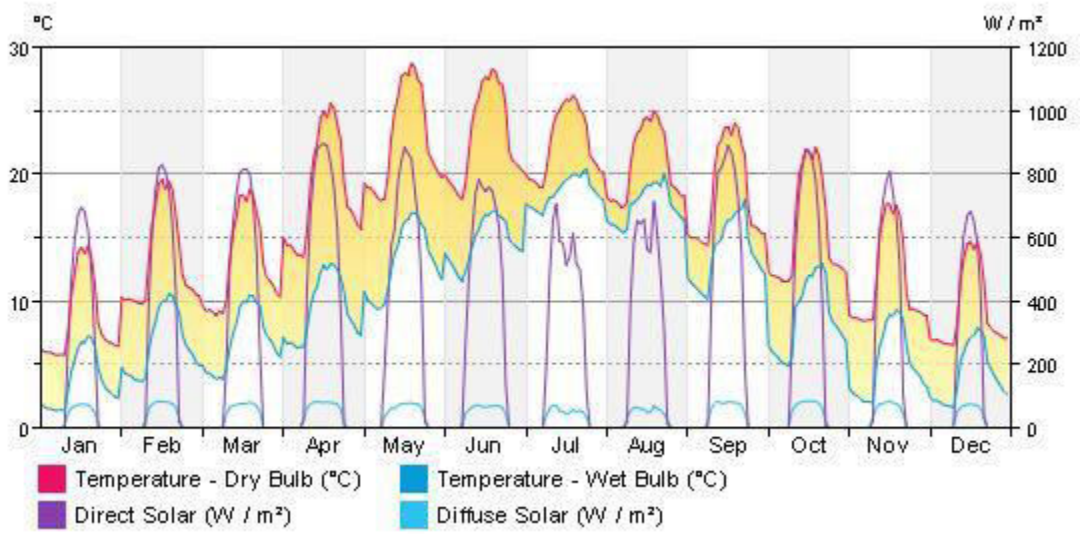
Monthly Design Data



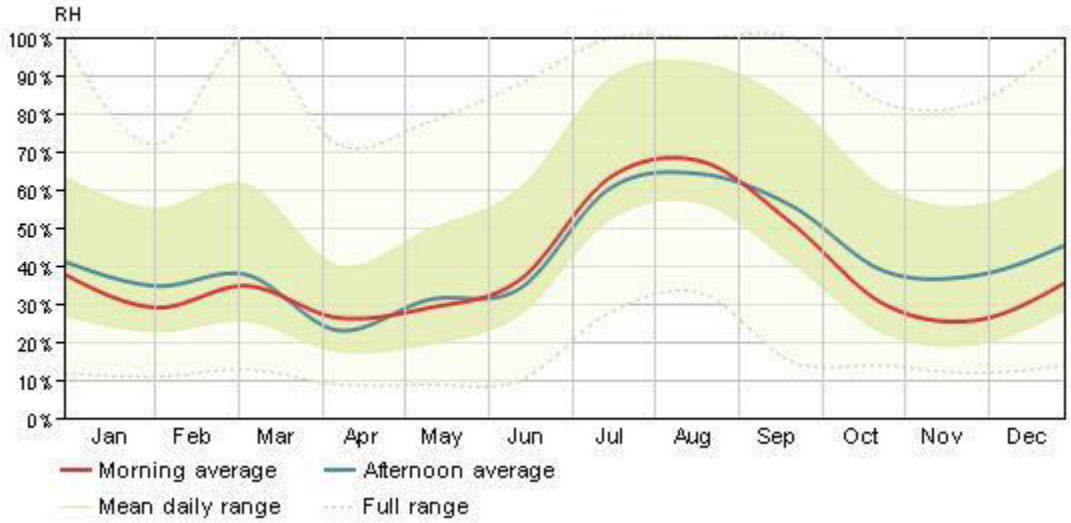
Annual Temperature Bins



Diurnal Weather Averages



Humidity



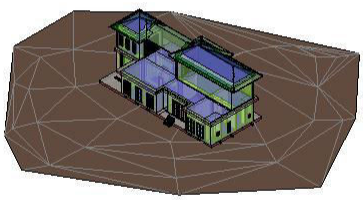
Energy Analysis Data

AUTODESK.

(5.4) ENERGY ANALYSIS RESULT FOR COLD AND CLOUDY CLIMATE (conventional) SHIMLA CONVENTIONAL BUILDING 2016

Analyzed at 4/23/2017 12:39:57 AM
Version 2017.99.15.25(DOE-2.2-48r)

Energy Analysis Result



Building Performance Factors

Location:	Shimla, India
Weather Station:	431091
Outdoor Temperature:	Max: 32°C/Min: 0°C
Floor Area:	182 m²
Exterior Wall Area:	337 m²
Average Lighting Power:	4.84 W / m²
People:	2 people
Exterior Window Ratio:	0.08
Electrical Cost:	$0.05 / kWh
Fuel Cost:	$0.14 / Therm

Energy Use Intensity

Electricity EUI:	105 kWh / sm / yr
Fuel EUI:	42 MJ / sm / yr
Total EUI:	422 MJ / sm / yr

Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	574,260 kWh
Life Cycle Fuel Use:	231,176 MJ
Life Cycle Energy Cost:	$12,398

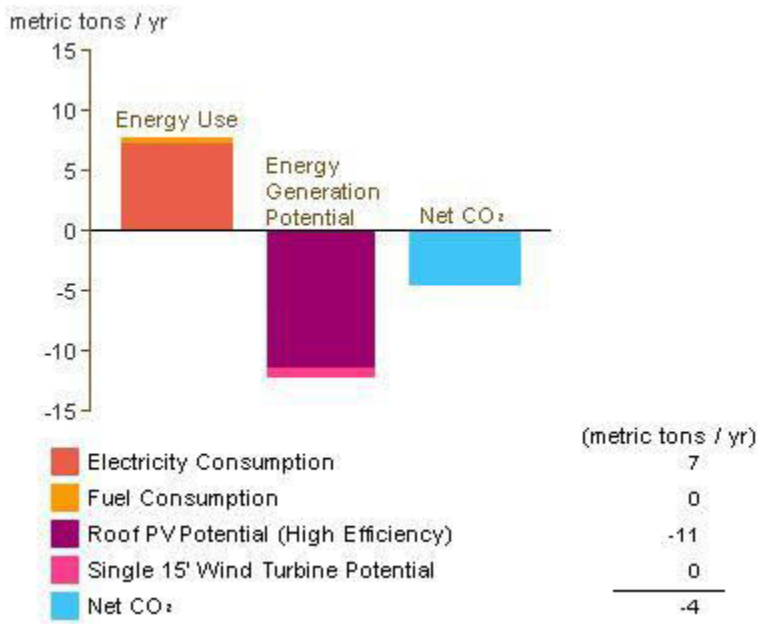
*30-year life and 6.1% discount rate for costs

Renewable Energy Potential

Roof Mounted PV System (Low efficiency):	9,946 kWh / yr
Roof Mounted PV System (Medium efficiency):	19,892 kWh / yr
Roof Mounted PV System (High efficiency):	29,838 kWh / yr
Single 15' Wind Turbine Potential:	2,245 kWh / yr

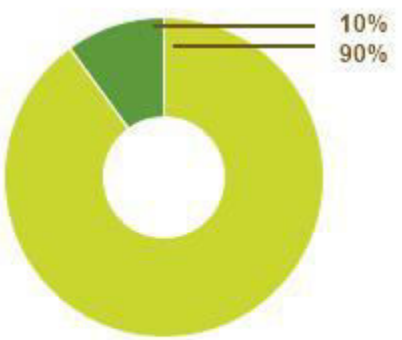
*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

Annual Carbon Emissions



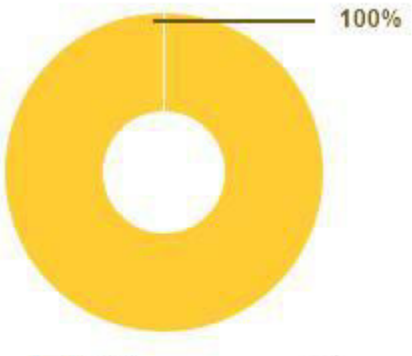
	(metric tons / yr)
Electricity Consumption	7
Fuel Consumption	0
Roof PV Potential (High Efficiency)	-11
Single 15' Wind Turbine Potential	0
Net CO₂	-4

Annual Energy Use/Cost



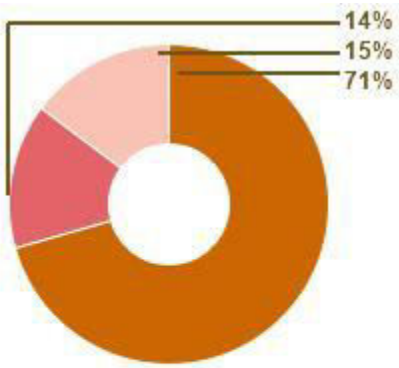
Electricity	90%	$900	19,141	kWh
Fuel	10%	$11	7,705	MJ
		$910		

Energy Use: Fuel



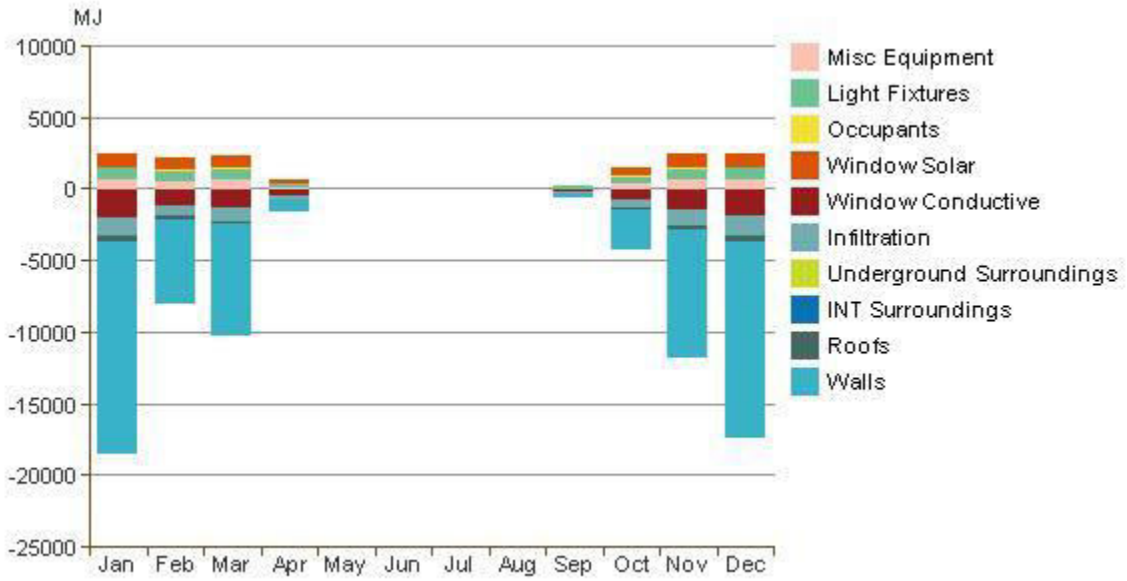
			(MJ)
HVAC	0%	$0	0
Domestic Hot Water	100%	$10	7,705
		$10	7,705

Energy Use: Electricity

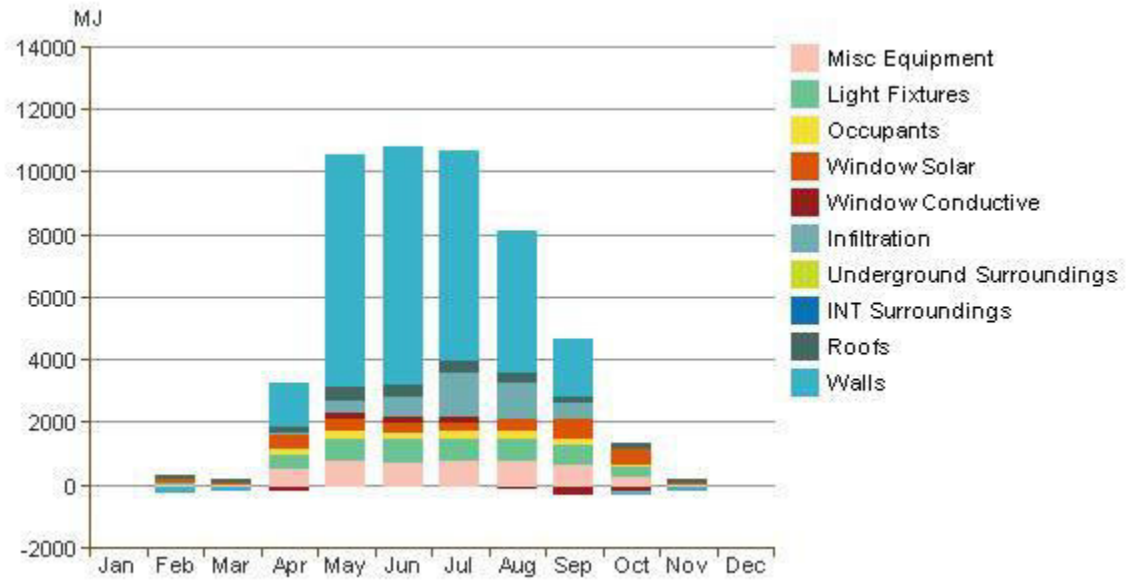


			(kWh)
HVAC	71%	$634	13,508
Lighting	14%	$131	2,808
Misc Equipment	15%	$132	2,825
		$897	19,141

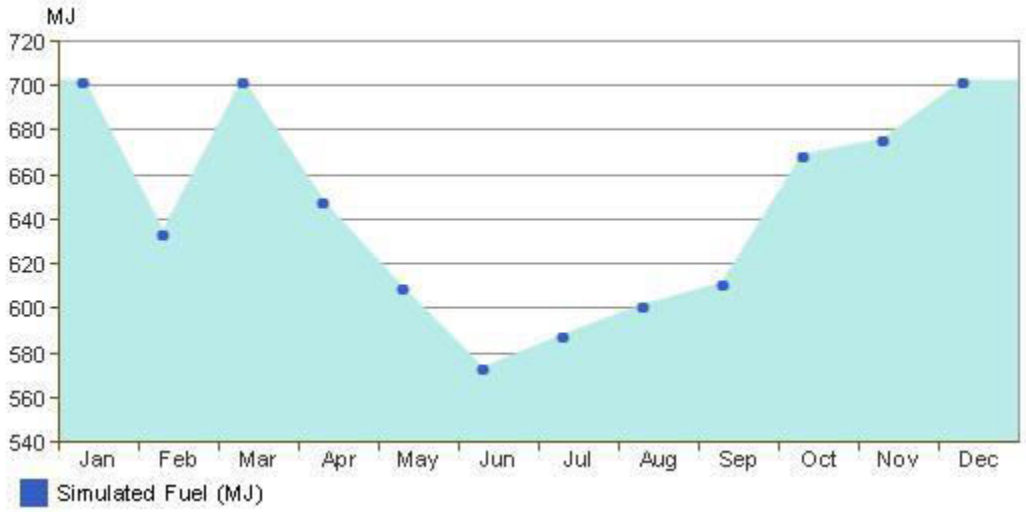
Monthly Heating Load



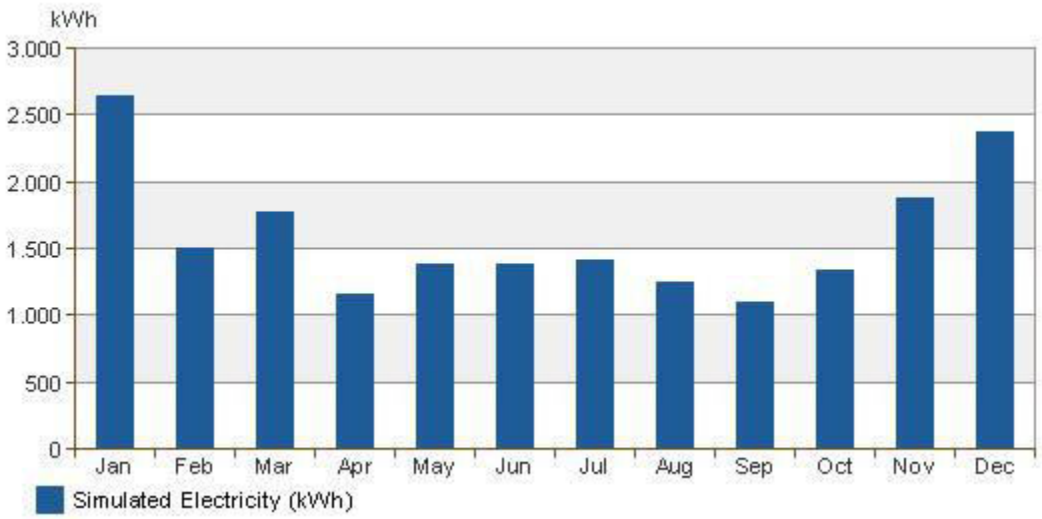
Monthly Cooling Load



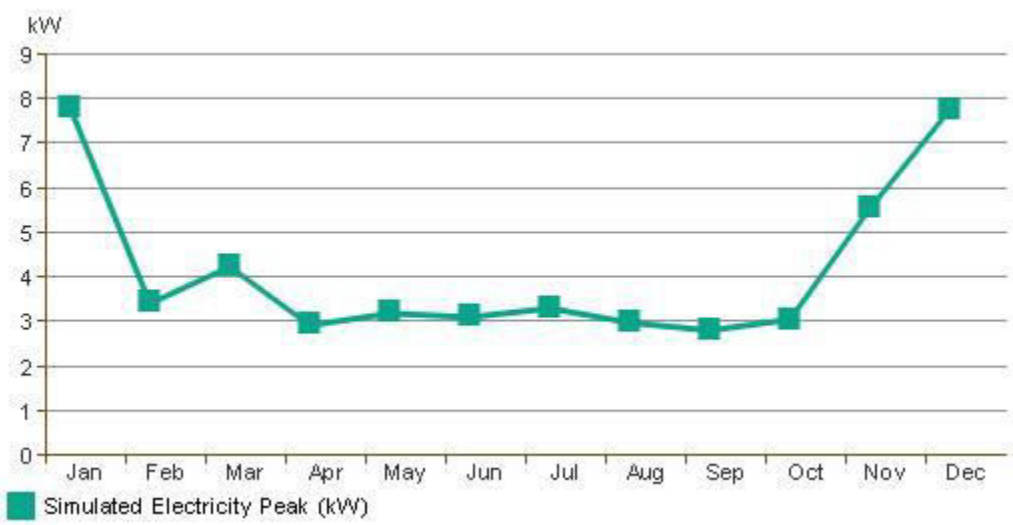
Monthly Fuel Consumption



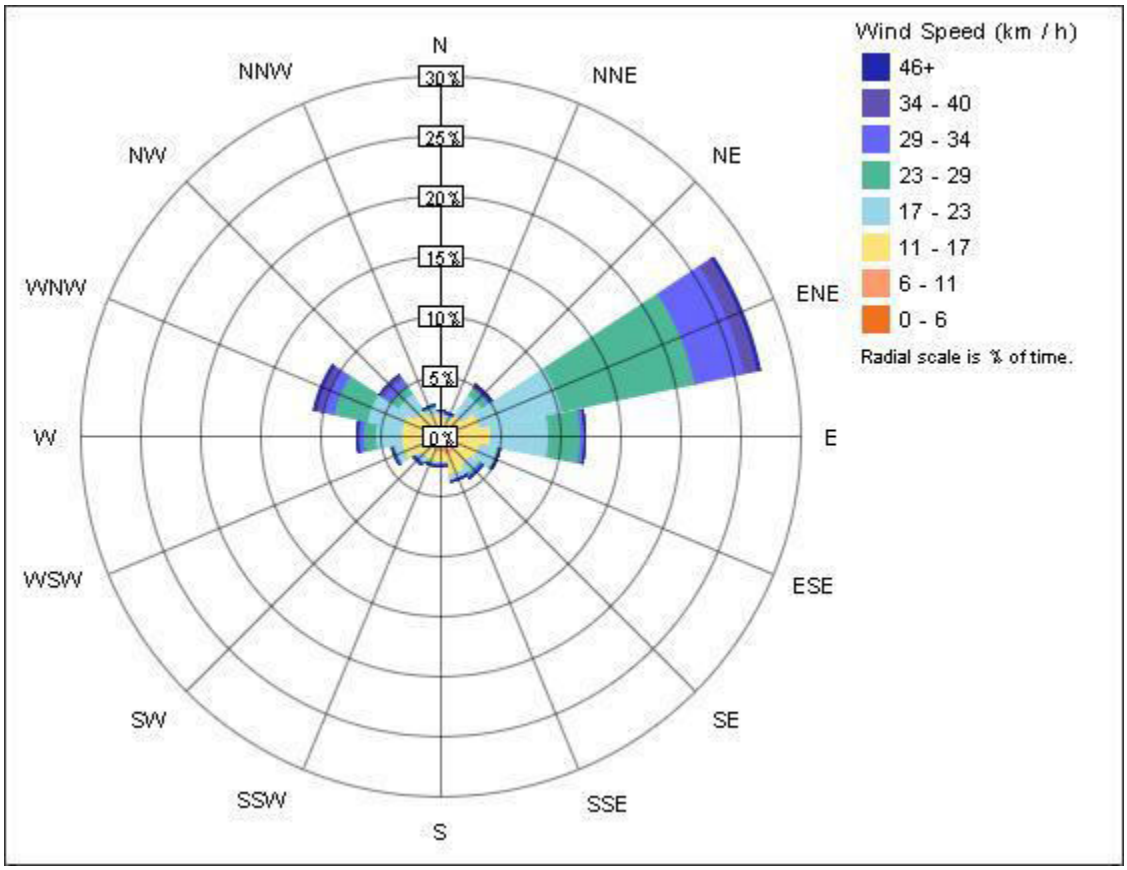
Monthly Electricity Consumption



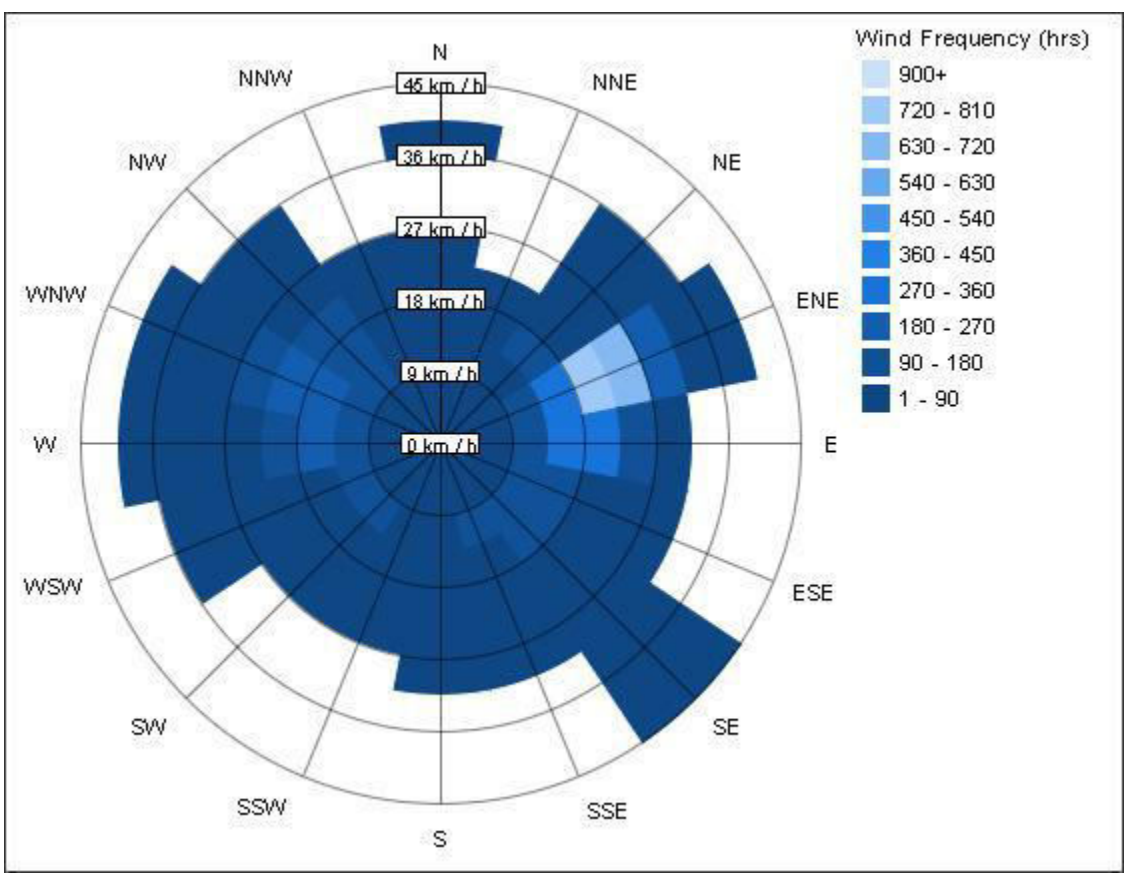
Monthly Peak Demand



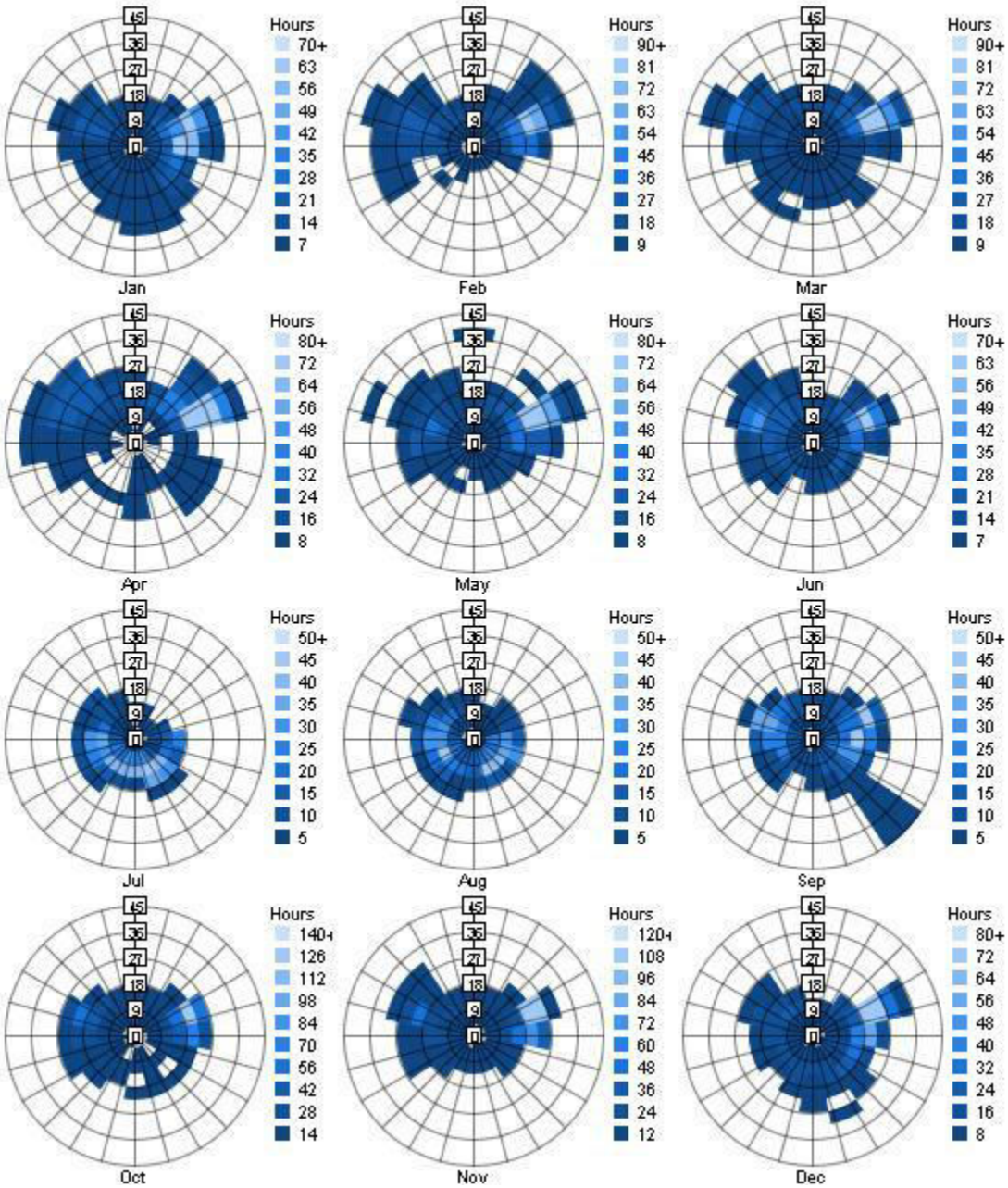
Annual Wind Rose (Speed Distributio



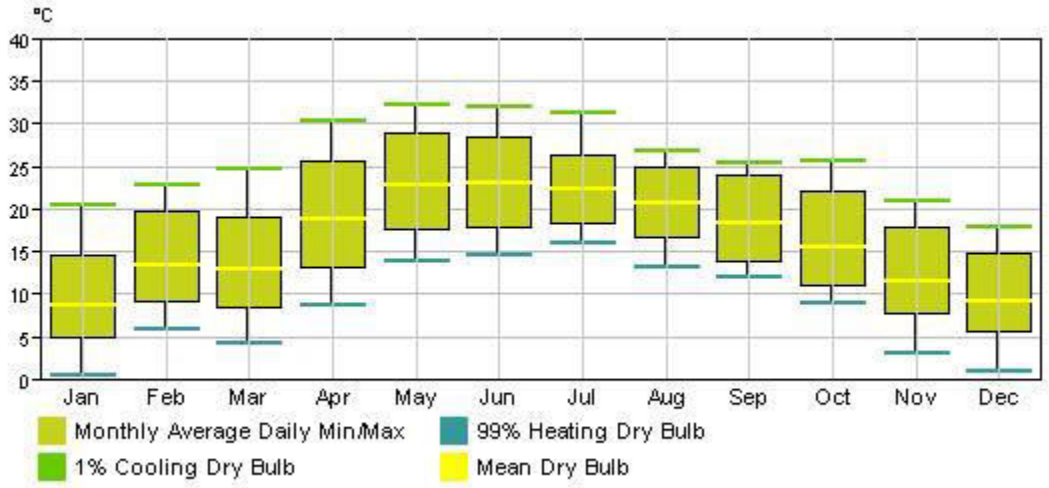
Annual Wind Rose (Frequency Distribution)



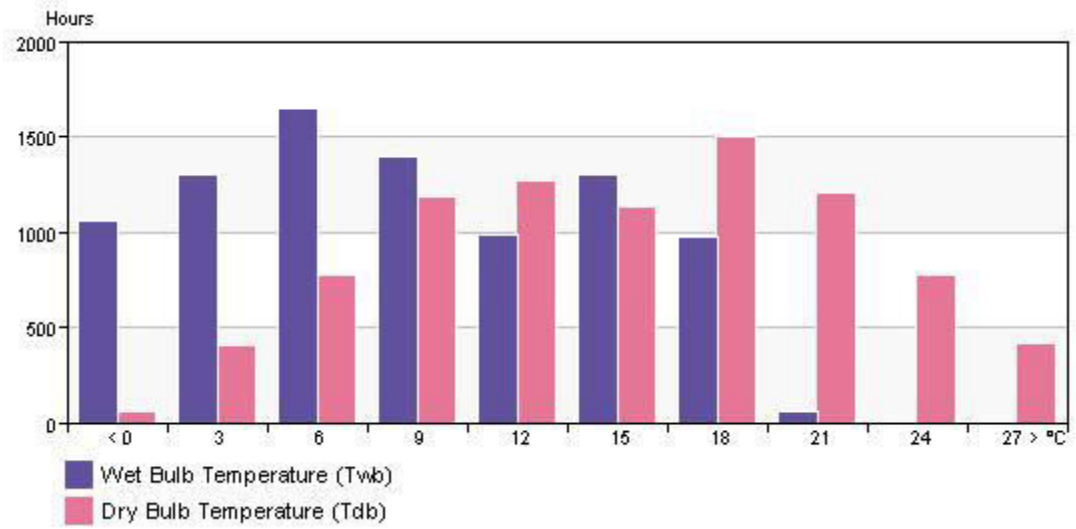
Monthly Wind Roses



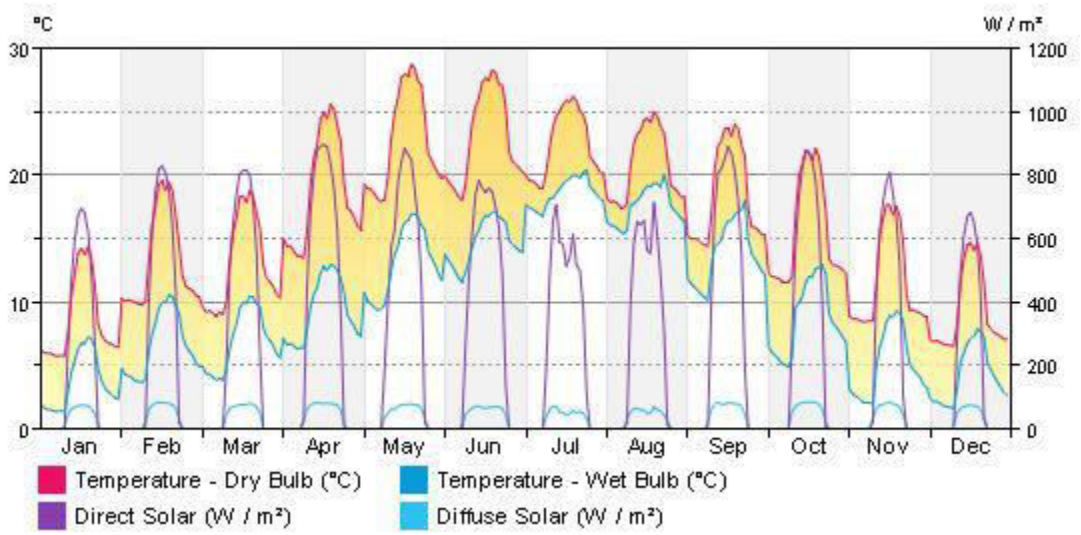
Monthly Design Data



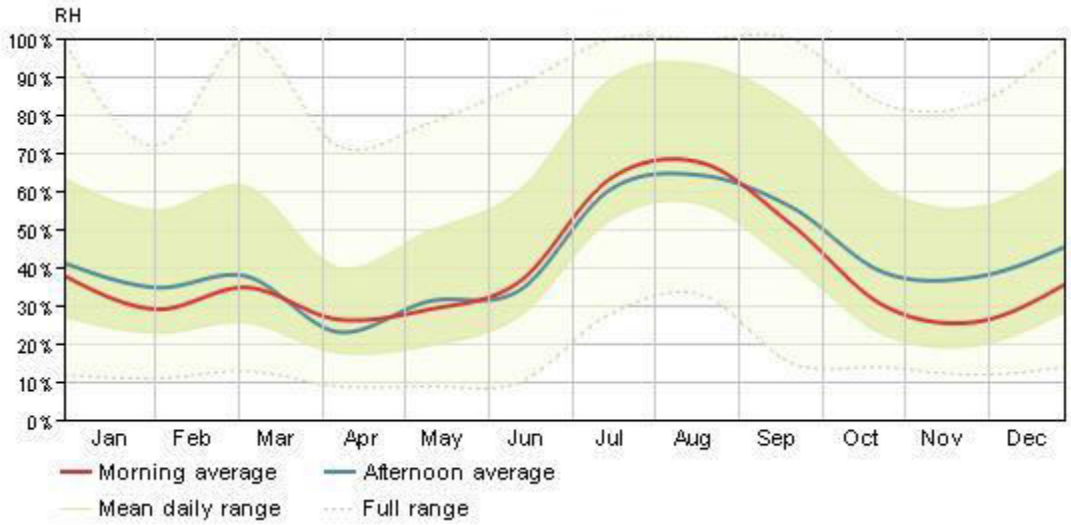
Annual Temperature Bins



Diurnal Weather Averages



Humidity



Energy Analysis Data

5.5 Results for the Composite climate

5.3.1 Obtaining internal temperature for the different spaces

Table 5.2 Calculation of ΔT, T_i, T_0 for composite climates

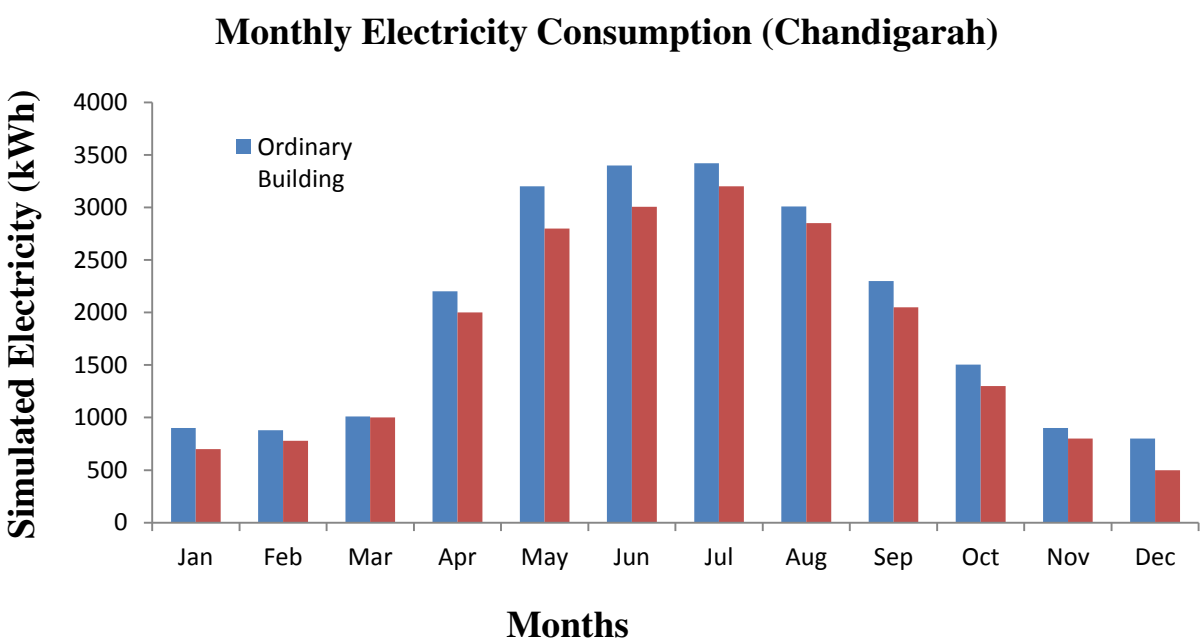
	ΔT	T0	Ti
R1	5.82	45	39.17
R2	6.05	45	38.94
R3	5.45	45	39.54
R4	4.44	45	40.55
R5	5.58	45	39.41
DR	5.66	45	39.33
K	8.88	45	36.11
WR1	9.63	45	35.36
WR2	5.47	45	39.52
WR3	17.74	45	27.25
WR4	25.70	45	19.29
2^{nd} Floor			
R1	12.11	45	32.88
R2	16.17	45	28.82
R3	13.59	45	31.40
R4	13.58	45	31.41
WR1	15.08	45	29.91
WR2	14.75	45	30.24

5.3.2 Obtaining energy analysis for the building

Obtaining the comfortable situation inside the spaces by theoretical means , it is needed to do whole energy analysis of the building for the real situation , which is done with the help of Autodesk Revit 2016. Energy analysis is done by the software and results are presented in the following sheets.

5.6 Discussion of results

Room2 has the most comfortable situations in both the floors and Room 4 in 1st floor and Room 1 in the has the least amongst all. Decrease in the temperature is due to the use of low embodied energy material which are environment friendly and we can say that green material which have a very few or negligible harmful effects on the living beings and the surrounding environment. On the other hand, comparison of the green building for the composite climate has shown improved results than the conventional building .This was made possible because of the improved design strategies adopted for the modeling . It is made clear from the results that green building improved building performance, lower life cycle energy cost, lower monthly heating and cooling loads, lower monthly electricity consumption. As the results are precise and valid , we can say that green buildings are way beyond than the conventional ones and it has effectiveness , weather it has been built in any climate . following is the comparison of the monthly temperature fluctuation for the respective models.

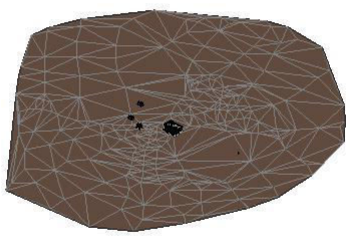


AUTODESK.

(5.7) ENERGY ANALYSIS RESULT FOR THE COMPOSITE CLIMATE (conventional) CHANDIGHAR CONVENTIONAL BUILDING 2016

Analyzed at 3/26/2017 5:14:42 PM
Version 2017.1.7.39(DOE-2.2-48r)

Energy Analysis Result



Building Performance Factors

Location:	Sector 32, India
Weather Station:	429737
Outdoor Temperature:	Max: 42°C/Min: 2°C
Floor Area:	694 m²
Exterior Wall Area:	435 m²
Average Lighting Power:	4.84 W / m²
People:	2 people
Exterior Window Ratio:	0.72
Electrical Cost:	$0.05 / kWh
Fuel Cost:	$0.14 / Therm

Energy Use Intensity

Electricity EUI:	96 kWh / sm / yr
Fuel EUI:	144 MJ / sm / yr
Total EUI:	490 MJ / sm / yr

Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	709,247 kWh
Life Cycle Fuel Use:	1,057,663 MJ
Life Cycle Energy Cost:	$15,794

*30-year life and 6.1% discount rate for costs

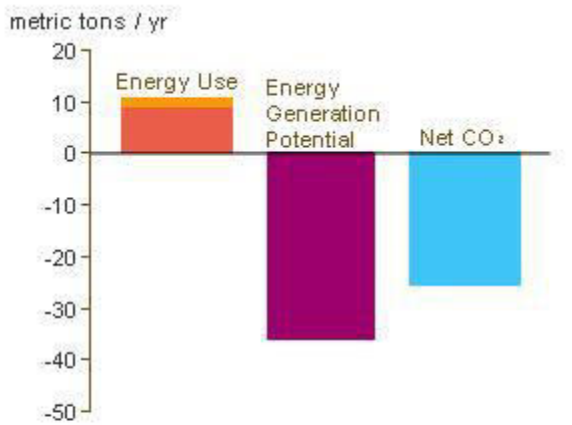
Energy Analysis Result

Renewable Energy Potential

Roof Mounted PV System (Low efficiency):	31,521 kWh / yr
Roof Mounted PV System (Medium efficiency):	63,041 kWh / yr
Roof Mounted PV System (High efficiency):	94,562 kWh / yr
Single 15' Wind Turbine Potential:	836 kWh / yr

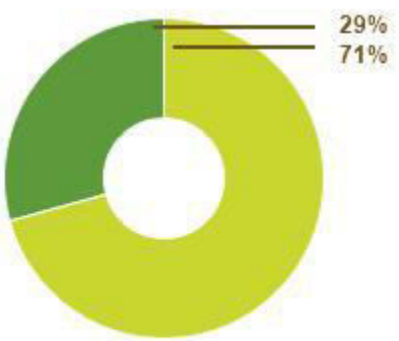
*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

Annual Carbon Emissions



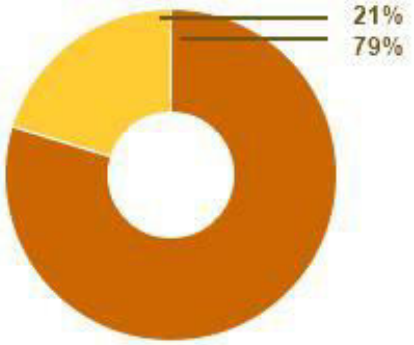
	(metric tons / yr)
Electricity Consumption	8
Fuel Consumption	1
Roof PV Potential (High Efficiency)	-35
Single 15' Wind Turbine Potential	0
Net CO₂	-26

Annual Energy Use/Cost



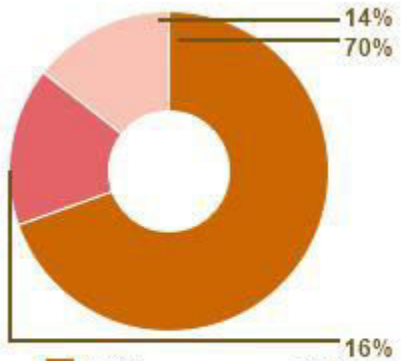
Electricity	71%	$1,111	23,641	kWh
Fuel	29%	$48	35,255	MJ
		$1,160		

Energy Use: Fuel



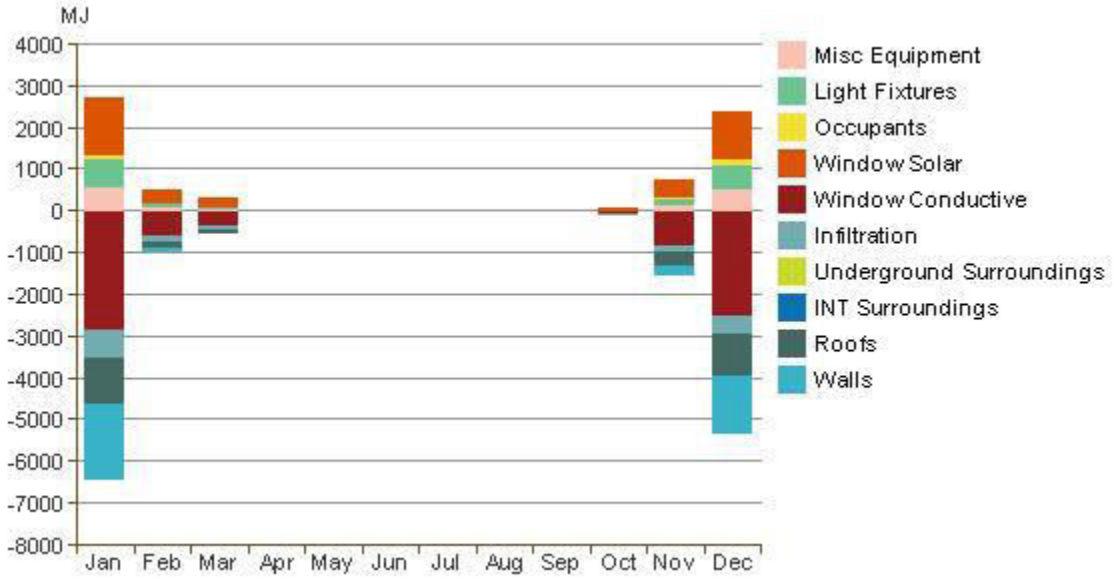
			(MJ)
HVAC	79%	$38	28,097
Domestic Hot Water	21%	$9	7,158
		$47	35,255

Energy Use: Electricity

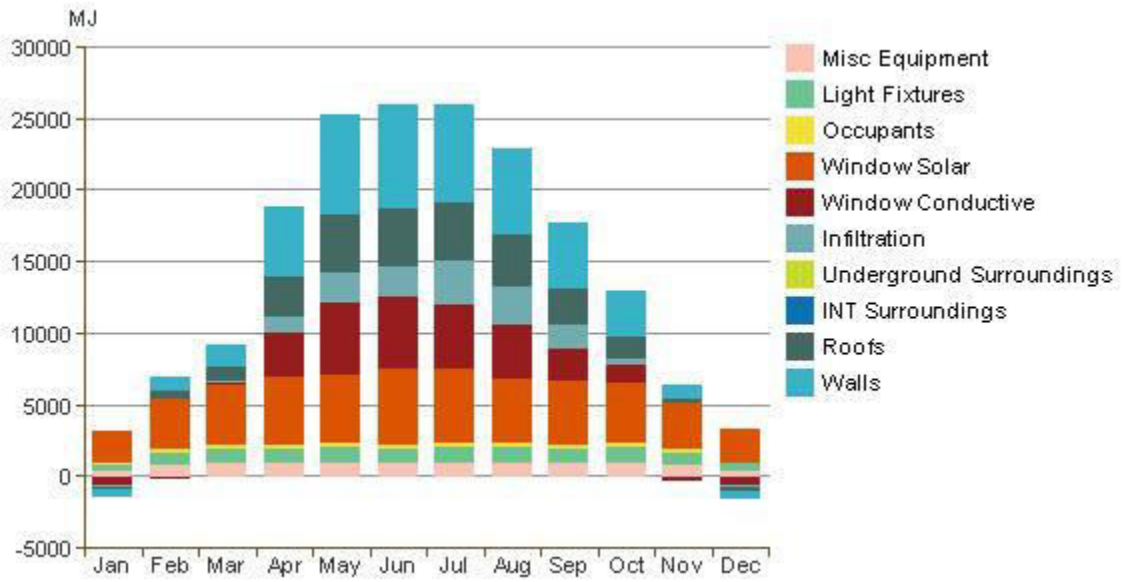


			(kWh)
HVAC	70%	$772	16,440
Lighting	16%	$178	3,796
Misc Equipment	14%	$160	3,404
		$1,110	23,640

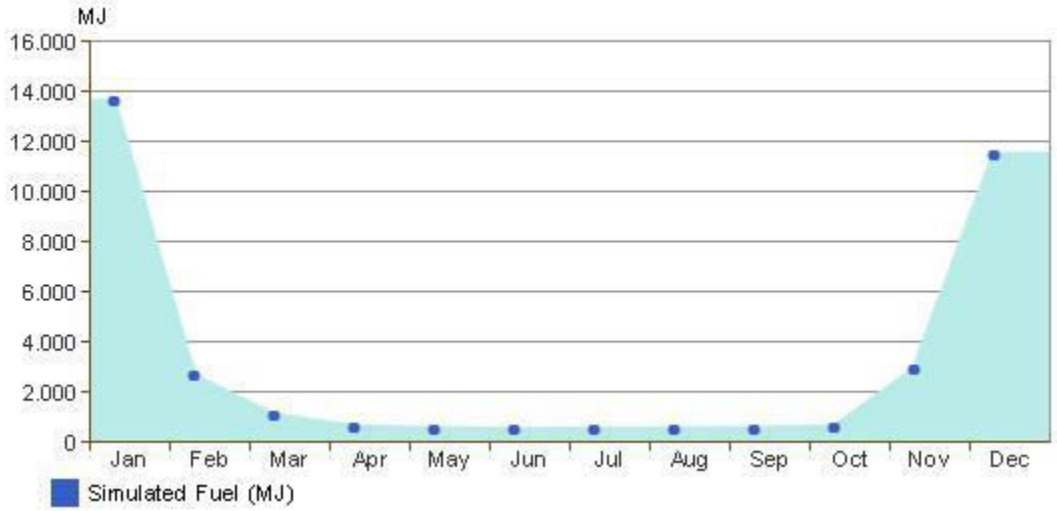
Monthly Heating Load



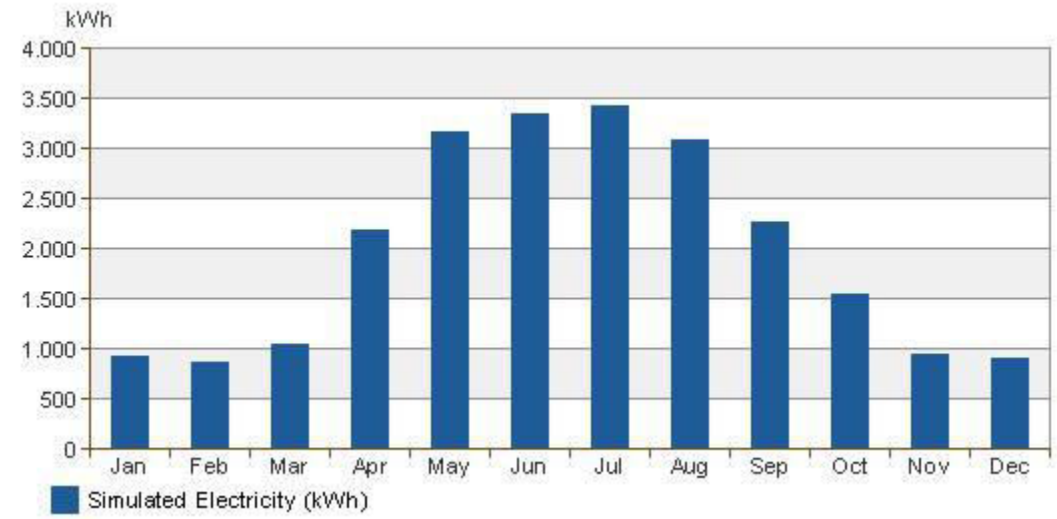
Monthly Cooling Load



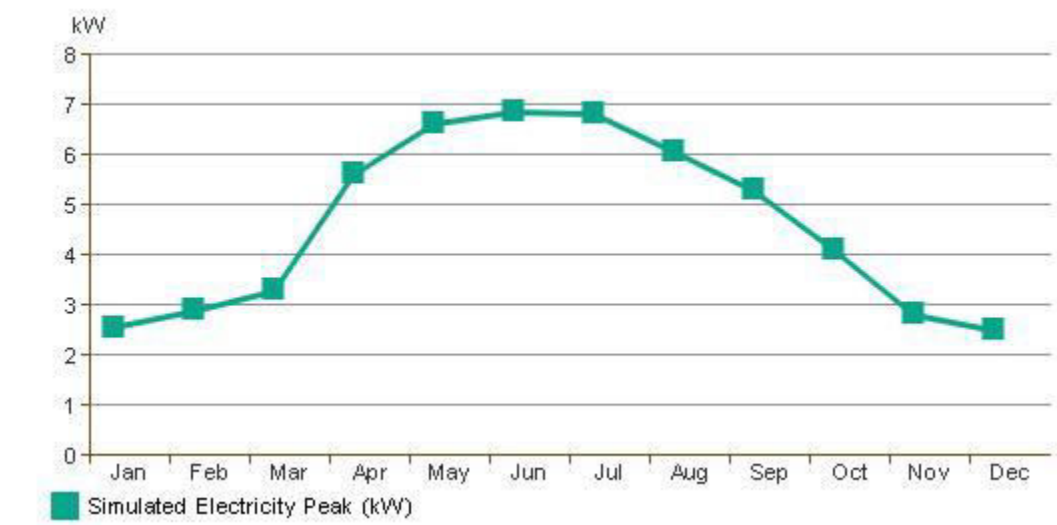
Monthly Fuel Consumption



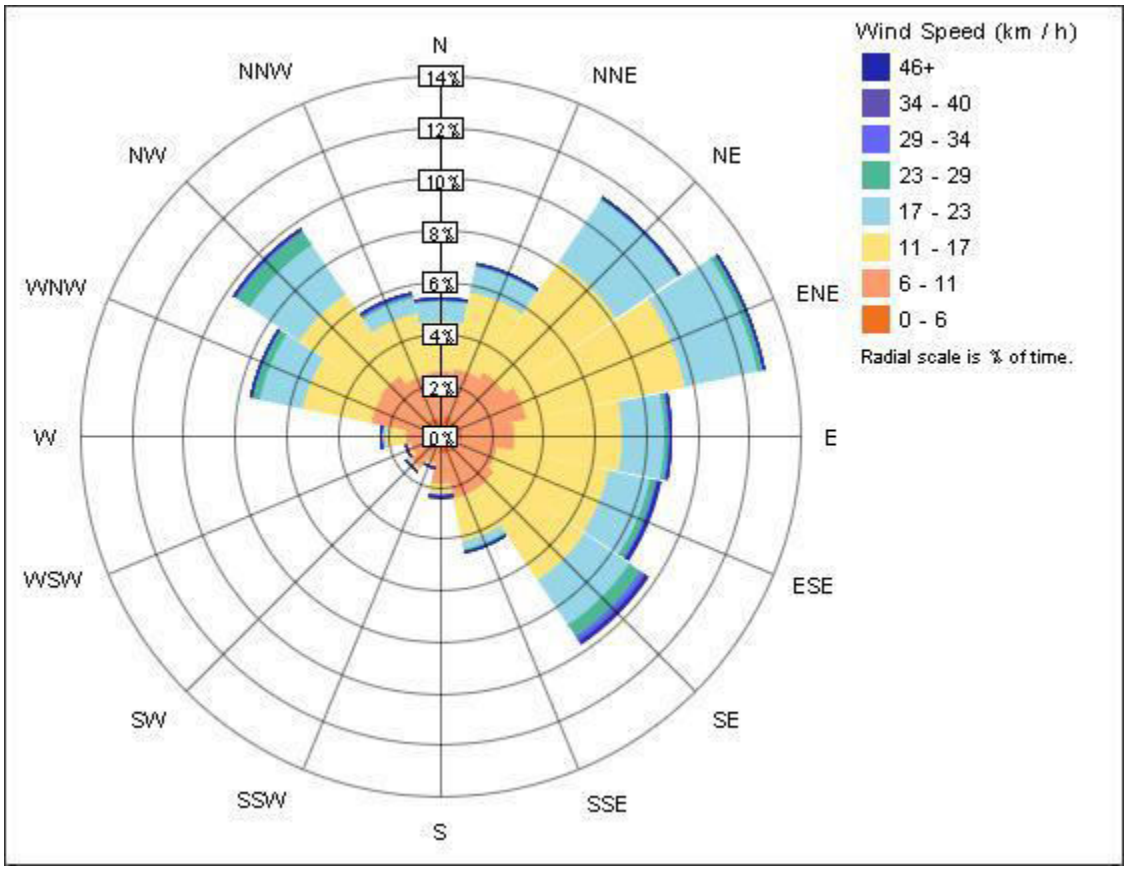
Monthly Electricity Consumption



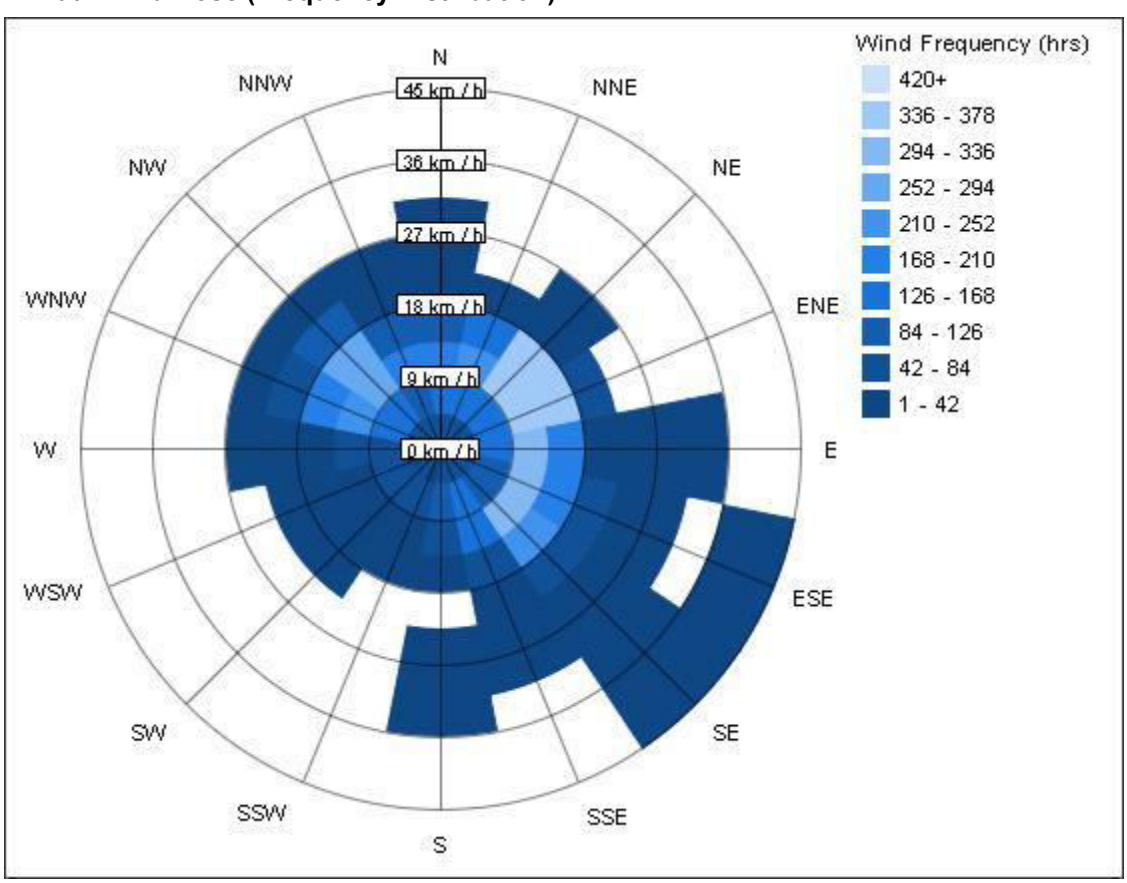
Monthly Peak Demand



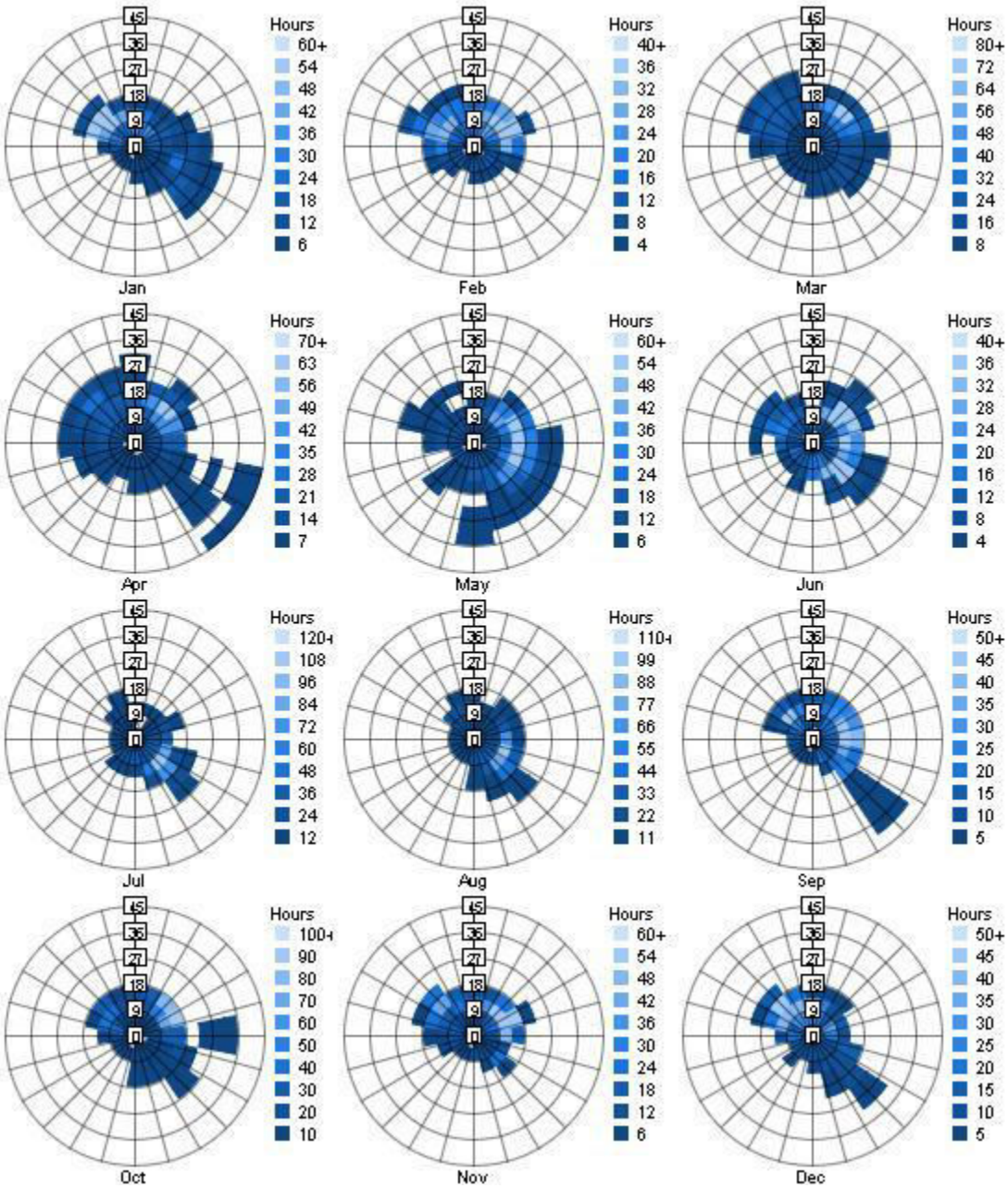
Annual Wind Rose (Speed Distribution)



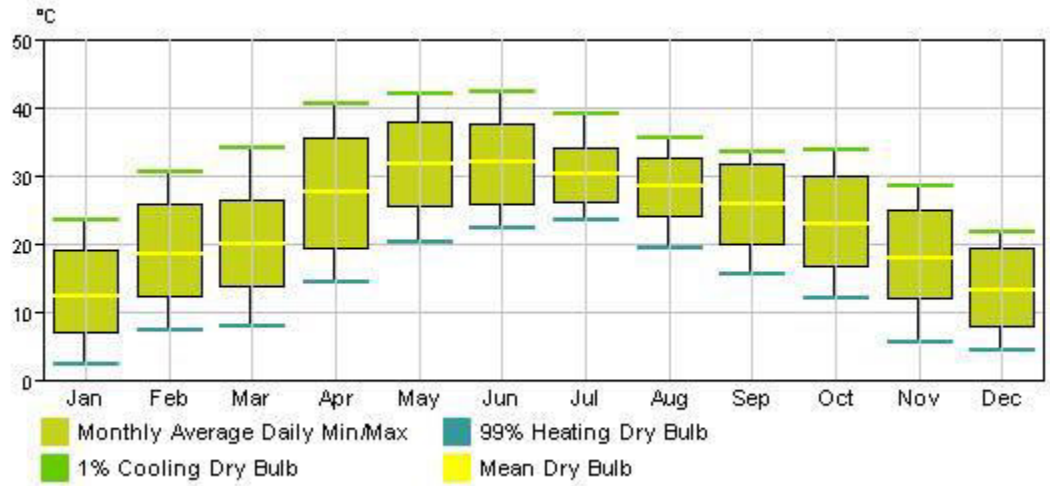
Annual Wind Rose (Frequency Distribution)



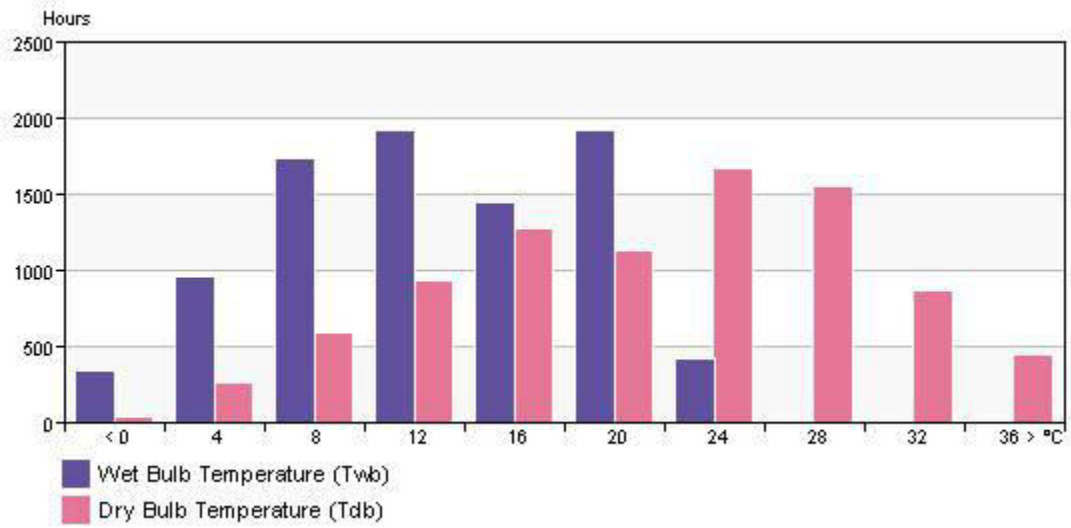
Monthly Wind Roses



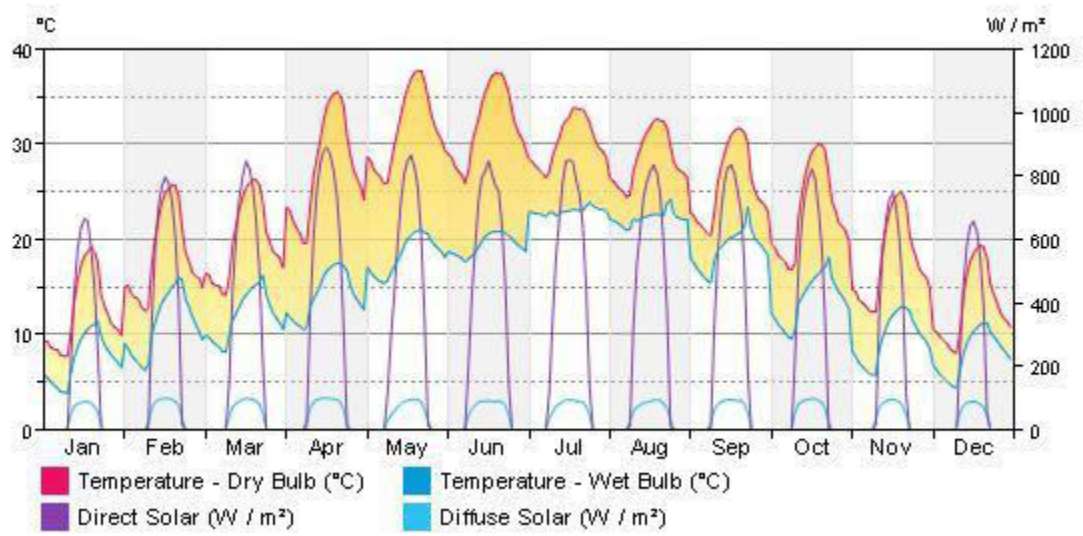
Monthly Design Data



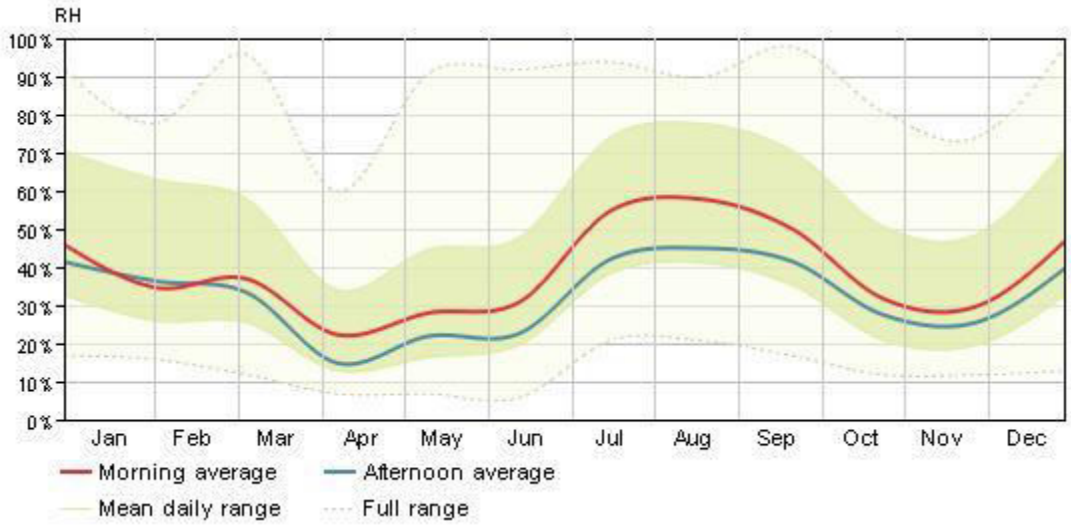
Annual Temperature Bins



Diurnal Weather Averages



Humidity



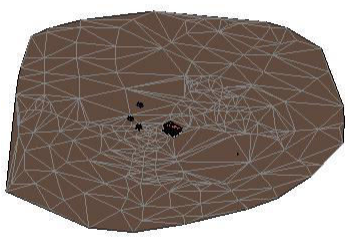
Energy Analysis Data

AUTODESK.

(5.8) ENERGY ANALYSIS RESULT FOR COLD AND CLOUDY CLIMATE (GREEN) CHANDIGHAR GREEN BUILDING 2016

Analyzed at 3/26/2017 12:23:01 PM
Version 2017.1.7.39(DOE-2.2-48r)

Energy Analysis Result



Building Performance Factors

Location:	Sector 32, India
Weather Station:	429737
Outdoor Temperature:	Max: 42°C/Min: 2°C
Floor Area:	694 m²
Exterior Wall Area:	431 m²
Average Lighting Power:	4.84 W / m²
People:	2 people
Exterior Window Ratio:	0.72
Electrical Cost:	$0.05 / kWh
Fuel Cost:	$0.14 / Therm

Energy Use Intensity

Electricity EUI:	89 kWh / sm / yr
Fuel EUI:	129 MJ / sm / yr
Total EUI:	451 MJ / sm / yr

Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	658,667 kWh
Life Cycle Fuel Use:	951,040 MJ
Life Cycle Energy Cost:	$14,648

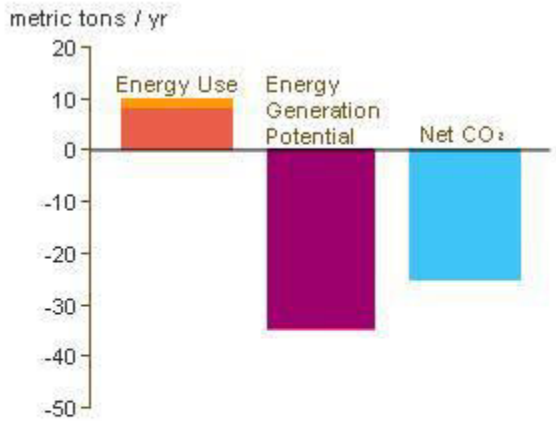
*30-year life and 6.1% discount rate for costs

Renewable Energy Potential

Roof Mounted PV System (Low efficiency):	30,434 kWh / yr
Roof Mounted PV System (Medium efficiency):	60,868 kWh / yr
Roof Mounted PV System (High efficiency):	91,302 kWh / yr
Single 15' Wind Turbine Potential:	836 kWh / yr

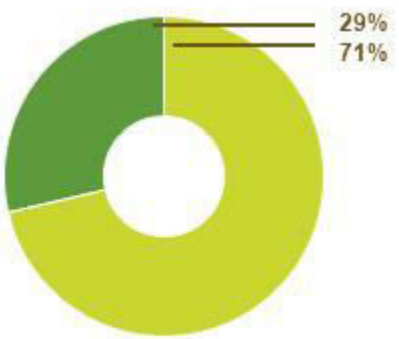
*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

Annual Carbon Emissions



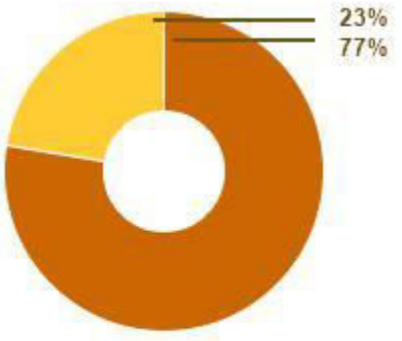
	(metric tons / yr)
Electricity Consumption	8
Fuel Consumption	1
Roof PV Potential (High Efficiency)	-34
Single 15' Wind Turbine Potential	0
Net CO2	-25

Annual Energy Use/Cost



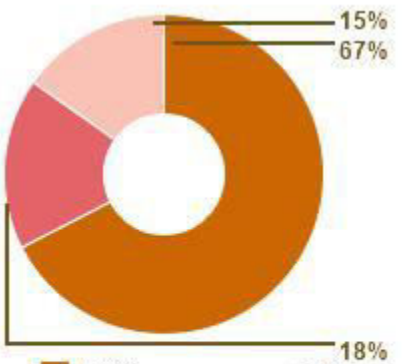
Electricity	71%	$1,032	21,955	kWh
Fuel	29%	$44	31,701	MJ
		$1,075		

Energy Use: Fuel



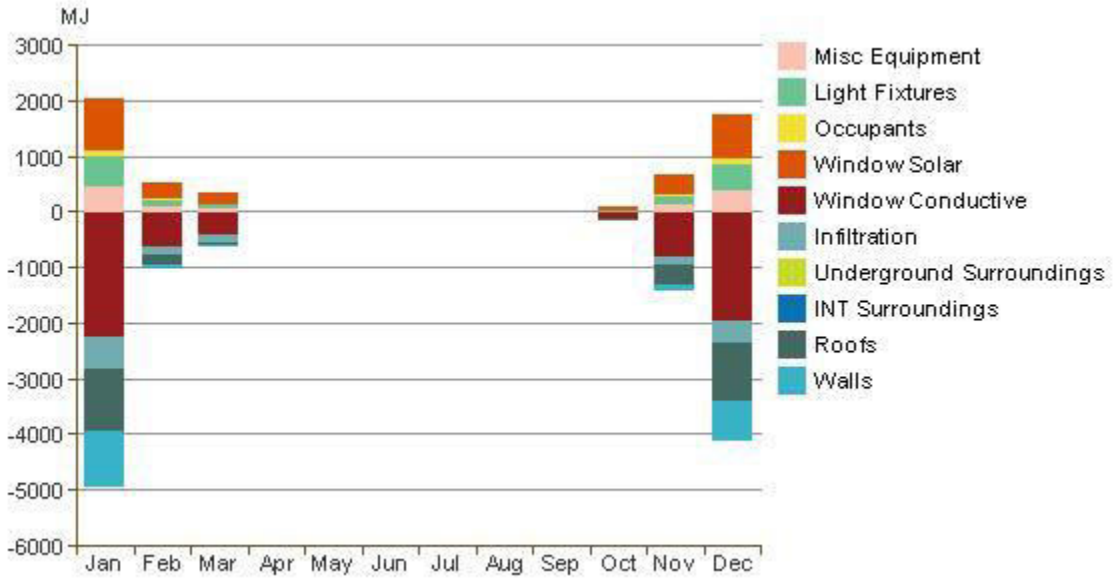
			(MJ)
HVAC	77%	$33	24,593
Domestic Hot Water	23%	$9	7,107
		$42	31,700

Energy Use: Electricity

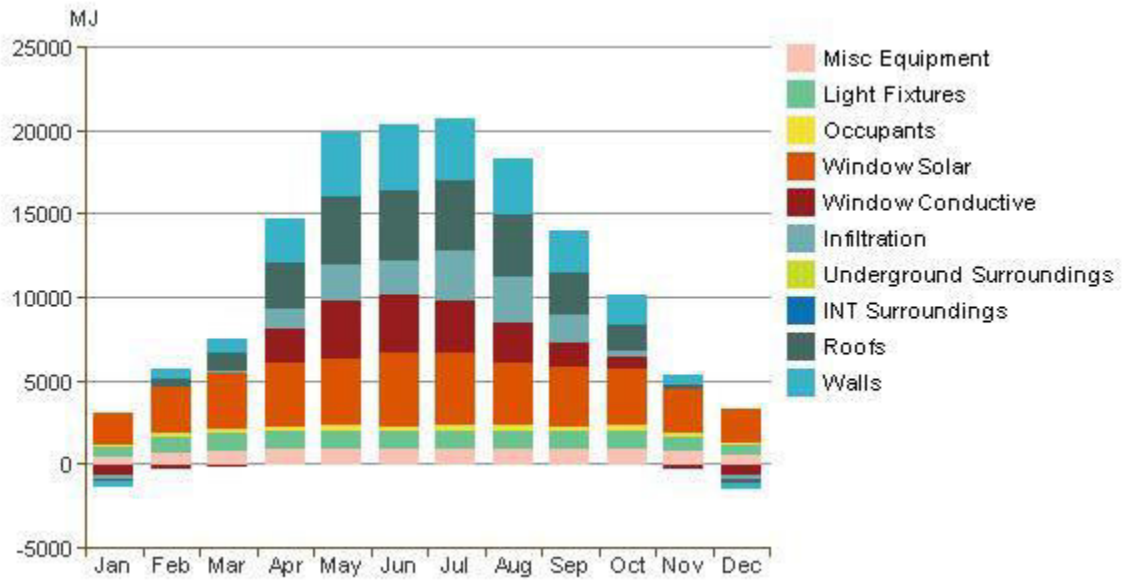


			(kWh)
HVAC	67%	$695	14,804
Lighting	18%	$178	3,799
Misc Equipment	15%	$157	3,351
		$1,030	21,954

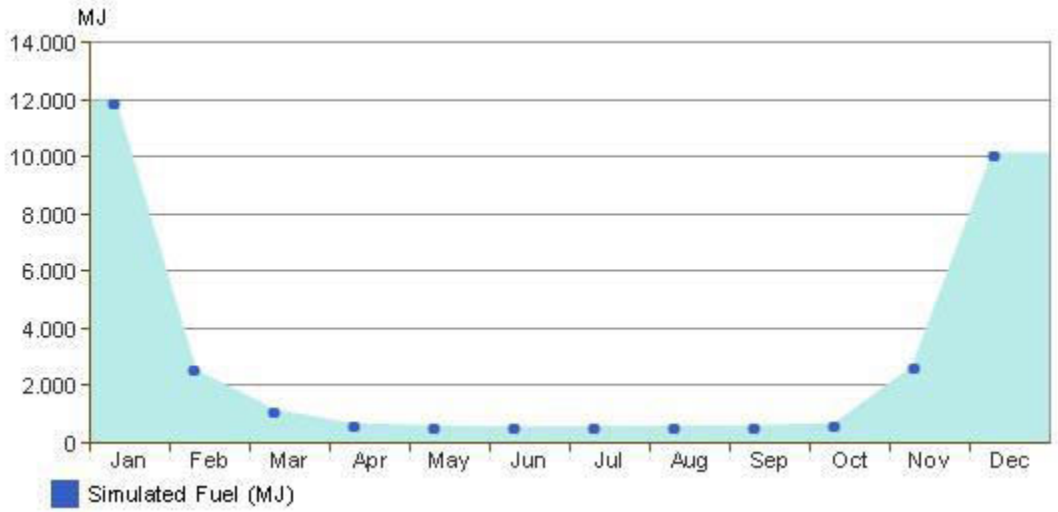
Monthly Heating Load



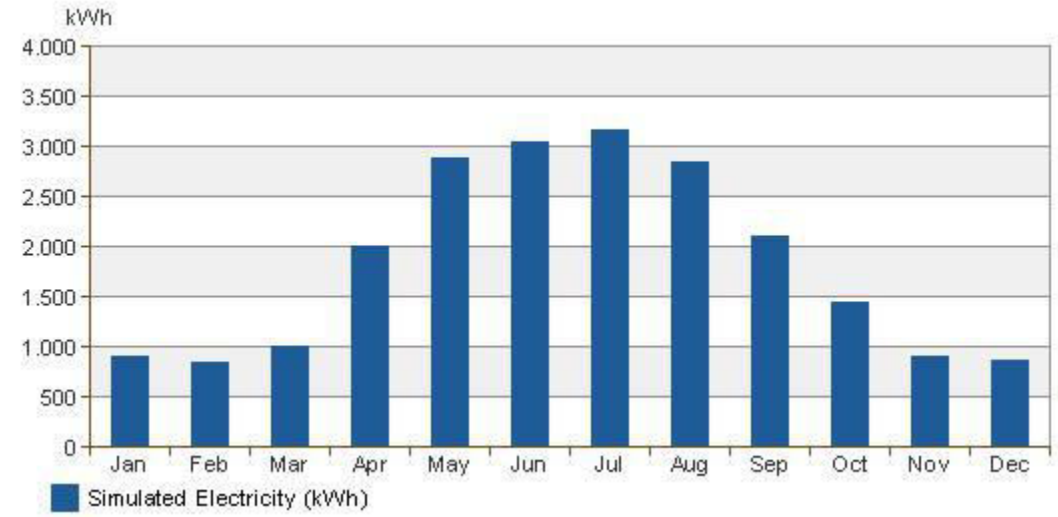
Monthly Cooling Load



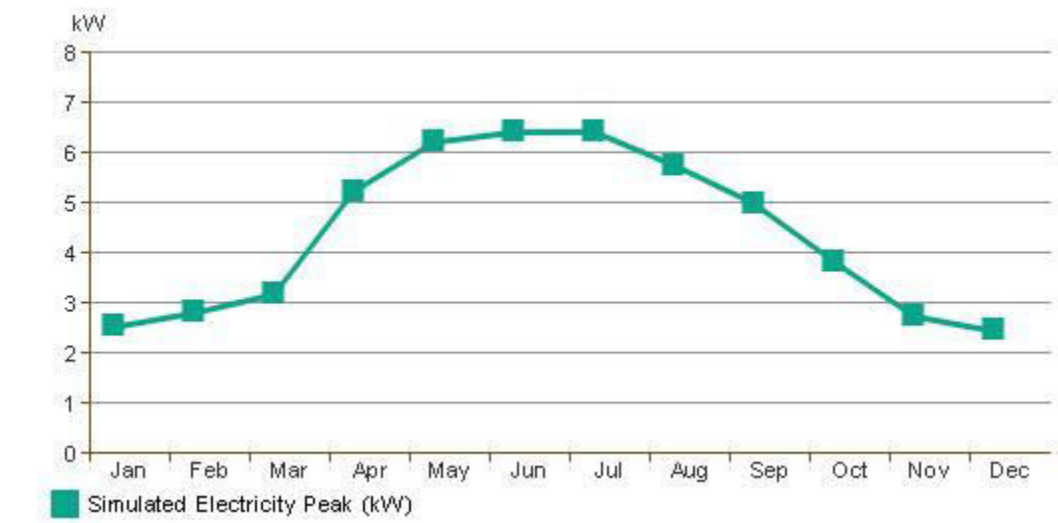
Monthly Fuel Consumption



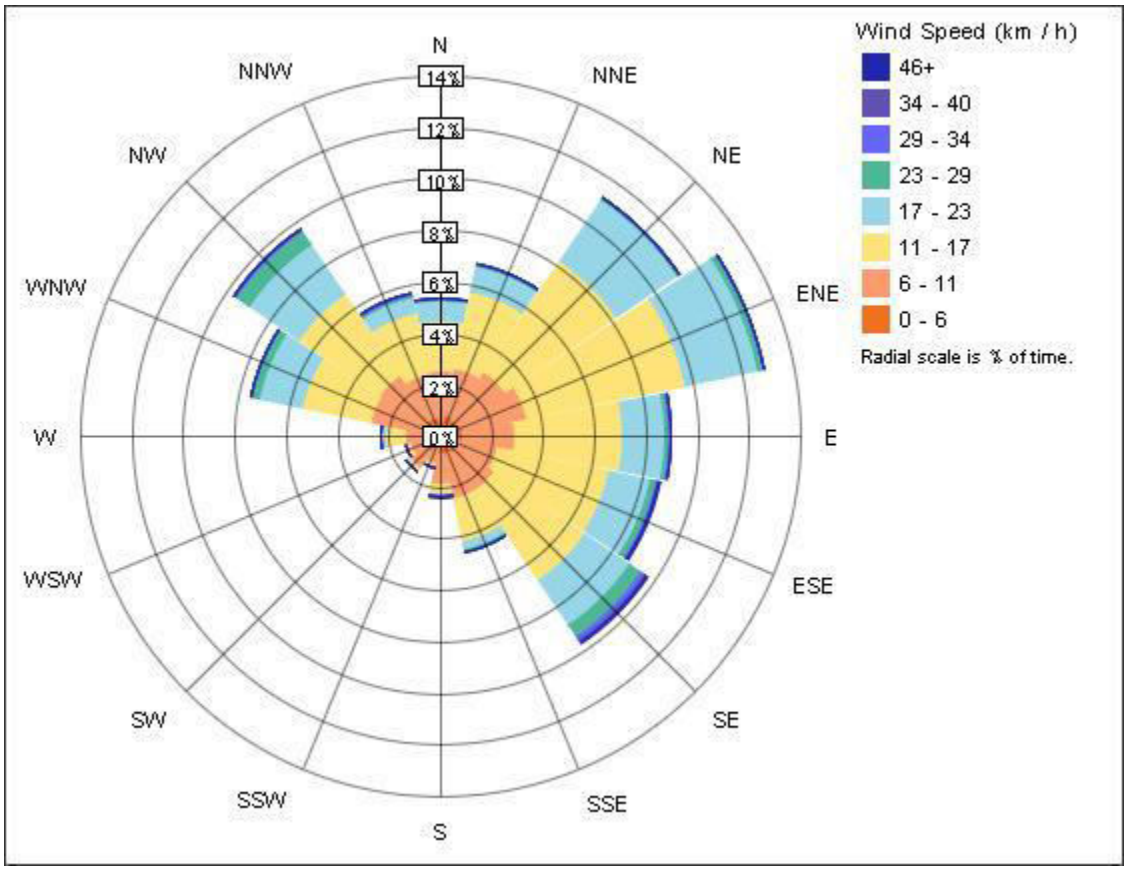
Monthly Electricity Consumption



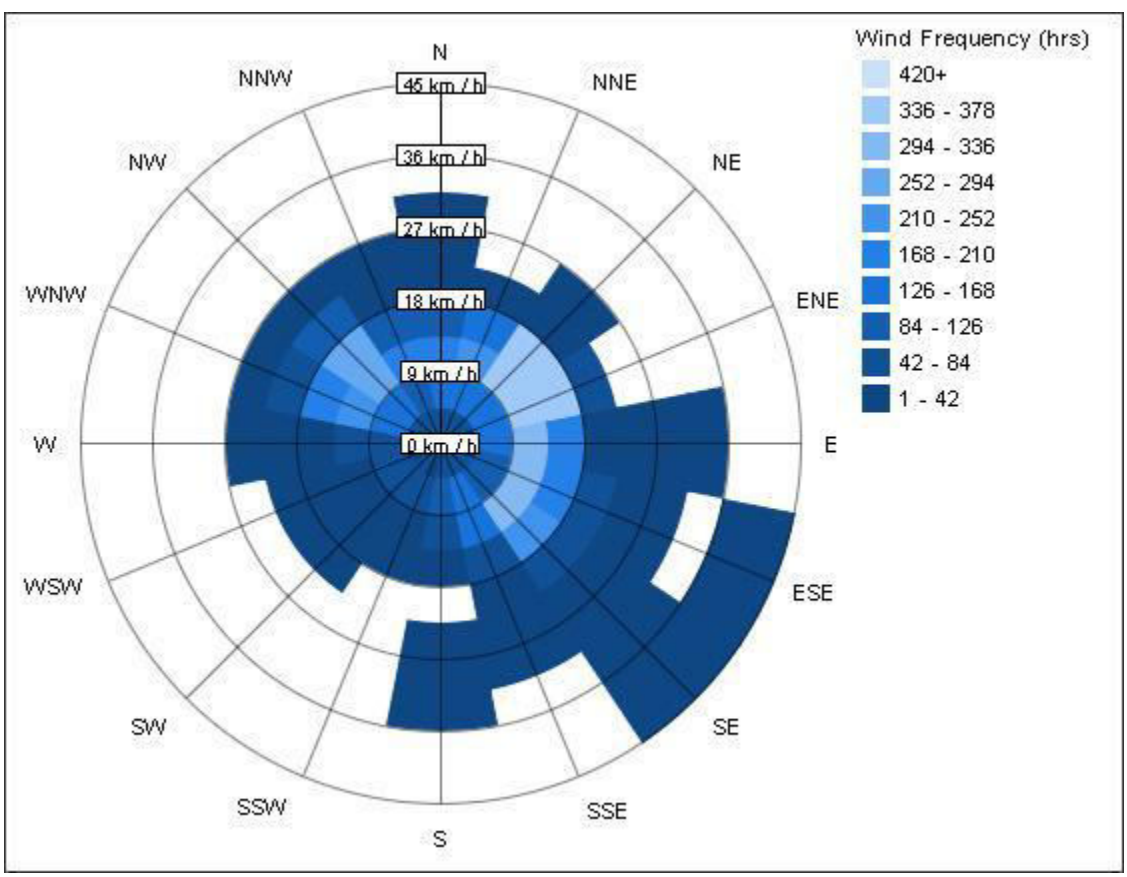
Monthly Peak Demand



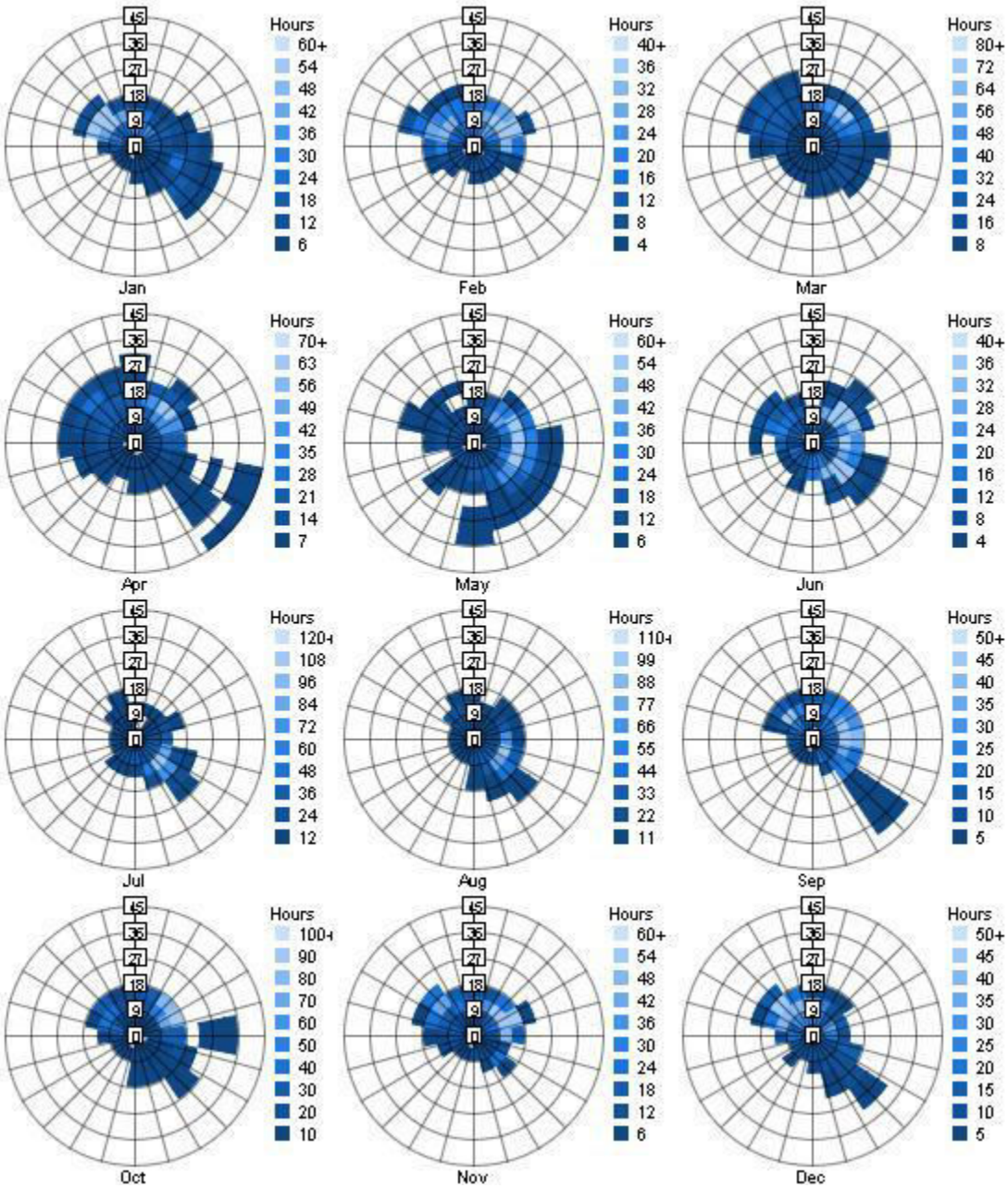
Annual Wind Rose (Speed Distribution)



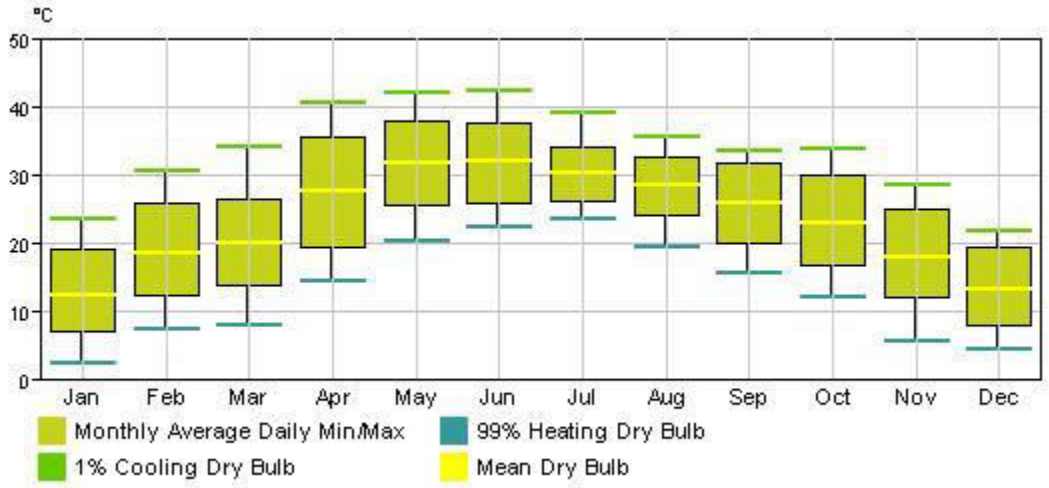
Annual Wind Rose (Frequency Distribution)



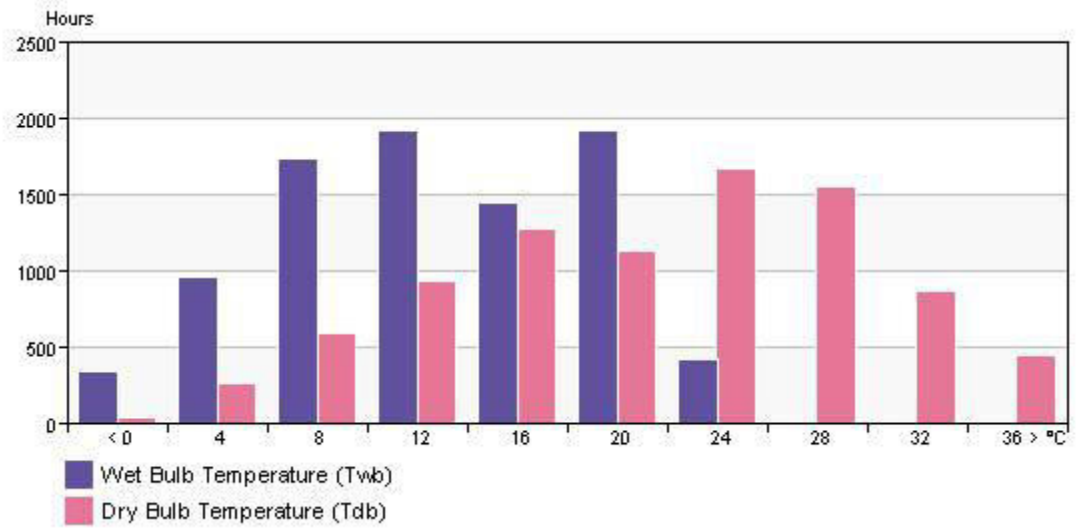
Monthly Wind Roses



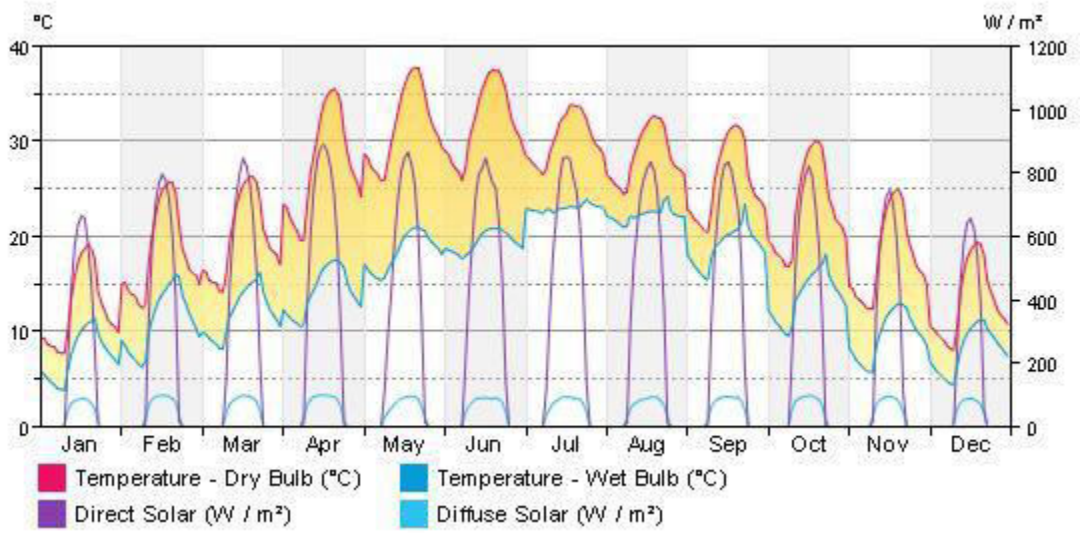
Monthly Design Data



Annual Temperature Bins

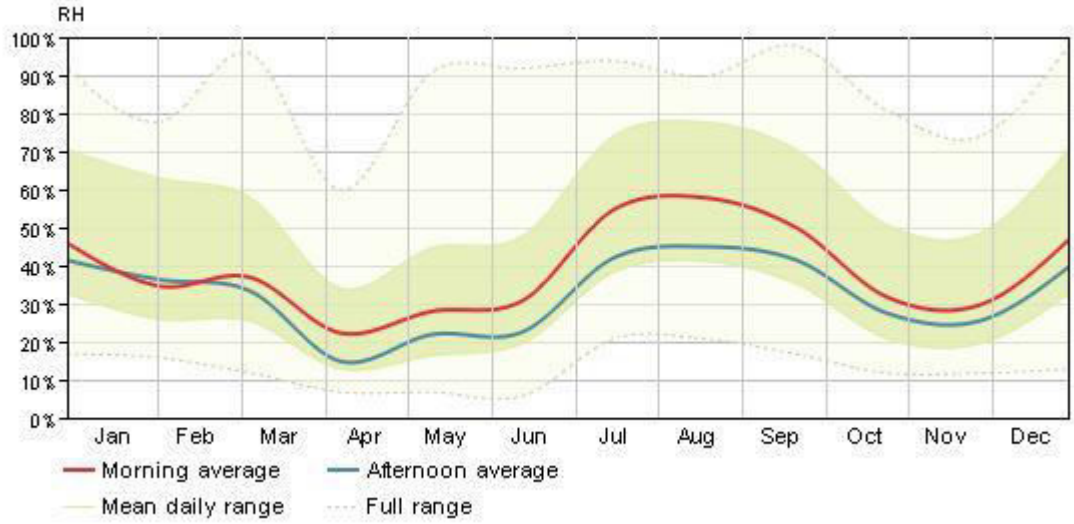


Diurnal Weather Averages



Energy Analysis Result

Humidity



5.9 Energy analysis results and discussion for the cold and cloudy climate

Life cycle electricity use for the green building is reduced by the 285,424 kwh and energy cost is reduced by the $3973. This shows improvement over the energy efficiency for the 30 years.

5.10 Construction cost results and discussion for the cold and cloudy climate

Construction cost for the conventional building is Rs.20,97,024.15 and construction cost for the green building basically is Rs.22,10,000 .Adding the solar PV 100Kw plant and the 200ltr. solar water heater which costs Rs.119,518 and adding the composite wall panels is Rs. 268,193.68 which increases the total cost to Rs.2,597,711.68. this cost is 23% higher than the conventional building cost and is recoverable over the 18-20 years as the energy efficiency will be more.

5.11 Energy analysis results and discussion for the composit climate

Life cycle electricity use for the green building is reduced by the 398,996 kwh and energy cost is reduced by the $1146. This shows improvement over the energy efficiency for the 30 years.

5.12 Construction cost results and discussion for the cold and cloudy climate

Construction cost for the conventional building is Rs.26,13,303 and construction cost for the green building basically is Rs.30,61,343. Adding the solar PV 100Kw plant and the 200ltr. solar water heater which costs Rs.119,518 and adding the composite wall panels is Rs. 2,87,193.76 which increases the total cost to Rs.34,68,054. this cost is 23% higher than the conventional building cost and is recoverable over the 18-20 years as the energy efficiency will be more.

CHAPTER-6

CONCLUSION

From the above results and discussion , conclusion is drawn on the basis of comparison of green energy analysis and cost for buildings built on different climatic zones with the conventional ones.

1. Construction Cost of the green building for the Shimla is 23% higher than conventional building cost. Cost for the green building for Chandighar is 17% higher than the conventional building. Life cycle electricity use for the green building is built in Shimla reduced by the 285,424 kwh and energy cost is reduced by the $3973. Life cycle electricity use for the green building built in Shimla is reduced by the 398,996 kwh and energy cost is reduced by the $1146. This shows improvement over the energy efficiency for the 30 years.This is because of the the industrilized construction material which are not loccally available at the place , the materials are little higher in cost as the manufacturing of it has various components. Second reason is the installation of the solar PV panels and water heater which is added after the construction has completerd. Due to the new innovative technologies buidings are becoming more energy efficient.
2. Energy analysis for both the green buildings has shown effective results in the life cycle energy use , electricity cost/yr , reduced carbon emmisin, higher potential of renewable energies . This is because of modelling of building adapting the passive solar techniques ,enhanced thermal, mechanical and insulation properties of materials which are used in flooring, roofing , walls and windows provide comfortable room tempreture reducing the need of heating and cooling mechanical devices and additionally saving in the long term energy bills.

FUTURE SCOPE OF WORK

1. Thermal analysis in this thesis is done for the steady heat flow. One can work out for the periodic heat flow.
2. Whole building cost can be taken for variability instead taking the construction cost.

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ANNEXURE-A

ANALYSIS OF COLD AND CLOUDY CLIMATE

A.1 Calculations of overall thickness and U-values of different walls

Calculation of overall thickness of walls and U- values											
		Material	K	1/K	b	b/K	$1/f_i$	$1/f_o$	$1/R_c$	Ra	U
Room1	wall1	12 mm plaster(vermiculite)	0.201	4.9751	0.01	0.06					
		114 mm lightweight bricks	0.374	2.6738	0.11	0.305					
		100 mm wood fibre softboard	0.065	15.384	0.1	1.53					
		internal surface of wall					0.123				
		external surface of wall(south)						0.076			
		total			0.226	1.903	0.123	0.076		2.102	0.48
	wall2 wall3	12 mm plaster(vermiculite)	0.201	4.9751	0.012	0.06					
		114 mm lightweight bricks	0.374	2.6738	0.114	0.305					
		100 mm wood fibre softboard	0.065	15.384	0.1	1.538					
		internal surface of wall					0.123				
		total			0.226	1.903	0.123	2.026		4.052	0.25
	wall4	150mm cork slab:regrannulated and baked	0.039	25.641	0.15	3.846					
		12 mm plaster(vermiculite)	0.201	4.9751	0.012	0.06					
		15 mm plasterboard	0.159	6.2893	0.015	0.094					
		internal surface of wall					0.123				
		external serface of wall(west)						0.076			

		total			0.177	4	0.123	0.076		4.199	0.24
										sum total	1.21
Room2	wall1 wall2	150mm cork slab:regrannulated and baked	0.039	25.641	0.15	3.846					
		12 mm plaster(vermiculite)	0.201	4.9751	0.012	0.06					
		15 mm plasterboard	0.159	6.2893	0.015	0.094					
		internal surface of wall					0.123				
		total			0.177	4	0.123	0		4.123	0.24
	wall3	114 mm lightweight Brickwork	0.374	2.6738	0.114	0.305					
		100mm glass wool blanket	0.042	23.809	0.1	2.381					
		50mm cavity with aluminium foil			0.05				0.35		
		7.62 mm mineral wool(rigid slab)	0.049	20.408	0.008	0.156					
		19 mm plasterwood	0.159	6.2893	0.019	0.119					
		internal surface of wall					0.123				
		external surface of wall(north)						0.053			
		total			0.291	2.961	0.123	0.053	0.35	3.489	0.29
	wall4	114 mm lightweight Brickwork	0.374	2.6738	0.114	0.305					
		100mm glass wool blanket	0.042	23.809	0.1	2.381					
		50mm cavity with aluminium foil			0.05				0.35		
		7.62 mm mineral wool(rigid slab)	0.049	20.408	0.008	0.156					
		19 mm plasterwood	0.159	6.2893	0.019	0.119					

		internal surface of wall					0.123				
		external surface of wall(west)						0.076			
		total			0.291	2.961	0.123	0.076	0.35	3.512	0.28
										Sum total	1.06
Room3	wall 1 wall 2	150mm cork slab:regrannulated and baked	0.039	25.641	0.15	3.846					
		12 mm plaster(vermiculite)	0.201	4.9751	0.012	0.06					
		15 mm plasterboard	0.159	6.2893	0.015	0.094					
		internal surface of wall					0.123				
		total			0.177	4	0.123	0		4.123	0.24
	wall3	114 mm lightweight Brickwork	0.374	2.6738	0.114	0.305					
		100mm glass wool blanket	0.042	23.809	0.1	2.381					
		50mm cavity with aluminium foil							0.35		
		7.62 mm mineral wool(rigid slab)	0.049	20.408	0.008	0.156					
		19 mm plasterwood	0.159	6.2893	0.019	0.119					
		internal surface of wall					0.123				
		external surface of wall(north)						0.053			
		total			0.241	2.961	0.123	0.053	0.35	3.489	0.29
	wall4	114 mm lightweight Brickwork	0.374	2.6738	0.114	0.305					
		100mm glass wool blanket	0.042	23.809	0.1	2.381					
		50mm cavity with aluminium foil							0.35		

		7.62 mm mineral wool(rigid slab)	0.049	20.408	0.008	0.156					
		19 mm plasterwood	0.159	6.2893	0.019	0.119					
		internal surface of wall					0.123				
		external surface of wall(east)						0.053			
		total			0.241	2.961	0.123	0.053	0.35	3.489	0.29
										sum total	1.06
Room4	wall1	12 mm plaster(vermiculite)	0.201	4.9751	0.012	0.06					
		114 mm lightweight bricks	0.374	2.6738	0.114	0.305					
		100 mm wood fibre softboard	0.065	15.384	0.1	1.538					
		internal surface of wall					0.123				
		total			0.226	1.903	0.123			2.026	0.49
wall 2 is same as wall wall1 in room 3											
	wall 3	114 mm lightweight Brickwork	0.374	2.6738	0.114	0.305					
		100mm glass wool blanket	0.042	23.809	0.1	2.381					
		50mm cavity with aluminium foil							0.35		
		7.62 mm mineral wool(rigid slab)	0.049	20.408	0.008	0.156					
		19 mm plasterwood	0.159	6.2893	0.019	0.119					
		internal surface of wall					0.123				
		external surface of wall(east)						0.053			
		total			0.241	2.961	0.123	0.053	0.35	3.489	0.29
	wall 4	12 mm plaster(vermiculite)	0.201	4.9751	0.012	0.06					

		114 mm lightweight bricks	0.374	2.6738	0.114	0.305					
		100 mm wood fibre softboard	0.065	15.384	0.1	1.538					
		internal surface of wall					0.123				
		external surface of wall(south)						0.076			
		total			0.226	1.903	0.123	0.076		2.102	0.48
										sum total	1.26
Drawing/Dining room walls are enclosed by all the N,E,S,W oriented pheripheral walls											
Wash room1	wall1	0.0031" thick latex paint									
		10.16 mm insulated fiborous concrete blockpanel	0.06	16.666							
		50 mm cavity			0.05				0.35		
		7.62 mm mineral wool	0.037	27.027	0.008	0.206					
		19mm plasterboard	0.159	6.2893	0.019	0.119					
		58.42 mm straw bales	0.018	55.555	0.058	3.246					
		19 mm plasterboard	0.159	6.2893	0.019	0.119					
		internal surface of wall					0.123				
		total			0.154	3.69	0.123		0.35	4.165	0.24
	wall2 wall3	0.0031" thick latex paint									
		10.16 mm insulated fiborous concrete blockpanel	0.06	16.666							
		50 mm cavity			0.05				0.35		
		7.62 mm mineral wool	0.037	27.027	0.008	0.206					
		19mm plasterboard	0.159	6.2893	0.019	0.119					
		58.42 mm straw bales	0.018	55.555	0.058	3.246					
		19 mm plasterboard	0.159	6.2893	0.019	0.119					

		internal surface of wall					0.123				
		external surface of wall(north, east)						0.053			
		total			0.154	3.69	0.123	0.053	0.35	4.218	0.24
Washroom 2 walls(1,2) are similar of bathroom 1 walls(1)											
Washroom 3 walls(1,2) are similar of bathroom 1 walls(1)											
Drawing/Dinning room	wall 1	114 mm lightweight Brickwork	0.374	2.6738	0.114	0.305					
		100mm glass wool blanket	0.042	23.809	0.1	2.381					
		50mm cavity with aluminium foil							0.35		
		7.62 mm mineral wool(rigid slab)	0.049	20.408	0.008	0.156					
		19 mm plasterwood	0.159	6.2893	0.019	0.119					
		internal surface of wall					0.123				
		external surface of wall(north)						0.053			
		total			0.241	2.961	0.123	0.053	0.35	3.489	0.29
	wall 1	material									
		12 mm plaster(vermiculite)	0.201	4.9751	0.012	0.06					
		114 mm lightweight bricks	0.374	2.6738	0.114	0.305					
		100 mm wood fibre softboard	0.065	15.384	0.1	1.538					
		internal surface of wall					0.123				
		external surface of wall(south)						0.076			
		total			0.226	1.903	0.123	0.076		2.102	0.48
Kitchen	wall 1 wall2	114 mm lightweight Brickwork	0.374	2.6738	0.114	0.305					

		100mm glass wool blanket	0.042	23.809	0.1	2.381					
		50mm cavity with aluminium foil			0.05				0.35		
		7.62 mm mineral wool(rigid slab)	0.049	20.408	0.008	0.156					
		19 mm plasterwood	0.159	6.2893	0.019	0.119					
		internal surface of wall					0.123				
		total			0.291	2.961	0.123		0.35	3.436	0.29
	Wall 3	114 mm lightweight Brickwork	0.374	2.6738	0.114	0.305					
		100mm glass wool blanket	0.042	23.809	0.1	2.381					
		50mm cavity with aluminium foil							0.35		
		7.62 mm mineral wool(rigid slab)	0.049	20.408	0.008	0.156					
		19 mm plasterwood	0.159	6.2893	0.019	0.119					
		internal surface of wall					0.123				
		external surface of wall(North)						0.053			
		total			0.241	2.961	0.123	0.053	0.35	3.489	0.29

A.2 Room specifications

Room specification			
Description	Room Dimensions (m)		
	L	W	H
Room1 is N oriented.	6.3038	4.118	3.3528
Room2 is N-W oriented.	4.4196	4.1148	3.3528
Room3 is N-E oriented.	4.51925	3.048	3.3528
Room4 is S-E oriented	4.7934	4.51925	3.3528
Drawing/ Dinning room(area=52.906$m^{2)}$			
Kitchen	3.3528	2.8956	3.3528
Washroom1 is N oriented	2.4384	1.4224	3.3528
Washroom2 is N-E oriented	1.3317	0.8491	3.3528
Washroom2 is S-E oriented	1.9419	1.1793	3.3528

A.3 Wall specifications

Wall specifications(m)															
Dimensions of walls(m)												U- values of walls(W/m^{2}degC)			
Wall 1			Wall 2			Wall 3			Wall 4			Wall1	Wall2	Wall3	Wall4
L	W	H	L	W	H	L	W	H	L	W	H				
6.30	0.22	3.3	4.1	0.2	3.3	6.30	0.2	3.35	4.1	0.177	3.352	0.4757	0.2467	0.246	0.238
4.11	0.17	3.3	4.4	0.1	3.3	4.11	0.2	3.35	4.41	0.290	3.352	0.2425	0.2425	0.286	0.284
4.51	0.17	3.3	3.0	0.1	3.3	4.51	0.2	3.35	3.04	0.240	3.352	0.2425	0.2425	0.286	0.286
4.79	0.22	3.3	4.5	0.1	3.3	4.79	0.2	3.35	4.51	0.226	3.352	0.4935	0.2425	0.286	0.475
6.40	0.24	3.3	1.9	0.2	3.3							0.2866	0.4757		
3.35	0.29	3.3	2.8	0.2	3.3	3.35	0.2	3.35				0.2910	0.2910	0.286	
2.43	0.15	3.3	1.4	0.1	3.3	2.43	0.1	3.35				0.2400	0.2370	0.237	
1.33	0.15	3.3	0.8	0.1	3.3							0.2400	0.240		
1.94	0.15	3.3	1.1	0.1	3.3							0.2400	0.2400		

A.4 Window specification

Window specification					
Description	Window dimensions(m)			U- value of window(W/m^2degC)	No. of windows
	L	W	H		
Window1 is South severe, double glazing ,20mm space	1.2192		2.1336	2.67	3
Window2 isN Normal,double glazing,20mm space	0.52	0.1143	1.27	2.84	1
Window1 is E oriented, nomal,double glazing,20mm spacing	1.054	0.1143	2.273	2.84	1
Window 2,3 is S oriented, severe,double glazing,20mm spacing	1.2192		2.1336	2.67	2
Window1 is N oriented,normal,double glazing,20mmspacing	1.2192		2.1336	2.84	1
Window1 is W oriented,normal,double glazing,20mmspacing	1.2192		2.1336	2.67	1
Window1 is N oriented, normal,double glazing,20mm spacing	0.406		0.61	2.84	1
Winndow1 is E oriented,normal,double glazing,20mm cavity	0.406		0.61	2.84	1
Winndow1 is E oriented,normal,double glazing,20mm cavity	0.406		0.61	2.84	1

A.5 Calculation of Qc, Qv, Qi

Qc	Qv=(1300*V*ΔT)				Qi=(n_1*W_1)+(n_2*W_2)			
Qc	1300	V=(N*room volume)/3600	Qv	No. of persons (n_1)	Heat produced (W_1)	No. of electrical source(n_2)	Heat produced (W_2)	Qi
37.54181	1300	0.0725	94.288	4	180	5	100	1220
15.28074	1300	0.0508	66.054	2	130	2	100	460
11.87729	1300	0.0384	50.032			2	80	160
22.526	1300	0.0605	78.682	3	130	2	120	630
23.577	1300	0.1478	192.14	3	150	7	120	1290
21.34721	1300	0.0271	35.262	2	160	2	120	560
4.126688	1300	0.0096	12.597	2	150	1	80	380
0.850837	1300	0.0031	4.1070	1	150	1	80	230
1.607764	1300	0.0063	8.3180	1	150	1	80	230

ANNEXURE-B

ANALYSIS OF COMPOSITE CLIMATE

B.1 Calculations of overall thickness and U-values of different walls

Calculation of overall thickness of walls and U- values											
1st floor											
		material	K	1/K	b	b/K	1/fi	1/f0	1/ Rc	Ra	U
Room1	wall 1 (external) south facing	12 mm rendering(cement, sand)	0.53	1.87	0.012	0.023					
		200 mm hempcrete blocks	0.06	16.6	0.2	3.333					
		50 mm polystyrene foam slab	0.03	30.3	0.05	1.538					
		internal surface of wall					0.123				
		external surface of wall(severe exposure south)						0.076			
		total			0.262	4.894	0.123	0.076		5.09	0.1963
	wall2 (external)	12 mm rendering(cement, sand)	0.53	1.87	0.012	0.023					
		200 mm hempcrete blocks	0.06	16.6	0.2	3.333					
		50 mm polystyrene foam slab	0.03	30.3	0.05	1.538					
		internal surface of wall					0.123				
		total			0.262	4.894	0.123			5.01	0.1993

	wall3 wall4 (internal)	75 mm fiberstyrene woodwool insulation board	0.08	12.5	0.075	0.938					
		100 mmpolystyrene foam board	0.03	30.3	0.1	3.03					
		19 mm plasterboard	0.15	6.28	0.019	0.119					
		internal surface of wall					0.123				
		total			0.194	4.087	0.123			4.21	0.2375
Room 2	wall1 (internal)	75 mm fiberstyrene woodwool insulation board	0.08	12.5	0.075	0.938					
		100 mmpolystyrene foam board	0.03	30.3	0.1	3.03					
		19 mm plasterboard	0.15	6.28	0.019	0.119					
		internal surface of wall					0.123				
		total			0.194	4.087	0.123			4.21	0.2375
	wall2 (external) west facing	12 mm rendering(cement, sand)	0.53	1.87	0.012	0.023					
		200 mm hempcrete blocks	0.06	16.6	0.2	3.333					
		50 mm polystyrene foam slab	0.03	30.3	0.05	1.538					
		internal surface of wall					0.123				

		external surface of wall(severe exposer west facing)						0.053			
		total			0.262	4.894	0.123	0.053		5.07	0.1972
	wall3 (external) south facing	12 mm rendering(cement, sand)	0.53	1.87	0.012	0.023					
		200 mm hempcrete blocks	0.06	16.6	0.2	3.333					
		50 mm polystyrene foam slab	0.03	30.3	0.05	1.538					
		internal surface of wall					0.123				
		external surface of wall(severe exposer south facing)						0.076			
		total			0.262	4.894	0.123	0.076		5.09	0.1963
	wall 4(externa l) east facing	12 mm rendering(cement, sand)	0.53	1.87	0.012	0.023					
		200 mm hempcrete blocks	0.06	16.6	0.2	3.333					
		50 mm polystyrene foam slab	0.03	30.3	0.05	1.538					
		internal surface of wall					0.123				
		external surface of wall(normal exposure east facing)						0.053			
		total			0.262	4.894	0.123	0.053		5.07 04	0.1972

Room 3	wall 1(externa l) north facing	12 mm vermiculite plaster	0.20	4.97	0.012	0.06					
		20 mm woodwool slab	0.08	12.1	0.02	0.244					
		50 mm cavity with aluminium foil			0.05				0.3		
		100 mm cellular glass block (CGB 800)	0.04	23.2	0.1	2.326					
		2 mm epoxy coat	0.35	2.85	0.002	0.006					
		internal surface of wall					0.123				
		external surface of wall(normal exposer north facing)						0.053			
		total			0.184	2.635	0.123	0.053	0.3	3.16	0.3162
	wall2 (external) west facing	12 mm rendering(cement, sand)	0.53	1.87	0.012	0.023					
		200 mm hempcrete blocks	0.06	16.6 667	0.2	3.333					
		50 mm polystyrene foam slab	0.03	30.3	0.05	1.538					
		internal surface of wall					0.123				
		external surface of wall(severe exposer west facing)						0.053			
		total			0.262	4.894	0.123	0.053		5.07	0.1972

	wall3 (internal)	75 mm fiberstyrene woodwool insulation board	0.08	12.5	0.075	0.938					
		100 mmpolystyrene foam board	0.03	30.3	0.1	3.03					
		19 mm plasterboard	0.15	6.28	0.019	0.119					
		internal surface of wall					0.123				
		total			0.194	4.087	0.123			4.2103	0.2375
Room 4	wall 1 wall2 (external) north-east facing	12 mm vermiculite plaster	0.20	4.97	0.012	0.06					
		20 mm woodwool slab	0.08	12.1	0.02	0.244					
		50 mm cavity with aluminium foil			0.05				0.3		
		100 mm cellular glass block (CGB 800)	0.043	23.2	0.1	2.326					
		2 mm epoxy coat	0.35	2.85	0.002	0.006					
		internal surface of wall					0.123				
		external surface of wall(normal exposer north - east facing)						0.053			
		total			0.184	2.635	0.123	0.053	0.3	3.16	0.3162
	wall3 wall 4 (internal)	75 mm fiberstyrene woodwool insulation board	0.08	12.5	0.075	0.938					

		100 mmpolystyrene foam board	0.03	30.3	0.1	3.03					
		19 mm plasterboard	0.15	6.28	0.019	0.119					
		internal surface of wall					0.123				
		total			0.194	4.087	0.123			4.21	0.2375
Room 5	wall 1 (external) south facing	12 mm rendering(cement, sand)	0.53	1.87	0.012	0.023					
		200 mm hempcrete blocks	0.06	16.6	0.2	3.333					
		50 mm polystyrene foam slab	0.03	30.3	0.05	1.538					
		internal surface of wall					0.123				
		external surface of wall(severe exposersouth)						0.076			
		total			0.262	4.894	0.123	0.076		5.09	0.1963
	wall 2(externa l) east facing	12 mm rendering(cement, sand)	0.53	1.87	0.012	0.023					
		200 mm hempcrete blocks	0.06	16.6	0.2	3.333					
		50 mm polystyrene foam slab	0.03	30.3	0.05	1.538					
		internal surface of wall					0.123				
		external surface of wall(normal exposure east facing)						0.053			
		total			0.262	4.894	0.123	0.053		5.07	0.1972

	wall3 (internal)	75 mm fiberstyrene woodwool insulation board	0.08	12.5	0.075	0.938					
		100 mmpolystyrene foam board	0.03	30.3	0.1	3.03					
		19 mm plasterboard	0.15	6.28	0.019	0.119					
		internal surface of wall					0.123				
		total			0.194	4.087	0.123			4.21	0.2375
Drawing/Dining room walls are enclosed by all the N,E,S,W oriented pheripheral walls											
Washroom 1	wall1 (internal)	0.0031" thick latex paint									
		10.16 mm insulated fiborous concrete blockpanel	0.06	16.6							
		50 mm cavity			0.05				0.3		
		7.62 mm mineral wool	0.03	27.0	0.007	0.20					
		25.4 mm expended polystyrene blocks	0.03	27.7	0.025	0.70					
		58.42 mm straw bales	0.01	55.5	0.058	3.24					
		18 mm polystyrene foam board	0.03	30.3	0.018	0.54					
		internal surface of wall					0.123				
		total			0.159	4.70	0.123		0.3	5.17	0.1931

	wall2 wall 3 (external) N-E facing	0.0031" thick latex paint									
		10.16 mm insulated fiborous concrete blockpanel	0.06	16.6							
		50 mm cavity			0.05				0.3		
		7.62 mm mineral wool	0.03	27.0	0.007	0.20					
		25.4 mm expended polystyrene blocks	0.03	27.7	0.025	0.70					
		58.42 mm straw bales	0.01	55.5	0.058	3.24					
		18 mm polystyrene foam board	0.03	30.3	0.018	0.54					
		internal surface of wall					0.123				
		external surface of wall(north, east)						0.053			
		total			0.159	4.70	0.123	0.053	0.3	5.23	0.1912
Washroom 2 walls(1,2) are similar of bathroom 1 wall(1)											
Washroom 3 walls(1,2) are similar of bathroom 1 wall(1)											
Washroom 4 walls(1,2) are similar of bathroom 1 wall(1)											
Drawing/ Dinning room	wall 1 (external) normal north facing	114 mm lightweight Brickwork	0.37	2.67	0.114	0.30					

		100mm glass wool blanket	0.04	23.8	0.1	2.38					
		50mm cavity with aluminium foil							0.3		
		7.62 mm mineral wool(rigid slab)	0.04	20.4	0.007	0.15					
		19 mm plasterwood	0.15	6.28	0.019	0.11					
		internal surface of wall					0.123				
		external surface of wall(normal exposer north)						0.053			
		total			0.240	2.96	0.123	0.053	0.3	3.48	0.2866
	wall 2 (external) severe south facing	12 mm rendering(cement, sand)	0.53	1.87	0.012	0.02					
		200 mm hempcrete blocks	0.06	16.6	0.2	3.33					
		50 mm polystyrene foam slab	0.03	30.3	0.05	1.53					
		internal surface of wall					0.123				
		external surface of wall(severe exposure south)						0.076			

		total			0.262	4.89	0.123	0.076		5.09	0.1963
Kitchen	wall 1 wall2 (internal)	114 mm lightweight Brickwork	0.37	2.67	0.114	0.30					
		100mm glass wool blanket	0.04	23.8	0.1	2.38					
		50mm cavity with aluminium foil			0.05				0.3		
		7.62 mm mineral wool(rigid slab)	0.04	20.4	0.007	0.15					
		19 mm plasterwood	0.15	6.28	0.019	0.11					
		internal surface of wall					0.123				
		total			0.290	2.96	0.123		0.3	3.43	0.2911
	wall 3	114 mm lightweight Brickwork	0.37	2.67	0.114	0.30					
		100mm glass wool blanket	0.04	23.8	0.1	2.38					
		50mm cavity with aluminium foil							0.3		
		7.62 mm mineral wool(rigid slab)	0.04	20.4	0.007	0.15					
		19 mm plasterwood	0.15	6.28	0.019	0.11					
		internal surface of wall					0.123				
		external surface of wall(North)						0.053			

		total			0.240	2.96	0.123	0.053	0.3	3.48	0.2866
	wall4(external) west facing	12 mm rendering(cement, sand)	0.53	1.87	0.012	0.02					
		200 mm hempcrete blocks	0.06	16.6	0.2	3.33					
		50 mm polystyrene foam slab	0.03	30.3	0.05	1.53					
		internal surface of wall					0.123				
		external surface of wall(severe exposer west facing)						0.053			
		total			0.262	4.89	0.123	0.053		5.07	0.1972
2nd floor											
Room 1	wall1 (external) west facing	12 mm rendering(cement, sand)	0.5	1.87	0.012	0.02					
		200 mm hempcrete blocks	0.06	16.6	0.2	3.33					
		50 mm polystyrene foam slab	0.03	30.3	0.05	1.53					
		internal surface of wall					0.123				
		external surface of wall(severe exposer west facing)						0.053			
		total			0.262	4.89	0.123	0.053		5.07	0.1972

	wall 2 (external) south facing	12 mm rendering(cement, sand)	0.53	1.87	0.012	0.02					
		200 mm hempcrete blocks	0.06	16.6	0.2	3.33					
		50 mm polystyrene foam slab	0.03	30.3	0.05	1.53					
		internal surface of wall					0.123				
		external surface of wall(severe exposure south)						0.076			
		total			0.262	4.89	0.123	0.076		5.09	0.1963
	wall 3 (external) east facing	12 mm vermiculite plaster	0.20	4.97	0.012	0.06					
		20 mm woodwool slab	0.08	12.1	0.02	0.24					
		50 mm cavity with aluminium foil			0.05				0.3		
		100 mm cellular glass block (CGB 800)	0.04	23.2	0.1	2.32					
		2 mm epoxy coat	0.35	2.85	0.002	0.006					
		internal surface of wall					0.123				
		external surface of wall(normal exposer						0.053			

		north - east facing)									
		total			0.184	2.63	0.123	0.053	0.3	3.16	0.3162
	wall4 (internal)	75 mm fiberstyrene woodwool insulation board	0.08	12.5	0.075	0.93					
		100 mmpolystyrene foam board	0.03	30.3	0.1	3.03					
		19 mm plasterboard	0.15	6.28	0.019	0.11					
		internal surface of wall					0.123				
		total			0.194	4.08	0.123			4.21	0.2375
Room2 walls are same as Room1 walls In 2nd floor except differing in dimensions											
Room3 walls are same as Room1 walls in 2nd floor											
Jim room/ hall walls are same as Room1 walls In 2nd floor except differing in orientation											
Washroom1 walls(1,2) are similar of Washroom 1 wall(1) as in floor 1 excepr differing in orientation											

B.2 Calculation of room specification

Room specification			
Description	Room Dimensions(m)		
	L	W	H
Room1 is south oriented.	5.7912	4.1148	3.3528
Room2 is S-W oriented.	5.334	4.1148	3.3528
Room3 is N-W oriented.	4.4196	4.1148	3.3528
Room4 is N-E oriented	4.5377	4.3273	3.3528
Room 5 is S-W oriented	4.3273	4.2781	3.3528
Drawing/ Dinning room(area=61.75m^2)			3.3528
Kitchen	3.3528	2.8956	3.3528
Washroom1 is N oriented	2.438	1.3829	3.3528
Washroom2 is S-E oriented	1.8288	1.7873	3.3528
Washroom3 is S-W oriented	2.1445	2.059	3.3528
Washroom4 is N-W oriented	1.7635	1.6764	3.3528

2nd floor			
Room1 is S-W oriented	Room1 area (21.5369m^2)		3.3528
Room2 is N-W oriented	Room2 area (22.286m2)		3.3528
Room3 is S oriented	Room3 area (24.2359m2)		3.3528
Room4 is open to all orientation	Room4 area (75.8054m2)		3.3528
Washroom 1	1.8731	1.8288	3.3528
Washroom 2	1.9266	1.8288	3.3528

B.3 Calculation of wall specification

Wall specifications																	
Dimensions of walls(m)																	
Wall1			Wall2			Wall3			Wall4			wall5			wall6		
L	W	H	L	W	H	L	W	H	L	W	H	L	W	H	L	W	H
Floor1																	
5.79	0.26	3.3	4.1	0.262	3.3	5.79	0.19	3.3	4.11	0.19	3.3						
4.11	0.19	3.3	5.3	0.262	3.3	4.11	0.26	3.3	2.05	0.26	3.3						
4.11	0.18	3.3	4.4	0.262	3.3	4.11	0.23	3.3									
4.32	0.18	3.3	4.5	0.184	3.3	4.32	0.19	3.3	4.53	0.19	3.3						
4.32	0.26	3.3	4.2	0.262	3.3	4.27	0.19	3.3									
6.59	0.26	3.3	6.5	0.184	3.3												
3.35	0.29	3.3	2.8	0.290	3.3	3.35	0.24	3.3	2.89	0.26	3.3						
2.43	0.15	3.3	1.3	0.159	3.3	2.43	0.15	3.3									
1.82	0.15	3.3	1.7	0.159	3.3												
2.14	0.15	3.3	2.0	0.159	3.3												

1.76	0.15	3.3	1.6	0.159	3.3												
Floor2																	
5.43	0.26	3.3	4.1	0.262	3.3	3.35	0.18	3.3	3.10	0.19	3.3						
3.65	0.18	3.3	4.1	0.240	3.3	5.61	0.26	3.3									
5.47	0.26	3.3	1.6	0.184	3.3	5.47	0.18	3.3	2.28	0.19	3.3	2.5021	0.1	3.3			
11.1	0.18	3.3	8.3	0.262	3.3	4.20	0.26	3.3	2.04	0.26	3.3	6.8689	0.2	3.3	6.07	0.2	3.3
1.87	0.15	3.3	1.8	0.159	3.3												
1.92	0.15	3.3	1.8	0.159	3.3												

B.4 U- Value of Windows

U- values of walls(W/m^{2}degC)					
wall1	wall2	wall3	wall4	wall5	wall6
Floor1					
0.196334387	0.19930835	0.23751277	0.2375127		
0.237512773	0.19722499	0.19633438	0.1972249		
0.316165583	0.19722499	0.23751277			
0.316165583	0.31616558	0.23751277	0.2375127		
0.196334387	0.19722499	0.23751277			
0.196334387	0.31616558				
0.291055379	0.29105537	0.28663378	0.1972249		
0.193142976	0.19118588	0.19118588			
0.193142976	0.19314297				
0.193142976	0.19314297				
0.193142976	0.19314297				

Floor2					
0.197224995	0.19633438	0.31616558	0.2375127		
0.316165583	0.28663378	0.19722499			
0.196334387	0.31616558	0.31616558	0.2375127	0.2375127	
0.316165583	0.19722499	0.19633438	0.1972249	0.1963343	0.19722499
0.193142976	0.19314297				
0.193142976	0.19314297				

B.5 Window specification

Window specification					
Description	Window Dimensions(m)			U- value of window(W/m^2degC)	No. of windows
	L	W	H		
East normal, double glazing ,20mm space	1.202		0.755	2.84	1
East Normal,double glazing,20mm space	1.202	0.1143	0.755	2.84	1
North normal,double glazing,20mm space	2.9194		1.0414	2.84	1
window1 ,2 are North oriented, nomal,double glazing,20mm spacing	1.054	0.1143	2.273	2.84	2
window 3 is East oriented, normal,double glazing,20mm spacing	0.5192		2.1336	2.84	1
window 3 is East oriented, normal,double glazing,20mm spacing	0.5192		2.1336	2.84	1

window 1 is South oriented, severel,double glazing,20mm spacing	1.2		0.9	2.67	1
window 3 is North oriented, normal,double glazing,20mm spacing	2.41		1.2	2.84	3
window 1,2 is N oriented,normal,double glazing,20mmspacing	1.39		0.9	2.84	2
window is N oriented, normal,double glazing,20mm spacing	1.2		0.85	2.84	1
window is E oriented,normal,double glazing,20mm cavity	0.406		0.61	2.84	1
winndow is W oriented,severe,double glazing,20mm cavity	0.406		0.61	2.84	1
winndow is N oriented,normal,double glazing,20mm cavity	1.2		0.85	2.84	1
Floor2					

winndow is E oriented,normal,double glazing,20mm cavity	0.406		0.61	2.84	1
winndow is N oriented,normal,double glazing,20mm cavity	1.2		0.85	2.84	1
winndow1,2 are N oriented,normal,double glazing,20mm cavity	1.2		0.85	2.84	2
winndow1,2 are N oriented,normal,double glazing,20mm cavity	2.41		1.2	2.84	1
winndow1,2 are E oriented,normal,double glazing,20mm cavity	2.41		1.2	2.84	2
winndow1,2 are S oriented,severe,double glazing,20mm cavity	1.2		0.9	2.67	2
winndow IS N oriented,normal,double glazing,20mm cavity	0.406		0.61	2.84	1
winndow IS S oriented,normal,double glazing,20mm cavity	0.406		0.61	2.67	1

B.6 Calculation of Qc,Qv,Qi

Qc= (A*U*ΔT)	Qv=(1300*V*ΔT)			Qi=(n_1*W_1)+(n2*W2)				
Qc	1300	V=(N*room volume)/3600	Qv	No.of persons (n_1)	Heat produced (W_1)	No. of electrical source(n_2)	Heat produced (W_2)	Qi
16.383008	1300	0.06658	86.55398	2	150	3	100	600
12.808639	1300	0.061324	79.72077	2	130	3	100	560
18.234210	1300	0.050811	66.05435			2	80	160
27.73565	1300	0.054863	71.32184	1	80	2	80	240
11.548046	1300	0.051724	67.24155	1	100	2	100	300
9.4419349	1300	0.17253	224.2884	3	130	6	100	990
16.532456	1300	0.027125	35.26273	2	160	2	100	520
6.4307336	1300	0.00942	12.246	2	130	1	80	340
2.7459719	1300	0.009133	11.87226			1	80	80
3.1263544	1300	0.012337	16.03807	2	130	2	100	460
4.8253157	1300	0.00826	10.73799	2	150	2	100	500

Floor2								
12.980969	1300	0.017947	23.33175	2	160	3	100	620
14.191469	1300	0.018572	24.14371	2	160	3	100	620
19.355734	1300	0.020197	26.25556	2	160	3	100	620
35.658777	1300	0.063171	82.12252	4	250	6	120	1600
2.8015334	1300	0.009571	12.44219	1	150	1	80	230
2.7940762	1300	0.009844	12.79757	1	150	1	80	230

ANNEXTURE-C

DETAILS OF MEASUREMENT AND CALCULATION OF QUANTITIES FOR COLD AND CLOUDY CLIMATIC REGION

C.1 Conventional building (Shimla)

EARTH WORKSFILLING FOUNDATION : Filling the foundation trenches with the cut earth available at **site in layers not exceeding 20 cms in** depth consolidating each deposited layers **by ramming and watering. Measurements** will be taken only the filled and **compacted earth.**					
Pcc	1.00	126.59	0.90	0.30	34.18
					34.18 Cu.M.
		Rate	110.00	Amount	3759.80
EARTH WORKSFILLING PLINTH USING EARTH FROM SITE : Filling the plinth and side of the foundation with the cut earth available at site in layers not **exceeding 20 cms in depth consolidating** each deposited layers by ramming and **watering. Measurements will be taken only the filled and compacted earth.**					
Room1	1.00	6.20	4.01	1.00	24.86
Room2	1.00	4.32	4.01	1.00	17.32
Room3	1.00	4.42	2.95	1.00	13.04
Room4	1.00	4.69	4.42	1.00	20.73
Dinning/Drawing room	1.00	8.23	6.30	1.00	51.85
Washroom1	1.00	2.33	1.32	1.00	3.08
Washroom2	1.00	1.23	0.75	1.00	0.92
Washroom3	1.00	1.84	1.08	1.00	1.99
Kitchen	1.00	3.25	2.80	1.00	9.10
					142.89 Cu.M.
		Rate	110.00	Amount	15717.90
					44542.30
PCC					

PCC FLOORING 1:2:4 CuM :					
Providing and laying P.C.C . 1:2:4 using					
40 mm nominal size broken stone well					
consolidated 100 mm thick including					
Room1	1.00	6.30	4.11	0.10	2.59
Room2	1.00	4.42	4.11	0.10	1.82
Room3	1.00	4.52	3.05	0.10	1.38
Room4	1.00	4.79	4.52	0.10	2.17
Dinning/Drawing room	1.00	8.33	6.40	0.10	5.33
Washroom1	1.00	2.43	1.42	0.10	0.35
Washroom2	1.00	1.33	0.85	0.10	0.11
Washroom3	1.00	1.94	1.18	0.10	0.23
Kitchen	1.00	3.35	2.90	0.10	0.97
					14.95 Cu.M.
		Rate	5,157.00	Amount	77097.15
					77097.15
BRICK WORKS					
BRICK WORKS FOUNDATION CM					
1:4 : First class brick work masonry in C.					
M. 1:4 (1 cement 4 coarse sand) with					
approved good quality country burnt					
bricks of compressive strength 35 kg/m2					
of standard size of on foundation. The					
rate shall include cost of all materials					
labour and other incidental charges of all					
materials to complete the work.					
1st footing	1.00	120.89	0.60	0.20	14.51
2nd footing	1.00	126.34	0.50	0.20	12.63
DPC 2.5 cm	1.00	126.59	0.40	0.01	0.51
plinth wall above footing	1.00	122.79	0.40	1.30	63.85
					91.50 Cu.M.
		Rate	4,970.00	Amount	454755.00

Description	Nos	L	B	H	Quantity
Washroom2(D1)	1.00	0.75	0.23	1.80	0.30
Washroom3(D1)	1.00	0.75	0.23	1.80	0.30
Washroom4(D1)	1.00	0.75	0.23	1.80	0.30
Room1(W1)	1.00	1.22	0.23	2.13	0.59
Washroom3(W1)	1.00	0.61	0.23	0.41	0.06
Washroom2(W1)	1.00	0.61	0.23	0.41	0.06
Washroom1(W1)	1.00	0.61	0.23	0.41	0.06
Drawing/Dinning Room(W1)	2.00	1.22	0.23	2.13	1.17
Room4(W1)	1.00	1.22	0.23	2.13	0.59
Room3(W1)	1.00	1.22	0.23	2.13	0.59
Room2(W1)	1.00	1.73	0.23	2.45	0.96
Kitchen(W1)	1.00	1.22	0.23	2.13	0.59
----					----
Total					13.56
					86.76 Cu.M.
		Rate	**5,582.00**	Amount	484294.32
					939049.32

BRICK WORKS CM 1:6 : First class **brick work masonry in C. M. 1:6 (1 cement 6 coarse sand) with approved** good quality country burnt bricks of **compressive strength 35 kg/m2 of** standard size of on super structure of all **thickness. The rate shall include cost of** all materials labour and other incidental charges of all materials to complete the work.					
Wall	1.00	132.99	0.23	3.35	100.32
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Total					100.32
Deduction for Openings					
Room3(D1)	1.00	1.20	0.23	2.10	0.57
Room2(D1)	1.00	1.00	0.23	2.00	0.45
Kitchen(D1)	1.00	2.00	0.23	1.50	0.68
Room4(D1)	1.00	1.20	0.23	2.10	0.57
Drawing/Dinning Room(D1)	1.00	1.00	0.23	2.00	0.45
Room1(D1)	1.00	1.00	0.23	2.10	0.47
Washroom1(D1)	1.00	0.75	8.00	0.80	4.80

FLOOR FINISHING MARBLE TILES: Supplying and fixing 20mm thick marble slabs size 80cm x 150cm fixed into the floors.					
Room1	1.00	6.30	4.11	-	25.94
Room2	1.00	4.42	4.11	-	18.19
Room3	1.00	4.52	3.05	-	13.77
Room4	1.00	4.79	4.52	-	21.66
Dinning/Drawing room	1.00	8.33	6.40	-	53.31
Washroom1	1.00	2.43	1.42	-	3.45
Washroom2	1.00	1.33	0.85	-	1.13
Washroom3	1.00	1.94	1.18	-	2.29
Kitchen	1.00	3.35	2.90	-	9.71
					149.45 Sq.M.
		Rate	3,035.00	Amount	453580.75
					453580.75
DOORS AND WINDOWS					
FRAMES WOOD: Supplying and fixing of doors and windows frames using good quality wood including M.S. clamps and fittings,fixing complete including a coat of tar at the contact surface of the frame.					
Room3(D1)	1.00	5.00	0.10	0.06	0.03
Room2(D1)	1.00	5.00	0.10	0.06	0.03
Kitchen(D1)	1.00	5.10	0.10	0.06	0.03
Room4(D1)	1.00	5.00	0.10	0.06	0.03
Drawing/Dinning Room(D1)	1.00	5.00	0.10	0.06	0.03
Room1(D1)	1.00	5.10	0.10	0.06	0.03
Washroom1(D1)	1.00	5.10	0.10	0.06	0.03
Washroom2(D1)	1.00	5.10	0.10	0.06	0.03
Washroom3(D1)	1.00	5.10	0.10	0.06	0.03
Washroom4(D1)	1.00	5.10	0.10	0.06	0.03
Room1(W1)	1.00	6.70	0.10	0.06	0.04

SHUTTERS WOOD GLAZED : Supplying and fixing of fully glazed shutters of good quality wood.					
Kitchen(D1)	1.00	1.90	-	1.45	2.76
Washroom4(D1)	1.00	0.65	-	1.75	1.14
Washroom3(D1)	1.00	0.65	-	1.75	1.14
Washroom2(D1)	1.00	0.65	-	1.75	1.14
Washroom1(D1)	1.00	0.65	-	0.75	0.49
Drawing/Dinning Room(D1)	1.00	0.90	-	1.95	1.76
Kitchen(W1)	1.00	1.22	-	2.13	2.60
Washroom3(W1)	1.00	0.61	-	0.41	0.25
Washroom2(W1)	1.00	0.61	-	0.41	0.25
Washroom1(W1)	1.00	0.61	-	0.41	0.25
Drawing/Dinning Room(W1)	2.00	1.12	-	2.08	4.66
Room4(W1)	1.00	1.22	-	2.13	2.60
Room3(W1)	1.00	1.22	-	2.13	2.60
Room2(W1)	1.00	1.73	-	2.45	4.25
Room1(W1)	1.00	1.22	-	2.13	2.60
					28.49 Sq.M.
		Rate	2,293.00	Amount	65327.57
					146959.75
PAINTING					
PAINTING WALLS PLASTIC EMULSION : Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty.					
Wall	2.00	132.99	-	3.35	891.78
----					----
Total					891.78
Deduction for Openings					
Room3(D1)	1.00	1.20	-	2.10	2.52
Room2(D1)	1.00	1.00	-	2.00	2.00

Description	Nos	L	B	H	Quantity
Kitchen(D1)	1.00	2.00	-	1.50	3.00
Room4(D1)	1.00	1.20	-	2.10	2.52
Drawing/Dinning Room(D1)	1.00	1.00	-	2.00	2.00
Room1(D1)	1.00	1.00	-	2.10	2.10
Washroom1(D1)	1.00	0.75	-	0.80	0.60
Washroom2(D1)	1.00	0.75	-	1.80	1.35
Washroom3(D1)	1.00	0.75	-	1.80	1.35
Washroom4(D1)	1.00	0.75	-	1.80	1.35
Room1(W1)	1.00	1.22	-	2.13	2.60
Washroom3(W1)	1.00	0.61	-	0.41	0.25
Washroom2(W1)	1.00	0.61	-	0.41	0.25
Washroom1(W1)	1.00	0.61	-	0.41	0.25
Drawing/Dinning Room(W1)	2.00	1.22	-	2.13	5.20
Room4(W1)	1.00	1.22	-	2.13	2.60
Room3(W1)	1.00	1.22	-	2.13	2.60
Room2(W1)	1.00	1.73	-	2.45	4.25
Kitchen(W1)	1.00	1.22	-	2.13	2.60
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Total					39.39
					852.39 Sq.M.
		Rate	48.00	Amount	40914.72
PAINTING ROOFTOPS PLASTIC EMULSION: Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty.					
Floor Slabs	1.00	121.55	8.78	-	1066.72
					1,066.72 Sq.M.
		Rate	48.00	Amount	51202.56
					92117.28
Total for GROUND FLOOR					1753346.55

Description	Nos	L	B	H	Quantity
		FIRST FLOOR			
FLOOR AND WALL FINISHES					
FLOOR FINISHING MARBLE TILES: **Supplying and fixing 20mm thick marble slabs size 80cm x 150cm** fixed into the floors.					
Ware house	1.00	4.35	5.39	-	23.45
Glass House	1.00	12.65	6.89	-	87.16
					110.61 Sq.M.
		Rate	3,035.94	Amount	335805.32
					335805.32
DOORS AND WINDOWS					
FRAMES WOOD: Supplying and fixing of doors and windows frames using **good quality wood including M.S. clamps and fittings,fixing complete including a** coat of tar at the contact surface of the **frame.**					
Warehouse(W1)	1.00	6.71	0.10	0.06	0.04
					0.04 Cu.M.
		Rate	85,386.00	Amount	3415.44
SHUTTERS WOOD GLAZED: Supplying and fixing of fully glazed **shutters of good quality wood.**					
Warehouse(W1)	1.00	0.22	-	2.13	0.47
					0.47 Sq.M.
		Rate	1,387.92	Amount	652.32
					4067.76
PAINTING					
PAINTING WALLS PLASTIC EMULSION: Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats **including putty.**					
Wall	2.00	10.89	-	3.35	73.02
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Total					73.02
Deduction for Openings					
Warehouse(W1)	1.00	0.22	-	2.13	0.47
---					---
Total					0.47
					72.55 Sq.M.
		Rate	52.44	Amount	3804.52

Description	Nos	L	B	H	Quantity
					3804.52
Total for FIRST FLOOR					343677.61
Total					2097024.15
Net Amount					**2097024.00**

C.2 Green building (Shimla)

Description	Nos	L	B	H	Quantity
GROUND FLOOR					
EARTH WORKS					
EARTH WORKSEXCAVATION : Earth work excavation for foundation trenches in all classes of soil and depositing on bank with initial lead upto **50 mt. and lift upto 1.5 m including** breaking clods , watering ramming and sectioning of spoil bank etc. complete.					
Earth Work washroom 1(wall1)	1.00	2.44	0.90	1.00	2.19
Earth Work in washroom 2(wall2	1.00	2.44	0.90	1.00	2.19
Earth Work in washroom(wall2	1.00	2.92	0.90	1.00	2.63
Earth Work in washroom2 (wall2)	1.00	0.85	0.90	1.00	0.76
Earth Work in drawing room(wall1	1.00	6.40	0.90	1.00	5.76
Earth Work in drawing washroom3 (wall1)	1.00	1.18	0.90	1.00	1.06
Earth Work in drawing washroom3 (wall2)	1.00	1.94	0.90	1.00	1.75
Earth Work in room1(wall1)	1.00	6.30	0.90	1.00	5.67
Earth Work in room1(wall2)	1.00	4.11	0.90	1.00	3.70
Earth Work in room1(wall3)	1.00	6.30	0.90	1.00	5.67
Earth Work in room1(wall4)	1.00	4.11	0.90	1.00	3.70
Earth Work in room2(wall1)	1.00	4.11	0.90	1.00	3.70
Earth Work in room2(wall2)	1.00	4.42	0.90	1.00	3.98
Earth Work in room2(wall3)	1.00	4.11	0.90	1.00	3.70
Earth Work in room2(wall4)	1.00	4.42	0.90	1.00	3.98
Earth Work in room3(wall1)	1.00	4.52	0.90	1.00	4.07
Earth Work in room3(wall2)	1.00	3.05	0.90	1.00	2.74
Earth Work in room3(wall3)	1.00	4.52	0.90	1.00	4.07
Earth Work in room3(wall4)	1.00	3.05	0.90	1.00	2.74
Earth Work in room4(wall1)	1.00	4.79	0.90	1.00	4.31
Earth Work in room4(wall2)	1.00	4.52	0.90	1.00	4.07
Earth Work in room4(wall3)	1.00	4.79	0.90	1.00	4.31
Earth Work in room4(wall4)	1.00	4.52	0.90	1.00	4.07

Earth Work in washroom1 (wall3)	1.00	2.44	0.90	1.00	2.19
Earth Work in washroom2 (wall1)	1.00	1.33	0.90	1.00	1.20
					84.21 Cu.M.
		Rate	220.00	Amount	18526.20
EARTH WORKSFILLING PLINTH USING EARTH FROM SITE : Filling the plinth and side of the foundation with the cut earth available at site in layers not **exceeding 20 cms in depth consolidating** each deposited layers by ramming and **watering. Measurements will be taken only the filled and compacted earth.**					
Room1	1.00	6.20	4.01	1.00	24.86

Description	Nos	L	B	H	Quantity
Room2	1.00	4.32	4.32	1.00	18.66
Room3	1.00	4.42	2.95	1.00	13.04
Room4	1.00	4.69	4.42	1.00	20.73
Drawing/Dinning Room	1.00	7.30	5.34	1.00	38.98
Kitchen	1.00	23.25	2.80	1.00	65.10
Washroom1	1.00	2.14	1.32	1.00	2.82
Washroom2	1.00	1.23	0.75	1.00	0.92
Washroom3	1.00	1.84	1.08		0.00
					185.11 Cu.M.
		Rate	110.00	Amount	20362.10
ANTI TERMITE TREATMENT : Anti termite treatment by providing and injecting chemical **emulsion/Aldrin/heptachler emulsible concentrates 0.50% and clilossdance** emulsifiable concentrate for pre contractional treatment and creating a **chemical barrier as per I.S 6313 (Part II)** 1951 in wall trench foundation top surface of plinth filling junction of wall and floor along the external perimeters of **the building complete (areas of building** shall be measured).					
Room1	1.00	6.30	4.11	-	25.94
Room2	1.00	4.42	4.42	-	19.53
Room3	1.00	4.52	3.05	-	13.77
Room4	1.00	4.79	4.52	-	21.66
Drawing/Dinning Room	1.00	7.40	5.44	-	40.28
Kitchen	1.00	23.35	2.90	-	67.62
Washroom1	1.00	2.24	1.42	-	3.18
Washroom2	1.00	1.33	0.85	-	1.13
Washroom3	1.00	1.94	1.18	-	2.29
					195.40 Sq.M.
		Rate	200.00	Amount	39080.00
					77968.30

Description	Nos	L	B	H	Quantity
Wall4	1.00	11.60	0.15	-	1.79
Wall5	1.00	11.60	0.15	-	1.79
Wall6	1.00	31.42	0.24	-	7.56
Wall7	1.00	20.15	0.23	-	4.53
---					---
Total					26.82
Deduction for Openings					
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Total					0.00
					26.82 Sq.M.
		Rate	314.85	Amount	8444.28
PCC FLOORING 1:2:4 CuM : **Providing and laying P.C.C . 1:2:4 using** 40 mm nominal size broken stone well **consolidated 100 mm thick including**					
Room1	1.00	6.30	4.11	0.10	2.59
Room2	1.00	4.42	4.42	0.10	1.95
Room3	1.00	4.52	3.05	0.10	1.38
Room4	1.00	4.79	4.52	0.10	2.17
Drawing/Dinning Room	1.00	7.40	5.44	0.10	4.03
Kitchen	1.00	23.35	2.90	0.10	6.77
Washroom1	1.00	2.24	1.42	0.10	0.32
Washroom2	1.00	1.33	0.85	0.10	0.11
Washroom3	1.00	1.94	1.18	0.10	0.23
					19.55 Cu.M.
		Rate	5,175.00	Amount	101171.25
					270957.87

PCC

PCC FOUNDATION 1:4:8 : Providing **and laying P.C.C. 1:4:8 using 40mm** nominal size broken stone well **consolidated including curing etc. complete for foundation.**					
Pcc	1.00	0.90	133.45	0.30	36.03
					36.03 Cu.M.
		Rate	4,478.00	Amount	161342.34
DAMP PROOF COURSE 1:2:4 : **Providing 4 cm thick P.C.C. as a Damp** Proof Course with stone chips and approved water proofing compound **beneath the walls as per IS:2645-1964.**					
Wall1	1.00	10.12	0.29	-	2.94
Wall2	1.00	20.62	0.18	-	3.65
Wall3	1.00	12.24	0.23	-	2.77
Wall4	1.00	11.60	0.15	-	1.79

BRICK WORKS CM 1:6 : First class **brick work masonry in C. M. 1:6 (1 cement 6 coarse sand) with approved** good quality country burnt bricks of **compressive strength 35 kg/m2 of** standard size of on super structure of all **thickness. The rate shall include cost of** all materials labour and other incidental charges of all materials to complete the work.					
Wall1	1.00	10.12	0.29	3.35	9.86
Wall2	1.00	20.62	0.18	3.35	12.24
Wall3	1.00	12.24	0.23	3.35	9.27
Wall4	1.00	11.60	0.15	3.35	5.99
Wall5	1.00	11.60	0.15	3.35	5.99
Wall6	1.00	31.42	0.24	3.35	25.34
Wall7	1.00	20.15	0.23	3.35	15.20
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Total					83.89
Deduction for Openings					
Washroom2(D1)	1.00	0.76	0.16	2.03	0.25
Washroom1(D1)	1.00	0.76	0.16	2.03	0.25
Kithen(D1)	1.00	0.76	0.24	2.03	0.37
Drawing/Dinning Room(D1)	1.00	2.13	0.23	1.83	0.88
Room4(D1)	1.00	2.13	0.23	1.83	0.88

Description	Nos	L	B	H	Quantity
Room3(D1)	1.00	2.13	0.18	1.83	0.69
Room2(D1)	1.00	2.13	0.18	1.83	0.69
Room1(D1)	1.00	2.13	0.23	1.83	0.88
Washroom3(D1)	1.00	0.76	0.16	2.03	0.25
Room1(W1)	3.00	1.22	0.23	2.13	1.76
Kitchen(W1)	1.00	1.22	0.24	2.13	0.63
Washroom 3(W1)	1.00	0.41	1.54	0.61	0.38
Washroom 2(W1)	1.00	0.41	1.54	0.61	0.38
Washroom1 (W1)	1.00	0.41	1.54	0.61	0.38
Dinnind/Drawing Room(W1)	2.00	1.22	0.23	2.13	1.18
Room4(W2)	2.00	1.22	0.23	2.13	1.18
Room4(W1)	1.00	1.05	0.24	2.27	0.58
Kitchen(W2)	1.00	1.22	0.18	2.13	0.46
Room2(W1)	1.00	1.27	0.29	0.52	0.19
Room3(W1)	1.00	1.27	0.24	0.52	0.16
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Total					12.42
					71.47 Cu.M.
		Rate	5,582.00	Amount	398945.54
					398945.54
FLOOR AND WALL FINISHES					
FLOOR FINISHING MARBLE TILES: Supplying and fixing 20mm thick marble slabs size 80cm x 150cm fixed into the floors.					
Room1	1.00	6.30	4.11	-	25.94
Room2	1.00	4.42	4.42	-	19.53
Room3	1.00	4.52	3.05	-	13.77
Room4	1.00	4.79	4.52	-	21.66
Drawing/Dinning Room	1.00	7.40	5.44	-	40.28
Kitchen	1.00	23.35	2.90	-	67.62
Washroom1	1.00	2.24	1.42	-	3.18
Washroom2	1.00	1.33	0.85	-	1.13
Washroom3	1.00	1.94	1.18	-	2.29
					195.40 Sq.M.
		Rate	3,035.00	Amount	593039.00

FLOOR AND WALL FINISHES

FLOOR FINISHING MARBLE TILES: Supplying and fixing 20mm thick marble slabs size 80cm x 150cm fixed into the floors.					
Room1	1.00	6.30	4.11	-	25.94
Room2	1.00	4.42	4.42	-	19.53
Room3	1.00	4.52	3.05	-	13.77
Room4	1.00	4.79	4.52	-	21.66
Drawing/Dinning Room	1.00	7.40	5.44	-	40.28
Kitchen	1.00	23.35	2.90	-	67.62
Washroom1	1.00	2.24	1.42	-	3.18
Washroom2	1.00	1.33	0.85	-	1.13
Washroom3	1.00	1.94	1.18	-	2.29
					195.40 Sq.M.
		Rate	3,035.00	Amount	593039.00
SKIRTING GRANITE TILES IN M : Supplying and fixing pre polished black **granite slab 20mm thick over 1:3,12mm** thick using necessary cement grout including closing the joints with pigment of the colour to match including washing, **cleaning, polishing the edges etc.** complete for skirting.					
Drawing/Dinning Room	1.00	25.69	-	-	25.69
Kitchen	1.00	52.50	-	-	52.50
Room1	1.00	20.84	-	-	20.84
Room2	1.00	17.68	-	-	17.68
Room3	1.00	15.13	-	-	15.13
Room4	1.00	18.63	-	-	18.63
					150.47 m
		Rate	456.00	Amount	68614.32

FRAMES WOOD : Supplying and fixing of doors and windows frames using **good quality wood including M.S. clamps and fittings,fixing complete including a** coat of tar at the contact surface of the frame.					
Washroom2(D1)	1.00	4.83	0.10	0.06	0.03
Washroom1(D1)	1.00	4.83	0.10	0.06	0.03
Kithen(D1)	1.00	4.83	0.10	0.06	0.03
Drawing/Dinning Room(D1)	1.00	5.79	0.10	0.06	0.03
Room4(D1)	1.00	5.79	0.10	0.06	0.03
Room3(D1)	1.00	5.79	0.10	0.06	0.03
Room2(D1)	1.00	5.79	0.10	0.06	0.03
Room1(D1)	1.00	5.79	0.10	0.06	0.03
Washroom3(D1)	1.00	4.83	0.10	0.06	0.03
Room1(W1)	3.00	4.80	0.10	0.06	0.09
Kitchen(W1)	1.00	6.71	0.10	0.06	0.04
Washroom 3(W1)	1.00	2.03	0.10	0.06	0.01
Washroom 2(W1)	1.00	2.03	0.10	0.06	0.01
Washroom1 (W1)	1.00	2.03	0.10	0.06	0.01
Dinnind/Drawing Room(W1)	2.00	6.71	0.10	0.06	0.08
Room4(W2)	2.00	6.71	0.10	0.06	0.08
Room4(W1)	1.00	6.65	0.10	0.06	0.04
Kitchen(W2)	1.00	6.71	0.10	0.06	0.04
Room2(W1)	1.00	3.58	0.10	0.06	0.02
Room3(W1)	1.00	3.58	0.10	0.06	0.02
					0.71 Cu.M.
		Rate	85,386.00	Amount	60624.06
SHUTTERS WOOD PANELLED : Supplying and fixing of shutters of good quality panelled wood.					
Washroom3(D1)	1.00	0.66	-	1.98	1.31
Washroom2(D1)	1.00	0.66	-	1.98	1.31
Washroom1(D1)	1.00	0.66	-	1.98	1.31
Kithen(D1)	1.00	0.66	-	1.98	1.31
Drawing/Dinning Room(D1)	1.00	2.03	-	1.78	3.61
Room4(D1)	1.00	2.03	-	1.78	3.61
Room2(D1)	1.00	2.03	-	1.78	3.61

Description	Nos	L	B	H	Quantity
Room1(D1)	1.00	2.03	-	1.78	3.61
					19.68 Sq.M.
		Rate	2,689.00	Amount	52919.52
SHUTTERS WOOD GLAZED : Supplying and fixing of fully glazed shutters of good quality wood.					
Room3(D1)	1.00	2.03	-	1.78	3.61
Room1(W1)	3.00	1.22	-	2.13	7.80
Room2(W1)	1.00	1.27	-	0.52	0.66
Room3(W1)	1.00	1.27	-	0.52	0.66
Room4(W1)	1.00	1.05	-	2.27	2.40
Room4(W2)	2.00	1.22	-	2.13	5.20
Dinnind/Drawing Room(W1)	2.00	1.12	-	2.08	4.66
Washroom1 (W1)	1.00	0.41	-	0.61	0.25
Washroom 2(W1)	1.00	0.41	-	0.61	0.25
Washroom 3(W1)	1.00	0.41	-	0.61	0.25
Kitchen(W1)	1.00	1.22	-	2.13	2.60
Kitchen(W2)	1.00	1.22	-	2.13	2.60
					30.94 Sq.M.
		Rate	2,293.00	Amount	70945.42
					184489.00

PLASTERING AND POINTING

PLASTERING WALLS CM 1:2 12

MM : Plastering witth cement mortar to **walls, columns and other structural** architectural features at all heights, floated hard and trowelled get smooth **finish. The rate shall include provision of** grooves scaffolding at any height curing **etc. complete as directed by the Engineer.**

Wall1	2.00	10.12	-	3.35	67.80
Wall2	2.00	20.62	-	3.35	138.15
Wall3	2.00	12.24	-	3.35	82.01
Wall4	2.00	11.60	-	3.35	77.72
Wall5	2.00	11.60	-	3.35	77.72
Wall6	2.00	31.42	-	3.35	210.51
Wall7	2.00	20.15	-	3.35	135.01
---					---
Total					788.92
Deduction for Openings					
Washroom2(D1)	1.00	0.76	-	2.03	1.54
Washroom1(D1)	1.00	0.76	-	2.03	1.54
Kithen(D1)	1.00	0.76	-	2.03	1.54
Drawing/Dinning Room(D1)	1.00	2.13	-	1.83	3.90
Room4(D1)	1.00	2.13	-	1.83	3.90
Room3(D1)	1.00	2.13	-	1.83	3.90
Room2(D1)	1.00	2.13	-	1.83	3.90
Room1(D1)	1.00	2.13	-	1.83	3.90
Washroom3(D1)	1.00	0.76	-	2.03	1.54
Room1(W1)	3.00	1.22	-	2.13	7.80
Kitchen(W1)	1.00	1.22	-	2.13	2.60
Washroom 3(W1)	1.00	0.41	-	0.61	0.25

Description	Nos	L	B	H	Quantity
Washroom 2(W1)	1.00	0.41	-	0.61	0.25
Washroom1 (W1)	1.00	0.41	-	0.61	0.25
Dinnind/Drawing Room(W1)	2.00	1.22	-	2.13	5.20
Room4(W2)	2.00	1.22	-	2.13	5.20
Room4(W1)	1.00	1.05	-	2.27	2.38
Kitchen(W2)	1.00	1.22	-	2.13	2.60
Room2(W1)	1.00	1.27	-	0.52	0.66
Room3(W1)	1.00	1.27	-	0.52	0.66
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Total					53.51
					735.41 Sq.M.
		Rate	201.95	Amount	148516.05
					148516.05
PAINTING					

PAINTING WALLS PLASTIC EMULSION: Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty.					
Wall1	2.00	10.12	-	3.35	67.80
Wall2	2.00	20.62	-	3.35	138.15
Wall3	2.00	12.24	-	3.35	82.01
Wall4	2.00	11.60	-	3.35	77.72
Wall5	2.00	11.60	-	3.35	77.72
Wall6	2.00	31.42	-	3.35	210.51
Wall7	2.00	20.15	-	3.35	135.01
---					---
Total					788.92
Deduction for Openings					
Washroom2(D1)	1.00	0.76	-	2.03	1.54
Washroom1(D1)	1.00	0.76	-	2.03	1.54
Kithen(D1)	1.00	0.76	-	2.03	1.54
Drawing/Dinning Room(D1)	1.00	2.13	-	1.83	3.90
Room4(D1)	1.00	2.13	-	1.83	3.90
Room3(D1)	1.00	2.13	-	1.83	3.90
Room2(D1)	1.00	2.13	-	1.83	3.90
Room1(D1)	1.00	2.13	-	1.83	3.90
Washroom3(D1)	1.00	0.76	-	2.03	1.54
Room1(W1)	3.00	1.22	-	2.13	7.80
Kitchen(W1)	1.00	1.22	-	2.13	2.60
Washroom 3(W1)	1.00	0.41	-	0.61	0.25
Washroom 2(W1)	1.00	0.41	-	0.61	0.25
Washroom1 (W1)	1.00	0.41	-	0.61	0.25
Dinnind/Drawing Room(W1)	2.00	1.22	-	2.13	5.20
Room4(W2)	2.00	1.22	-	2.13	5.20
Room4(W1)	1.00	1.05	-	2.27	2.38
Kitchen(W2)	1.00	1.22	-	2.13	2.60
Room2(W1)	1.00	1.27	-	0.52	0.66
Room3(W1)	1.00	1.27	-	0.52	0.66
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Total					53.51
					735.41 Sq.M.

Description	Nos	L	B	H	Quantity
		Rate	48.00	Amount	35299.
PAINTING WALLS INT. **DISTEMPER** : Distempering two coats to the walls, including smoothening with sand paper.					
Wall1	2.00	10.12	-	3.35	67.88
Wall2	2.00	20.62	-	3.35	138.28
Wall3	2.00	12.24	-	3.35	82.06
Wall4	2.00	11.60	-	3.35	77.79
Wall5	2.00	11.60	-	3.35	77.79
Wall6	2.00	31.42	-	3.35	210.66
Wall7	2.00	20.15	-	3.35	135.14
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Total					789.60
Deduction for Openings					
Outside Area	1.00	0.00	-	0.00	0.00
Washroom2(D1)	1.00	0.76	-	2.03	1.55
Washroom1(D1)	1.00	0.76	-	2.03	1.55
Kithen(D1)	1.00	0.76	-	2.03	1.55
Drawing/Dinning Room(D1)	1.00	2.13	-	1.83	3.91
Room4(D1)	1.00	2.13	-	1.83	3.91
Room3(D1)	1.00	2.13	-	1.83	3.91
Room2(D1)	1.00	2.13	-	1.83	3.91
Room1(D1)	1.00	2.13	-	1.83	3.91
Washroom3(D1)	1.00	0.76	-	2.03	1.55
Room1(W1)	3.00	1.22	-	2.13	7.80
Kitchen(W1)	1.00	1.22	-	2.13	2.60
Washroom 3(W1)	1.00	0.41	-	0.61	0.25
Washroom 2(W1)	1.00	0.41	-	0.61	0.25
Washroom1 (W1)	1.00	0.41	-	0.61	0.25
Dinnind/Drawing Room(W1)	2.00	1.22	-	2.13	5.20
Room4(W2)	2.00	1.22	-	2.13	5.20
Room4(W1)	1.00	1.05	-	2.27	2.40
Kitchen(W2)	1.00	1.22	-	2.13	2.60
Room2(W1)	1.00	1.27	-	0.52	0.66
Room3(W1)	1.00	1.27	-	0.52	0.66
----					----
Total					53.62
					735.98 Sq.M.
		Rate	49.65	Amount	36541.41
					71841.09
Total for GROUND FLOOR					1824469.16

FLOOR FINISHING MARBLE					
TILES: Supplying and fixing 20mm thick marble slabs size 80cm x 150cm fixed into the floors.					
Warehouse	1.00	4.36	5.39	-	23.48
Glass House	1.00	12.65	6.89	-	87.16
					110.64 Sq.M.
		Rate	3,035.00	Amount	335792.40
					335792.40
DOORS AND WINDOWS					
FRAMES WOOD: Supplying and fixing of doors and windows frames using **good quality wood including M.S. clamps and fittings,fixing complete including a** coat of tar at the contact surface of the frame.					
Warehouse(D1)	1.00	4.83	0.10	0.06	0.03
Warehouse(W1)	3.00	6.71	0.10	0.06	0.12
					0.15 Cu.M.
		Rate	85,386.00	Amount	12807.90
SHUTTERS WOOD PANELLED: Supplying and fixing of shutters of good quality panelled wood.					
Warehouse(D1)	1.00	0.66	-	1.98	1.31
					1.31 Sq.M.

SHUTTERS WOOD GLAZED : Supplying and fixing of fully glazed shutters of good quality wood.					
Warehouse(W1)	3.00	1.22	-	2.13	7.80
					7.80 Sq.M.
		Rate	2,293.00	Amount	17885.40
					34215.96
PAINTING					
PAINTING WOOD POLISH : Polishing wood including preparing and smoothening the surface.					
Warehouse(D1)	2.60	0.76	-	2.03	4.03
Warehouse(W1)	4.80	1.22	-	2.13	12.49
					16.52 Sq.M.
		Rate	81.70	Amount	1349.68
PAINTING WALLS PLASTIC EMULSION : Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty.					
Wall	2.00	16.78	-	0.35	11.75
Wall	2.00	16.78	-	0.35	11.84
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Total					23.59
Deduction for Openings					
Warehouse(D1)	1.00	0.76	-	2.03	1.54
Warehouse(W1)	3.00	1.22	-	2.13	7.80
---					---
Total					9.34
					14.25 Sq.M.
		Rate	52.44	Amount	747.27
					2096.95
Total for FIRST FLOOR					377631.49
Total					2202100.65

ANNEXTURE-D

DETAILS OF MEASUREMENT AND CALCULATION OF QUANTITIES FOR COMPOSITE CLIMATIC REGION

D.1-CONVENTIONAL BUILDING (CHANDIGHAR)

Description	Nos	L	B	H	Quantity
		GROUND FLOOR			
EARTH WORKS					
EARTH WORKSEXCAVATION : Earth work excavation for foundation trenches in all classes of soil and depositing on bank with initial lead upto **50 mt. and lift upto 1.5 m including breaking clods , watering ramming and sectioning of spoil bank etc. complete.**					
Earth Work	1.00	132.26	0.90	1.00	119.03
					119.03 Cu.M.
		Rate	220.00	Amount	26186.60
EARTH WORKSFILLING PLINTH USING EARTH FROM SITE : Filling the plinth and side of the foundation with the cut earth available at site in layers not **exceeding 20 cms in depth consolidating** each deposited layers by ramming and **watering. Measurements will be taken only the filled and compacted earth.**					
Room1	1.00	5.69	4.01	3.35	76.50
Room2	1.00	5.23	4.01	3.35	70.32
Room3	1.00	4.32	4.01	3.35	58.08
Kitchen	1.00	3.25	2.80	3.35	30.51
Room4	1.00	4.44	4.23	3.35	62.97
Room5	1.00	4.23	4.18	3.35	59.28
Drawing/Dinning room	1.00	9.44	5.57	3.35	176.29
Washroom1	1.00	2.34	1.28	3.35	10.04
Washroom2	1.00	1.73	1.69	3.35	9.80
Washroom3	1.00	2.04	1.96	3.35	13.41
Washroom4	1.00	1.66	1.58	3.35	8.79
					575.99 Cu.M.
		Rate	110.00	Amount	63358.90
					89545.50

PCC FOUNDATION 1:4:8 : Providing **and laying P.C.C. 1:4:8 using 40mm** nominal size broken stone well consolidated including curing etc. complete for foundation.					
Pcc	1.00	132.26	0.90	0.30	35.71
					35.71 Cu.M.
		Rate	4,478.00	Amount	159909.38

DAMP PROOF COURSE 1:2:4 : **Providing 4 cm thick P.C.C. as a Damp** Proof Course with stone chips and approved water proofing compound **beneath the walls as per IS:2645-1964.**					
Plinth wall above footing	1.00	137.27	0.40	-	54.91
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Total					54.91
Deduction for Openings					
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Total					0.00
					54.91 Sq.M.
		Rate	257.80	Amount	14155.80
PCC FLOORING 1:2:4 CuM : **Providing and laying P.C.C . 1:2:4 using** 40 mm nominal size broken stone well consolidated 100 mm thick including					
Room1	1.00	5.79	4.11	0.10	2.38
Room2	1.00	5.33	4.11	0.10	2.19
Room3	1.00	4.42	4.11	0.10	1.82
Kitchen	1.00	3.35	2.90	0.10	0.97
Room4	1.00	4.54	4.33	0.10	1.97
Room5	1.00	4.33	4.28	0.10	1.85
Drawing/Dinning room	1.00	9.54	5.67	0.10	5.41
Washroom1	1.00	2.44	1.38	0.10	0.34
Washroom2	1.00	1.83	1.79	0.10	0.33
Washroom3	1.00	2.14	2.06	0.10	0.44
Washroom4	1.00	1.76	1.68	0.10	0.30
					18.00 Cu.M.
		Rate	6,778.20	Amount	122007.60
					296072.78

BRICK WORKS

BRICK WORKS FOUNDATION CM 1:4 : First class brick work masonry in C. M. 1:4 (1 cement 4 coarse sand) with approved good quality country burnt bricks of compressive strength 35 kg/m2 of standard size of on foundation. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work.					
1st footing	1.00	132.26	0.60	0.20	15.87
2nd footing	1.00	136.27	0.50	0.20	13.63
Plinth wall above footing	1.00	137.27	0.40	0.90	49.42
					78.92 Cu.M.
		Rate	4,970.00	Amount	392232.40

BRICK WORKS CM 1:6 : First class brick work masonry in C. M. 1:6 (1 cement 6 coarse sand) with approved good quality country burnt bricks of compressive strength 35 kg/m2 of standard size of on super structure of all thickness. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work.					
Wall	1.00	139.02	0.23	3.35	104.87
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Total					104.87
Deduction for Openings					
Washroom2(D1)	1.00	0.75	0.23	1.80	0.30
Washroom1(D1)	1.00	1.20	0.23	2.10	0.57
Jim Room/Hall(D1)	1.00	1.20	0.23	2.10	0.57
Room3(D1)	1.00	1.20	0.23	2.10	0.57
Room2(D1)	1.00	1.20	0.23	2.10	0.57
Room1(D1)	1.00	1.20	0.23	2.10	0.57
Washroom2(W1)	1.00	0.75	0.23	1.80	0.30
Washroom1(W1)	1.00	0.75	0.23	1.80	0.30
Jim Room/ Hall (W1)	2.00	0.90	0.23	1.50	0.61
Room3(W1)	1.00	0.90	0.23	1.20	0.24
Room2(W1)	1.00	0.90	0.23	1.20	0.24
Room1(W1)	1.00	0.90	0.23	1.20	0.24
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Total					5.08
					99.79 Cu.M.
		Rate	5,582.00	Amount	557027.78
					949260.18

FLOOR AND WALL FINISHES					
FLOOR FINISHING MARBLE TILES: Supplying and fixing 20mm thick marble slabs size 80cm x 150cm fixed into the floors.					
Kitchen	1.00	3.35	2.90	-	9.71
					9.71 Sq.M.
		Rate	3,035.00	Amount	29469.85
FLOOR FINISHING GRANITE TILES: Supplying and fixing pre polished black granite slab 20mm thick over 1:3,12mm thick using necessary cement grout including closing the joints with pigment of the colour to match including washing, cleaning, polishing the edges etc. complete as per pavior					
Room1	1.00	5.79	4.11	-	23.83
Room2	1.00	5.33	4.11	-	21.95
Room3	1.00	4.42	4.11	-	18.19
Kitchen	1.00	3.35	2.90	-	9.71
Room4	1.00	4.54	4.33	-	19.64
Room5	1.00	4.33	4.28	-	18.51

Description	Nos	L	B	H	Quantity
Drawing/Dinning room	1.00	9.54	5.67	-	54.10
					165.93 Sq.M.
		Rate	3,907.00	Amount	648288.51
					677758.36
DOORS AND WINDOWS					
FRAMES WOOD : Supplying and fixing of doors and windows frames using **good quality wood including M.S. clamps and fittings,fixing complete including a** coat of tar at the contact surface of the frame.					
Washroom2(D1)	1.00	5.40	0.10	0.06	0.03
Washroom1(D1)	1.00	5.40	0.10	0.06	0.03
Jim Room/Hall(D1)	1.00	5.40	0.10	0.06	0.03
Room3(D1)	1.00	5.40	0.10	0.06	0.03
Room2(D1)	1.00	5.40	0.10	0.06	0.03
Room1(D1)	1.00	5.40	0.10	0.06	0.03
Washroom2(W1)	1.00	4.20	0.10	0.06	0.03
Washroom1(W1)	1.00	4.20	0.10	0.06	0.03
Jim Room/ Hall (W1)	2.00	4.20	0.10	0.06	0.05
Room3(W1)	1.00	4.20	0.10	0.06	0.03
Room2(W1)	1.00	4.20	0.10	0.06	0.03
Room1(W1)	1.00	4.20	0.10	0.06	0.03
					0.38 Cu.M.
		Rate	85,386.00	Amount	32446.68
SHUTTERS WOOD PANELLED : Supplying and fixing of shutters of good quality panelled wood.					
Room2(D1)	1.00	1.10	-	2.05	2.26
Jim Room/Hall(D1)	1.00	1.11	-	2.06	2.29
Room1(D1)	1.00	1.11	-	2.06	2.29
Room2(D1)	1.00	1.11	-	2.06	2.29
Room3(D1)	1.00	1.11	-	2.06	2.29
Washroom1(D1)	1.00	1.11	-	2.06	2.29
Washroom2(D1)	1.00	0.66	-	1.76	1.16
					14.87 Sq.M.
		Rate	1,731.05	Amount	25740.71

SHUTTERS WOOD GLAZED : Supplying and fixing of fully glazed shutters of good quality wood.					
Washroom2(W1)	1.00	0.75	-	1.80	1.35
Washroom1(W1)	1.00	0.75	-	1.80	1.35
Jim Room/ Hall (W1)	2.00	0.90	-	1.50	2.70
Room3(W1)	1.00	0.90	-	1.20	1.08
Room2(W1)	1.00	0.90	-	1.20	1.08
Room1(W1)	1.00	0.90	-	1.20	1.08
					8.64 Sq.M.
		Rate	**2,293.00**	Amount	19811.52
					77998.91
PAINTING					

Description	Nos	L	B	H	Quantity
PAINTING WALLS DISTEMPER : Distempering two coats to the walls, including smoothening with sand paper.					
Wall	2.00	139.02	-	3.35	932.20
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Total					932.20
Deduction for Openings					
Washroom2(D1)	1.00	0.75	-	1.80	1.35
Washroom1(D1)	1.00	1.20	-	2.10	2.52
Jim Room/Hall(D1)	1.00	1.20	-	2.10	2.52
Room3(D1)	1.00	1.20	-	2.10	2.52
Room2(D1)	1.00	1.20	-	2.10	2.52
Room1(D1)	1.00	1.20	-	2.10	2.52
Washroom2(W1)	1.00	0.75	-	1.80	1.35
Washroom1(W1)	1.00	0.75	-	1.80	1.35
Jim Room/ Hall (W1)	2.00	0.90	-	1.50	2.70
Room3(W1)	1.00	0.90	-	1.20	1.08
Room2(W1)	1.00	0.90	-	1.20	1.08
Room1(W1)	1.00	0.90	-	1.20	1.08
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Total					22.59
					909.61 Sq.M.
		Rate	**49.65**	Amount	45162.14
					45162.14
Total for GROUND FLOOR					2135797.87

Description	Nos	L	B	H	Quantity
		FIRST FLOOR			
BRICK WORKS					
BRICK WORKS CM 1:6 : First class **brick work masonry in C. M. 1:6 (1 cement 6 coarse sand) with approved** good quality country burnt bricks of **compressive strength 35 kg/m2 of** standard size of on super structure of all **thickness. The rate shall include cost of** all materials labour and other incidental charges of all materials to complete the work.					
Wall	1.00	134.38	0.23	3.35	101.37
----					----
Total					101.37
Deduction for Openings					
----					----
Total					0.00
					101.37 Cu.M.
		Rate	2,338.90	Amount	237094.29
					237094.29
FLOOR AND WALL FINISHES					
FLOOR FINISHING MARBLE TILES: **Supplying and fixing 20mm thick marble slabs size 80cm x 150cm** fixed into the floors.					
Room1	1.00	5.43	4.16	-	22.60
Room2	1.00	5.61	4.16	-	23.35
Room3	1.00	5.48	4.04	-	22.10
Jim Room/Hall	1.00	11.11	6.07	-	67.47
Washroom1	1.00	1.87	1.83	-	3.43
Washroom2	1.00	1.93	1.83	-	3.52
					142.47 Sq.M.
		Rate	732.94	Amount	104421.96

DOORS AND WINDOWS					
FRAMES WOOD : Supplying and fixing of doors and windows frames using **good quality wood including M.S. clamps and fittings,fixing complete including a** coat of tar at the contact surface of the frame.					
Jim Room/ Hall (W1)	2.00	4.20	0.10	0.06	0.05
Jim Room/Hall(D1)	1.00	5.40	0.10	0.06	0.03
Room1(D1)	1.00	5.40	0.10	0.06	0.03
Room1(W1)	1.00	4.20	0.10	0.06	0.03
Room2(D1)	1.00	5.40	0.10	0.06	0.03
Room2(W1)	1.00	4.20	0.10	0.06	0.03
Room3(D1)	1.00	5.40	0.10	0.06	0.03
Room3(W1)	1.00	4.20	0.10	0.06	0.03
Washroom1(D1)	1.00	5.40	0.10	0.06	0.03

Description	Nos	L	B	H	Quantity
Washroom1(W1)	1.00	4.20	0.10	0.06	0.03
Washroom1(W1)	1.00	4.20	0.10	0.06	0.03
Washroom2(D1)	1.00	5.40	0.10	0.06	0.03
Washroom2(W1)	1.00	4.20	0.10	0.06	0.03
					0.41 Cu.M.
		Rate	**85,386.00**	Amount	35008.26
SHUTTERS WOOD PANELLED : Supplying and fixing of shutters of good quality panelled wood.					
Jim Room/Hall(D1)	1.00	1.11	-	2.06	2.29
Room1(D1)	1.00	1.11	-	2.06	2.29
Room2(D1)	1.00	1.11	-	2.06	2.29
Room3(D1)	1.00	1.11	-	2.06	2.29
Washroom1(D1)	1.00	1.11	-	2.06	2.29
Washroom2(D1)	1.00	0.66	-	1.76	1.16
					12.61 Sq.M.
		Rate	**2,689.05**	Amount	33908.92
SHUTTERS WOOD GLAZED : Supplying and fixing of fully glazed shutters of good quality wood.					
Jim Room/ Hall (W1)	2.00	0.90	-	1.50	2.70
Room1(W1)	1.00	0.90	-	1.20	1.08
Room2(W1)	1.00	0.90	-	1.20	1.08
Room3(W1)	1.00	0.90	-	1.20	1.08
Washroom1(W1)	1.00	0.75	-	1.80	1.35
Washroom2(W1)	1.00	0.75	-	1.80	1.35
					8.64 Sq.M.
		Rate	**2,293.92**	Amount	19819.47
					88736.65

PAINTING WALLS PLASTIC EMULSION : Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty.					
Wall	2.00	134.38	-	3.35	901.08
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Total					901.08
Deduction for Openings					
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Total					0.00
					901.08 Sq.M.
		Rate	52.44	Amount	47252.64
					47252.64
Total for FIRST FLOOR					477505.54
Total					2613303.41

D. 2

Description	Nos	L	B	H	Quantity
GROUND FLOOR					
EARTH WORKS					
EARTH WORKSEXCAVATION : Earth work excavation for foundation trenches in all classes of soil and depositing on bank with initial lead upto **50 mt. and lift upto 1.5 m including breaking clods , watering ramming and sectioning of spoil bank etc. complete.**					
Earth Work in back and front varandah including stair area	1.00	12.78	0.90	1.00	11.50
Earth Work in dinning/drawing room(wall1)	1.00	6.59	0.90	1.00	5.93
Earth Work in dinning/drawing room(wall2)	1.00	2.59	0.90	1.00	2.33
Earth Work in kitchen(wall1)	1.00	2.90	0.90	1.00	2.61
Earth Work in kitchen(wall2)	1.00	2.90	0.90	1.00	2.61
Earth Work in room1(wall1)	1.00	5.79	0.90	1.00	5.21
Earth Work in room1(wall2)	1.00	4.11	0.90	1.00	3.70
Earth Work in room1(wall3)	1.00	5.79	0.90	1.00	5.21
Earth Work in room1(wall4)	1.00	5.33	0.90	1.00	4.80
Earth Work in room2(wall1)	1.00	4.11	0.90	1.00	3.70
Earth Work in room2(wall2)	1.00	5.33	0.90	1.00	4.80
Earth Work in room2(wall3)	1.00	4.11	0.90	1.00	3.70
Earth Work in room3(wall1)	1.00	4.11	0.90	1.00	3.70
Earth Work in room3(wall2)	1.00	4.42	0.90	1.00	3.98
Earth Work in room3(wall3)	1.00	4.11	0.90	1.00	3.70
Earth Work in room3(wall4)	1.00	4.42	0.90	1.00	3.98
Earth Work in room4(wall1)	1.00	4.33	0.90	1.00	3.89
Earth Work in room4(wall2)	1.00	4.54	0.90	1.00	4.08
Earth Work in room4(wall3)	1.00	4.33	0.90	1.00	3.89

Earth Work in room4(wall4)	1.00	4.54	0.90	1.00	4.08
Earth Work in room5(wall1)	1.00	4.33	0.90	1.00	3.89
Earth Work in room5(wall2))	1.00	4.28	0.90	1.00	3.85
Earth Work in room5(wall3))	1.00	4.28	0.90	1.00	3.85
Earth Work in washroom1(wall1)	1.00	2.44	0.90	1.00	2.19
Earth Work in washroom1(wall3)	1.00	2.44	0.90	1.00	2.19
Earth Work in washroom2(wall1)	1.00	1.83	0.90	1.00	1.65
Earth Work in washroom2(wall2)	1.00	1.79	0.90	1.00	1.61
Earth Work in washroom3(wall1)	1.00	2.14	0.90	1.00	1.93
Earth Work in washroom3(wall2)	1.00	2.06	0.90	1.00	1.85
Earth Work in washroom4(wall1)	1.00	1.76	0.90	1.00	1.59
Earth Work in washroom4(wall2)	1.00	1.76	0.90	1.00	1.59
					113.59 Cu.M.
		Rate	220.00	Amount	24989.80

Description	Nos	L	B	H	Quantity
EARTH WORKSFILLING PLINTH USING EARTH FROM SITE : Filling the plinth and side of the foundation with the cut earth available at site in layers not **exceeding 20 cms in depth consolidating** each deposited layers by ramming and **watering. Measurements will be taken only the filled and compacted earth.**					
Room1	1.00	5.69	4.01	0.60	13.69
Room2	1.00	5.23	4.01	0.60	12.58
Room3	1.00	4.32	4.01	0.60	10.39
Room4	1.00	4.44	4.23	0.60	11.27
Room5	1.00	4.23	4.18	0.60	10.61
Dinning/Drawing	1.00	8.34	5.88	0.60	29.42
Washroom1	1.00	2.74	1.28	0.60	2.10
Washroom2	1.00	1.73	1.69	0.60	1.75
Washroom3	1.00	2.04	1.96	0.60	2.40
Washroom4	1.00	1.66	1.58	0.60	1.57
Kitchen	1.00	3.25	2.80	0.60	5.46
					101.24 Cu.M.
		Rate	110.00	Amount	11136.40

ANTI TERMITE TREATMENT : Anti termite treatment by providing and injecting chemical **emulsion/Aldrin/heptachler emulsible concentrates 0.50% and clilossdance** emulsifiable concentrate for pre contractional treatment and creating a **chemical barrier as per I.S 6313 (Part II)** 1951 in wall trench foundation top surface of plinth filling junction of wall and floor along the external perimeters of **the building complete (areas of building** shall be measured).					
Room1	1.00	5.79	4.11	-	23.83
Room2	1.00	5.33	4.11	-	21.95
Room3	1.00	4.42	4.11	-	18.19
Room4	1.00	4.54	4.33	-	19.64
Room5	1.00	4.33	4.28	-	18.51
Dinning/Drawing	1.00	8.44	5.98	-	50.43
Washroom1	1.00	2.84	1.38	-	3.93
Washroom2	1.00	1.83	1.79	-	3.27
Washroom3	1.00	2.14	2.06	-	4.42
Washroom4	1.00	1.76	1.68	-	2.96
Kitchen	1.00	3.35	2.90	-	9.71
					176.84 Sq.M.
		Rate	200.00	Amount	35368.00
					71494.20
PCC					

Description	Nos	L	B	H	Quantity
PCC FOUNDATION 1:4:8 : Providing **and laying P.C.C. 1:4:8 using 40mm** nominal size broken stone well **consolidated including curing etc. complete for foundation.**					
Pcc	1.00	137.67	0.90	0.30	37.17
					37.17 Cu.M.
		Rate	4,478.00	Amount	166447.26
DAMP PROOF COURSE 1:2:4 : **Providing 4 cm thick P.C.C. as a Damp** Proof Course with stone chips and approved water proofing compound **beneath the walls as per IS:2645-1964.**					
plinth wall above footing	1.00	141.27	0.40	-	56.51
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Total					56.51
Deduction for Openings					
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Total					0.00
					56.51 Sq.M.
		Rate	314.85	Amount	17792.17
PCC FLOORING 1:2:4 CuM : **Providing and laying P.C.C . 1:2:4 using** 40 mm nominal size broken stone well **consolidated 100 mm thick including**					
Room1	1.00	5.79	4.11	0.10	2.38
Room2	1.00	5.33	4.11	0.10	2.19
Room3	1.00	4.42	4.11	0.10	1.82
Room4	1.00	4.54	4.33	0.10	1.97
Room5	1.00	4.33	4.28	0.10	1.85
Dinning/Drawing	1.00	8.44	5.98	0.10	5.05
Washroom1	1.00	2.84	1.38	0.10	0.39
Washroom2	1.00	1.83	1.79	0.10	0.33
Washroom3	1.00	2.14	2.06	0.10	0.44
Washroom4	1.00	1.76	1.68	0.10	0.30
Kitchen	1.00	3.35	2.90	0.10	0.97
					17.69 Cu.M.
		Rate	3,233.00	Amount	57191.77
					241431.20

BRICK WORKS

BRICK WORKS FOUNDATION CM 1:4 : First class brick work masonry in C. M. 1:4 (1 cement 4 coarse sand) with approved good quality country burnt bricks of compressive strength 35 kg/m2 of standard size of on foundation. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work.					
1st footing	1.00	139.27	0.60	0.20	16.71
2nd footing	1.00	140.27	0.50	0.20	14.03
plinth wall above footing	1.00	141.27	0.40	0.90	50.86
					81.60 Cu.M.

Description	Nos	L	B	H	Quantity
		Rate	4,970.00	Amount	405552.00
BRICK WORKS CM 1:6 : First class brick work masonry in C. M. 1:6 (1 cement 6 coarse sand) with approved good quality country burnt bricks of compressive strength 35 kg/m2 of standard size of on super structure of all thickness. The rate shall include cost of all materials labour and other incidental charges of all materials to complete the work.					
Wall1	1.00	41.87	0.26	3.35	36.78
Wall2	1.00	22.27	0.19	3.35	14.49
Wall3	1.00	15.08	0.16	3.35	8.06
Wall4	1.00	8.44	0.18	3.35	5.21
Wall5	1.00	4.95	0.24	3.35	3.99
Wall6	1.00	12.08	0.23	3.35	9.11
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Total					77.64
Deduction for Openings					
Drawing/Dinning Room(DD)	1.00	1.81	0.24	2.07	0.90
Washroom4(D1)	1.00	0.76	0.16	2.03	0.25
Room2(D1)	1.00	0.76	0.19	2.03	0.30
Room3(D1)	1.00	0.76	0.26	2.03	0.41
Room4(D1)	1.00	0.76	0.19	2.03	0.30
Room5(D1)	1.00	0.76	0.19	2.03	0.30
Washroom1(D1)	1.00	0.76	0.16	2.03	0.25
Washroom2(D1)	1.00	0.76	0.16	2.03	0.25
Washroom3(D1)	1.00	0.76	0.16	2.03	0.25
Room1(D1)	1.00	0.76	0.19	2.03	0.30
Washroom3(W1)	2.00	0.16	0.16	0.41	0.02
Dinning/Drawing room(W2)	3.00	1.20	0.26	2.41	2.27

Room1(W1)	1.00	0.76	0.26	1.20	0.24
Washroom2(W1)	2.00	0.[@I (String)]	0.16	0.41	0.02
Washroom1(W1)	2.00	0.85	0.16	1.20	0.33
kitchen(W1)	2.00	0.90	0.26	1.39	0.65
Dinning/Drawing room(W1)	1.00	0.90	0.24	1.20	0.26
Room5(W1)	1.00	0.52	0.26	2.13	0.29
Room4(W2)	1.00	0.52	0.18	2.13	0.20
Room4(W1)	2.00	1.05	0.18	2.27	0.88
Washroom4(W1)	2.00	0.85	0.16	1.20	0.33
Room2(W1)	1.00	0.76	0.26	1.20	0.24
Room3(W2)	1.00	1.04	0.26	2.92	0.80
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Total					10.04
					67.60 Cu.M.
		Rate	5,582.00	Amount	377343.20
					782895.20
FLOOR AND WALL FINISHES					
FLOOR FINISHING MARBLE TILES: Supplying and fixing 20mm thick marble slabs size 80cm x 150cm fixed into the floors.					
Room1	1.00	5.79	4.11	-	23.83

Description	Nos	L	B	H	Quantity
Room2	1.00	5.33	4.11	-	21.95
Room3	1.00	4.42	4.11	-	18.19
Room4	1.00	4.54	4.33	-	19.64
Room5	1.00	4.33	4.28	-	18.51
Dinning/Drawing	1.00	8.44	5.98	-	50.43
Washroom1	1.00	2.84	1.38	-	3.93
Washroom2	1.00	1.83	1.79	-	3.27
Washroom3	1.00	2.14	2.06	-	4.42
Washroom4	1.00	1.76	1.68	-	2.96
Kitchen	1.00	3.35	2.90	-	9.71
					176.84 Sq.M.
		Rate	3,035.00	Amount	536709.40
SKIRTING MARBLE SLABSIN SqM : Skirting using Marble Slabs					
Room1	1.00	19.81	-	0.10	1.98
Room2	1.00	18.90	-	0.10	1.89
Room3	1.00	17.07	-	0.10	1.71
Room4	1.00	17.73	-	0.10	1.77
Room5	1.00	17.21	-	0.10	1.72
Dinning/Drawing	1.00	28.83	-	0.10	2.88
Washroom1	1.00	8.44	-	0.10	0.84
Washroom2	1.00	7.23	-	0.10	0.72
Washroom3	1.00	8.41	-	0.10	0.84
Washroom4	1.00	6.88	-	0.10	0.69
Kitchen	1.00	12.50	-	0.10	1.25
					16.29 Sq.M.
		Rate	2,937.00	Amount	47843.73
					584553.13

DOORS AND WINDOWS					
FRAMES WOOD : Supplying and fixing of doors and windows frames using **good quality wood including M.S. clamps and fittings,fixing complete including a** coat of tar at the contact surface of the frame.					
Drawing/Dinning Room(DD)	1.00	7.76	0.10	0.06	0.05
Washroom4(D1)	1.00	4.83	0.10	0.06	0.03
Room2(D1)	1.00	4.83	0.10	0.06	0.03
Room3(D1)	1.00	4.83	0.10	0.06	0.03
Room4(D1)	1.00	4.83	0.10	0.06	0.03
Room5(D1)	1.00	4.83	0.10	0.06	0.03
Washroom1(D1)	1.00	4.83	0.10	0.06	0.03
Washroom2(D1)	1.00	4.83	0.10	0.06	0.03
Washroom3(D1)	1.00	4.83	0.10	0.06	0.03
Room1(D1)	1.00	4.83	0.10	0.06	0.03
Washroom3(W1)	2.00	1.13	0.10	0.06	0.01
Dinning/Drawing room(W2)	3.00	7.22	0.10	0.06	0.13
Room1(W1)	1.00	3.91	0.10	0.06	0.02
Washroom2(W1)	2.00	1.13	0.10	0.06	0.01
Washroom1(W1)	2.00	4.10	0.10	0.06	0.05
kitchen(W1)	2.00	4.58	0.10	0.06	0.05
Dinning/Drawing room(W1)	1.00	4.20	0.10	0.06	0.03
Room5(W1)	1.00	5.31	0.10	0.06	0.03

Description	Nos	L	B	H	Quantity
Room4(W2)	1.00	5.31	0.10	0.06	0.03
Room4(W1)	2.00	6.65	0.10	0.06	0.08
Washroom4(W1)	2.00	4.10	0.10	0.06	0.05
Room2(W1)	1.00	3.91	0.10	0.06	0.02
Room3(W2)	1.00	7.92	0.10	0.06	0.05
					0.88 Cu.M.
		Rate	**85,386.00**	Amount	75139.68
SHUTTERS WOOD PANELLED : Supplying and fixing of shutters of good quality panelled wood.					
Drawing/Dinning Room(DD)	1.00	1.71	-	2.02	3.45
Room1(D1)	1.00	0.66	-	1.98	1.31
Washroom3(D1)	1.00	0.66	-	1.98	1.31
Washroom2(D1)	1.00	0.66	-	1.98	1.31
Washroom1(D1)	1.00	0.66	-	1.98	1.31
Room5(D1)	1.00	0.66	-	1.98	1.31
Room4(D1)	1.00	0.66	-	1.98	1.31
Room3(D1)	1.00	0.66	-	1.98	1.31
Room2(D1)	1.00	0.66	-	1.98	1.31
Washroom4(D1)	1.00	0.66	-	1.98	1.31
					15.24 Sq.M.
		Rate	**2,689.05**	Amount	40981.12

SHUTTERS WOOD GLAZED : Supplying and fixing of fully glazed shutters of good quality wood.					
Room1(W1)	1.00	0.76	-	1.20	0.91
Room2(W1)	1.00	0.76	-	1.20	0.91
Washroom4(W1)	2.00	0.85	-	1.20	2.04
Room4(W1)	2.00	1.05	-	2.27	4.79
Room4(W2)	1.00	0.52	-	2.13	1.11
Room5(W1)	1.00	0.52	-	2.13	1.11
Dinning/Drawing room(W1)	1.00	0.80	-	1.15	0.92
kitchen(W1)	2.00	0.90	-	1.39	2.50
Washroom1(W1)	2.00	0.85	-	1.20	2.04
Washroom2(W1)	2.00	0.16	-	0.41	0.13
Washroom3(W1)	2.00	0.16	-	0.41	0.13
Dinning/Drawing room(W2)	3.00	1.10	-	2.36	7.79
Room3(W2)	1.00	1.04	-	2.92	3.04
					27.42 Sq.M.
		Rate	2,293.00	Amount	62874.06
					178994.86
PLASTERING AND POINTING					
PLASTERING WALLS CM 1:2 12 MM : Plastering witth cement mortar to walls, columns and other structural architectural features at all heights, floated hard and trowelled get smooth finish. The rate shall include provision of grooves scaffolding at any height curing etc. complete as directed by the Engineer.					
Wall1	2.00	41.87	-	3.35	280.75
Wall2	2.00	22.27	-	3.35	149.33

Description	Nos	L	B	H	Quantity
Wall3	2.00	15.08	-	3.35	101.12
Wall4	2.00	8.44	-	3.35	56.61
Wall5	2.00	4.95	-	3.35	33.17
Wall6	2.00	12.08	-	3.35	80.99
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Total					701.97
Deduction for Openings					
Drawing/Dinning Room(DD)	1.00	1.81	-	2.07	3.75
Washroom4(D1)	1.00	0.76	-	2.03	1.55
Room2(D1)	1.00	0.76	-	2.03	1.55
Room3(D1)	1.00	0.76	-	2.03	1.55
Room4(D1)	1.00	0.76	-	2.03	1.55
Room5(D1)	1.00	0.76	-	2.03	1.55
Washroom1(D1)	1.00	0.76	-	2.03	1.55
Washroom2(D1)	1.00	0.76	-	2.03	1.55
Washroom3(D1)	1.00	0.76	-	2.03	1.55
Room1(D1)	1.00	0.76	-	2.03	1.55
Washroom3(W1)	2.00	0.16	-	0.41	0.13
Dinning/Drawing room(W2)	3.00	1.20	-	2.41	8.68
Room1(W1)	1.00	0.76	-	1.20	0.91
Washroom2(W1)	2.00	0.16	-	0.41	0.13
Washroom1(W1)	2.00	0.85	-	1.20	2.04
kitchen(W1)	2.00	0.90	-	1.39	2.50
Dinning/Drawing room(W1)	1.00	0.90	-	1.20	1.08
Room5(W1)	1.00	0.52	-	2.13	1.11
Room4(W2)	1.00	0.52	-	2.13	1.11
Room4(W1)	2.00	1.05	-	2.27	4.79
Washroom4(W1)	2.00	0.85	-	1.20	2.04
Room2(W1)	1.00	0.76	-	1.20	0.91
Room3(W2)	1.00	1.04	-	2.92	3.04
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Total					46.17
					655.80 Sq.M.
		Rate	201.95	Amount	132438.81
					132438.81
PAINTING					

PAINTING WALLS PLASTIC EMULSION : Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty.

Wall1	2.00	41.87	-	3.35	280.75
Wall2	2.00	22.27	-	3.35	149.33
Wall3	2.00	15.08	-	3.35	101.12
Wall4	2.00	8.44	-	3.35	56.61
Wall5	2.00	4.95	-	3.35	33.17
Wall6	2.00	12.08	-	3.35	80.99
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Total					701.97
Deduction for Openings					
Drawing/Dinning Room(DD)	1.00	1.81	-	2.07	3.75
Washroom4(D1)	1.00	0.76	-	2.03	1.55
Room2(D1)	1.00	0.76	-	2.03	1.55
Room3(D1)	1.00	0.76	-	2.03	1.55
Room4(D1)	1.00	0.76	-	2.03	1.55
Room5(D1)	1.00	0.76	-	2.03	1.55
Washroom1(D1)	1.00	0.76	-	2.03	1.55
Washroom2(D1)	1.00	0.76	-	2.03	1.55
Washroom3(D1)	1.00	0.76	-	2.03	1.55
Room1(D1)	1.00	0.76	-	2.03	1.55
Washroom3(W1)	2.00	0.16	-	0.41	0.13
Dinning/Drawing room(W2)	3.00	1.20	-	2.41	8.68
Room1(W1)	1.00	0.76	-	1.20	0.91
Washroom2(W1)	2.00	0.16	-	0.41	0.13
Washroom1(W1)	2.00	0.85	-	1.20	2.04
kitchen(W1)	2.00	0.90	-	1.39	2.50
Dinning/Drawing room(W1)	1.00	0.90	-	1.20	1.08
Room5(W1)	1.00	0.52	-	2.13	1.11
Room4(W2)	1.00	0.52	-	2.13	1.11
Room4(W1)	2.00	1.05	-	2.27	4.79
Washroom4(W1)	2.00	0.85	-	1.20	2.04
Room2(W1)	1.00	0.76	-	1.20	0.91
Room3(W2)	1.00	1.04	-	2.92	3.04
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Total					46.17
					655.80 Sq.M.
		Rate	**48.00**	Amount	**31478.40**

PAINTING WALLS INT. PLASTIC EMULSION : Applying plastic emulsion paint two coats including cement primer on prepared plastered surface and sand papering to all intermediate coats including putty.

Wall1	2.00	41.87	-	3.35	280.75
Wall2	2.00	22.27	-	3.35	149.33
Wall3	2.00	15.08	-	3.35	101.12
Wall4	2.00	8.44	-	3.35	56.61
Wall5	2.00	4.95	-	3.35	33.17
Wall6	2.00	12.08	-	3.35	80.99
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Total					701.97
Deduction for Openings					
Outside Area	1.00	0.00	-	0.00	0.00
Drawing/Dinning Room(DD)	1.00	1.81	-	2.07	3.75
Washroom4(D1)	1.00	0.76	-	2.03	1.55
Room2(D1)	1.00	0.76	-	2.03	1.55
Room3(D1)	1.00	0.76	-	2.03	1.55
Room4(D1)	1.00	0.76	-	2.03	1.55
Room5(D1)	1.00	0.76	-	2.03	1.55
Washroom1(D1)	1.00	0.76	-	2.03	1.55
Washroom2(D1)	1.00	0.76	-	2.03	1.55
Washroom3(D1)	1.00	0.76	-	2.03	1.55
Room1(D1)	1.00	0.76	-	2.03	1.55
Washroom3(W1)	2.00	0.16	-	0.41	0.13
Dinning/Drawing room(W2)	3.00	1.20	-	2.41	8.68
Room1(W1)	1.00	0.76	-	1.20	0.91
Washroom2(W1)	2.00	0.16	-	0.41	0.13
Washroom1(W1)	2.00	0.85	-	1.20	2.04

Description	Nos	L	B	H	Quantity
kitchen(W1)	2.00	0.90	-	1.39	2.50
Dinning/Drawing room(W1)	1.00	0.90	-	1.20	1.08
Room5(W1)	1.00	0.52	-	2.13	1.11
Room4(W2)	1.00	0.52	-	2.13	1.11
Room4(W1)	2.00	1.05	-	2.27	4.79
Washroom4(W1)	2.00	0.85	-	1.20	2.04
Room2(W1)	1.00	0.76	-	1.20	0.91
Room3(W2)	1.00	1.04	-	2.92	3.04
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Total					46.17
					655.80 Sq.M.
		Rate	48.00	Amount	31478.40
					62956.80
Total for GROUND FLOOR					2054764.21

Description	Nos	L	B	H	Quantity
		FIRST FLOOR			
BRICK WORKS					
BRICK WORKS CM 1:6 : First class **brick work masonry in C. M. 1:6 (1 cement 6 coarse sand) with approved** good quality country burnt bricks of **compressive strength 35 kg/m2 of** standard size of on super structure of all **thickness. The rate shall include cost of** all materials labour and other incidental charges of all materials to complete the work.					
Wall1	1.00	7.74	0.19	3.35	5.03
Wall2	1.00	25.22	0.18	3.35	15.56
Wall3	1.00	48.17	0.26	3.35	42.31
Wall4	1.00	11.73	0.16	3.35	6.27
Wall5	1.00	16.74	0.23	3.35	12.63
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Total					81.80
Deduction for Openings					
Jim Room/Hall(D1)	1.00	0.92	0.26	2.13	0.51
Room3(D1)	1.00	0.92	0.18	2.13	0.36
Room2(D1)	1.00	0.92	0.18	2.13	0.36
Room1(D1)	1.00	0.92	0.18	2.13	0.36
Washroom1(D1)	1.00	0.76	0.16	2.03	0.25
Washroom2(D1)	1.00	0.76	0.16	2.03	0.25
Jim Room/Hall(W2)	2.00	1.20	0.26	1.20	0.75
Jim Room/Hall(W1)	3.00	1.20	0.26	1.20	1.13
Room3(W1)	2.00	0.85	0.18	1.20	0.38
Room2(W1)	1.00	0.85	0.24	1.20	0.25
Room1(W1)	1.00	0.61	0.18	0.41	0.05
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Total					4.65
					77.15 Cu.M.
		Rate	5,583.00	Amount	430728.45
					430728.45

FLOOR AND WALL FINISHES					
FLOOR FINISHING GRANITE TILES : Supplying and fixing pre **polished black granite slab 20mm thick over 1:3,12mm thick using necessary** cement grout including closing the joints with pigment of the colour to match **including washing, cleaning, polishing the edges etc. complete as per pavior**					
Jim Room/Hall	1.00	8.39	9.45	-	79.29
Room1	1.00	4.35	5.10	-	22.21
Room2	1.00	5.61	3.66	-	20.53
Room3	1.00	5.48	4.89	-	26.78
Washroom1	1.00	1.87	1.87	-	3.51
Washroom2	1.00	1.93	1.83	-	3.52
					155.84 Sq.M.

Description	Nos	L	B	H	Quantity
		Rate	2,937.00	Amount	457702.08
SKIRTING GRANITE TILES IN M : Supplying and fixing pre polished black **granite slab 20mm thick over 1:3,12mm** thick using necessary cement grout including closing the joints with pigment of the colour to match including washing, **cleaning, polishing the edges etc.** complete for skirting.					
Jim Room/Hall	1.00	35.68	-	-	35.68
Room1	1.00	18.91	-	-	18.91
Room2	1.00	18.54	-	-	18.54
Room3	1.00	20.73	-	-	20.73
					93.86 m
		Rate	358.00	Amount	33601.88
					491303.96
DOORS AND WINDOWS					
FRAMES WOOD : Supplying and fixing of doors and windows frames using **good quality wood including M.S. clamps and fittings,fixing complete including a** coat of tar at the contact surface of the frame.					
Jim Room/Hall(D1)	1.00	5.18	0.10	0.06	0.03
Room3(D1)	1.00	5.18	0.10	0.06	0.03
Room2(D1)	1.00	5.18	0.10	0.06	0.03
Room1(D1)	1.00	5.18	0.10	0.06	0.03
Washroom1(D1)	1.00	4.83	0.10	0.06	0.03
Washroom2(D1)	1.00	4.83	0.10	0.06	0.03
Jim Room/Hall(W2)	2.00	4.80	0.10	0.06	0.06
Jim Room/Hall(W1)	3.00	4.80	0.10	0.06	0.09
Room3(W1)	2.00	4.10	0.10	0.06	0.05
Room2(W1)	1.00	4.10	0.10	0.06	0.02
Room1(W1)	1.00	2.03	0.10	0.06	0.01
					0.41 Cu.M.
		Rate	85,386.00	Amount	35008.26

SHUTTERS WOOD PANELLED : Supplying and fixing of shutters of good quality panelled wood.					
Jim Room/Hall(D1)	1.00	0.82	-	2.08	1.71
Room3(D1)	1.00	0.82	-	2.08	1.71
Room2(D1)	1.00	0.82	-	2.08	1.71
Room1(D1)	1.00	0.82	-	2.08	1.71
Washroom1(D1)	1.00	0.66	-	1.98	1.31
Washroom2(D1)	1.00	0.66	-	1.98	1.31
					9.46 Sq.M.
		Rate	**2,689.05**	Amount	25438.41
SHUTTERS WOOD GLAZED : Supplying and fixing of fully glazed shutters of good quality wood.					
Jim Room/Hall(W2)	2.00	1.20	-	1.20	2.88
Jim Room/Hall(W1)	3.00	1.20	-	1.20	4.32
Room3(W1)	2.00	0.85	-	1.20	2.04

Description	Nos	L	B	H	Quantity
Room2(W1)	1.00	0.85	-	1.20	1.02
Room1(W1)	1.00	0.61	-	0.41	0.25
					10.51 Sq.M.
		Rate	**2,293.00**	Amount	24099.43
					84546.10
Total for FIRST FLOOR					1006578.51
Total					3061342.72
Net Amount					**3061343.00**