COST ESTIMATING OF TYPICAL BHUTANESE RESIDENTIAL APARTMENT INCLUDING ENERGY PERFORMANCE USING BIM AND ENERGY SIMULATOR

CHOTEN TSHERING

A Thesis Submitted to the Graduate School of Naresuan University
in Partial Fulfillment of the Requirements
for the Master of Engineering in Civil Engineering
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has been approved by the Graduate School as partial fulfillment of the requirements

for the Master of Engineering in Civil Engineering of Naresuan University

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ABSTRACT

Bhutan is in the Himalayan Mountain between India and China. Most of the districts experience cold weather from September to February month and moderate with humid temperatures in summer. Due to cold weather, people use simple heating systems such as electrical heating systems and kerosene heating systems to heat space. However, these heating devices consume a lot of energy thereby hampering the economy of the nation. Building designers and engineers use simple drawing programs like 2D AutoCAD and Google SketchUp for drawing, quantity takeout, and visualization. The application of the BIM concept in the construction sector is extremely limited due to a lack of resources. So, in this study, the BIM is applied in analyzing the energy performance of typical Bhutanese residential buildings. The typical Bhutanese residential building uses traditional plastered brick walls and concrete block walls without insulation, resulting in greater heat loss from the structure. The heat loss from the building has a direct impact on the energy consumption of the building. Moreover, the choice of construction materials is based on its ease and availability and there was no comprehensive study done on exploring building attributes which can minimize the construction cost and energy consumption. The purpose of this study was to cost estimate of building alternatives and perform energy performance of building using BIM and to provide better alternatives that can

improve the comfort for occupants. So, the model has been constructed using software called ‘Open Building Designer’. The model was first created in Open Building Designer and exported to ‘Energy Simulator’ with help of an energy analysis tool. The simulation was carried out on the six building alternatives which were classified based on the floors and walls attributes. The simulation was carried out and a comparison was drawn between building scenarios based on annual electricity consumption, heat loss, and heat gain. The simulation result revealed that the typical two storied Bhutanese residential building can consume energy of 15301.43 kWh per year amounting to Nu. 37488. The results showed that brick and concrete block walls lose more heat than stone walls, whereas stone walls can retain the most heat. It was discovered that walls with better insulation can retain the most heat and lose the least amount of heat. The CIBSE heat gain tool was used to calculate the heat gain in building models. The heat gain result revealed that the building obtains heat from solar, fabric, casual, convective, and latent sources. The building constructed with traditional materials (timber, stone wall) will cost minimum construction cost of Nu. 2399006 while building constructed with modern materials (cement, concrete, reinforcement etc.) will cost maximum of Nu. 5931026. It was found that the cost of constructing increases as better insulated materials is employed, but that the energy performance of insulated walls is far superior to that of uninsulated walls. The result shows that a large portion of a residential building's budget is spent on building construction and good amount in operational energy use. The specific amount of money is also spent for operational water use and demolition. If the building owner does not take a bank loan, a 20-year return period is sufficient to fully repay the initial investment. However, if the owner takes out a complete construction loan, it will take at least 30 years for the owner to pay off the interest and the initial expenditure. (Nu: Ngultrum; Bhutanese currency; 1 US $≅45 Nu).

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CHOTEN TSHERING

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CHAPTER I

INTRODUCTION

1.1 Background and Significance of the Study

Bhutan is a tiny and landlocked country sandwiched between two giant nations: the people's republic of China (Tibet) to the north and India to the south (Maxwell, 2018). Bhutan (Figure 1) has a land area of 38394 Sq.km and 71% forest cover. According to the population and housing census of Bhutan 2017, the total population found was 681720. The total urban population in 2005 and 2017 were 196111 and 274316 respectively (NSB, 2020).As the population increases a greater number of houses are needed to accommodate those people. However, people always look for a proper house for their healthy life.

Figure 1 Bhutan Map

Source: Dundruk, 2019

The typical Bhutanese residential building is constructed with stone masonry with timber flooring but now the modern materials like brick, cement, concrete, sand, steel etc. are used widely in urban areas. In this research, the models can be drawn in BIM software called Open Building Designer. Here the Open Building Designer is used because it can be used for a modelling and energy analysis of the building.

This research will have benefits to building owners by reducing the construction cost of building by altering the building components by using selective materials. The study will also aim to find out the present worth of life cycle costs and energy consumption in various building models. The aim of this study is to improve comfort to occupants and have low energy consumption thereby reducing the energy consumption bills. This study will also present basic building alternatives for designers and planners using Open Building Designer software and help them easily visualize traditional Bhutanese building types at glance and attenuate the time of choosing the building types with available capital.

1.2 Statement of the Problems

The rate of energy consumption in the construction sector, both industrial and residential, is one of the most significant difficulties we face globally (Berardi, 2017). In Bhutan, most of the place's experiences cold weather with low temperature. The Bhutanese houses constructed are not energy efficiently designed to cope up with those weather. It is important to prevent heat loss and relying on the artificial heating system especially during winter to minimize energy consumption. One of the typical observations that, only public buildings like hospitals, institutional buildings, the hotel uses air conditioners. Most households predominately use ceiling fans for cooling space. The population of Bhutan is also increasing and with more people, more houses are constructed to accommodate all of them. The increasing household has a direct and proportionate impact on electricity consumption. which lead to huge energy consumption. In Bhutan, the building sector utilizes 42% of the total energy consumption. The energy is used in the form of electricity, biomass, and solid/liquid (LPG, Kerosene, etc.) while in one of the observations made by building energy audit, the Bhutanese building requires energy mainly for space heating and cooking(Energy, 2015).The electricity consumption in the household (Figure 2) is

much higher than the commercial and institutional buildings. Moreover, the electricity consumption for both sectors is increasing from the year 2006 to 2014. This indicates that more amount of electricity is required in future in the building sector of Bhutan.

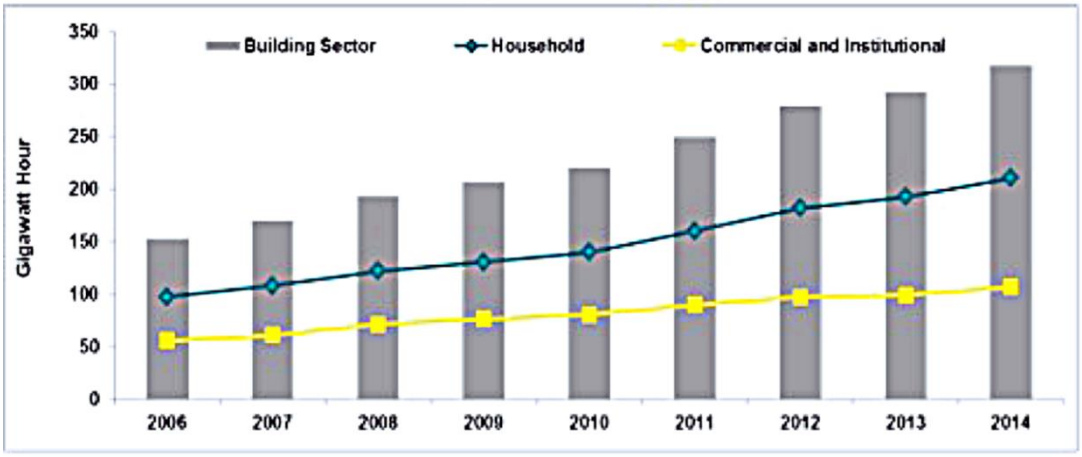


Figure 2 Electricity Consumption Split by Consumer Segments Under Buildings Sector (in GWh)

Source: Developed from Bhutan Power Data Handbook, 2014

The electricity export to India generates the second highest revenue in Bhutan contributing approximately 10% of the GDP at present. However, the national income is affected due to an increase in domestic electricity consumption (Energy, 2015). Another challenge faced by building owners is high land cost and material costs. The building owners are not able to repay commercial housing loans even with high rental incomes. And due to expensive housing costs, most people leaving cannot afford to own houses and must stay in rent. This issue will continue and only 43 percent of households in the country own houses. It is therefore important to design affordable housing for the people of Bhutan (MoWHS, 2014). The study also found out that Bhutan is facing unbalanced distribution of population. Thimphu the capital city alone has over 100,000 people and followed by Phuentsholing and Paro town (Rinzin, 2020). The rapid urbanization has led to the housing shortage in Bhutan especially in urban areas. The housing survey conducted in 2014 found out that more than 9500

people live in Jaigon (India) outside Bhutan. The survey showed that the income of people living in Jaigon ranges from Nu.5000 ($70) to Nu.20000 ($277). It indicates that the people were not able to pay rent due to low income (Kuensel, 2018). To this, the designer needs to come up with a low-cost house design to benefit the lower-income groups.

The building designer and building owners have not paid much attention to the importance of low-cost housing and the energy consumption of buildings. To this, the designer needs to come up with a building design that will have low cost and energy consumption in building sectors. Therefore, this study will try to explore the building alternatives which can minimize the cost of building construction and improve the energy efficiency of buildings.

1.3 Purposes of the Study

The purpose of this study is to develop a model of the typical Bhutanese residential building using BIM and perform energy simulation by changing the main components associated with it. The BIM tool is used because the analytical model which was created can be exported to an energy analysis tool to simulate the energy performance, heat gain and heat loss. Based on cost estimation and energy analysis, the B-C ratio and present worth of the residential building was calculated. Moreover, this study will illustrate how changes in building attributes will affect the energy performance and the construction costs of building.

1.4 Objectives of Study

1. To create Bhutanese architectural features and develop the base model (building) using Open Building Designer.
2. To perform energy simulation on different building model alternatives in Energy Simulator (Open Building Designer).
3. To compare the cost implication on different building models alternatives based on floors and walls attributes.
4. To determine the present worth of building alternatives.
5. Evaluation of project (residential building) using conventional B-C ratio.

CHAPTER II

LITERATURE REVIEW

2.1 Low-Cost Housing

The world has reached the stage where middle- and lower-income groups are not able to own houses. To overcome this problem the building designer and developer must adopt cost-effective, innovative, and environmentally friendly construction technologies to reduce the cost of building. To improve the quality of life, the selected building materials must meet the needs of local conditions and by constructing new structures or by improving on the pre-existing structure (Shinde & Karankal, 2013).

2.2 Cost Estimation

Cost Estimation is defined as the scientific way of calculating the approximate cost of a construction project before the kickoff of work. Cheng, Tsai, and Sudjono (2010) defined cost estimation as a critical task because it has a direct impact on planning, bidding, design, budget, and construction management. The case study was carried out to compare the cost of low-cost housing technology and traditional construction method in wall and roof materials components. The result showed 26.11% and 22.65% construction costs saved using low-cost housing technology (Srivastava & Kumar, 2018).

2.3 Bhutanese Building

Bhutan has got a unique and rich culture that depicts the identity of the people. Consequently, Bhutan gives top priority to the culture and how it has a direct impact on people life. These rich cultures are demonstrated through architecture, arts, dance, festivals, language, costumes, and sacred sites. The measures are taken by the government to preserve and promote the cultural heritage of old low-rise traditional structures. However, it is difficult to preserve due to rapid urbanization and emerging new technologies in construction. Ministry of Works and Human Settlement takes full

charge ship in taking the correct steps towards the promotion of Bhutanese architecture. Architecture in Bhutan meets to satisfy social and spiritual requirements besides its functional and economical needs (MoWHS, 2014).

2.3.1 Dzongs

The Bhutanese word Dzong means ‘fortress’. The Dzong (Figure 3) is usually located at a strategic ridge overlooking because the primary objectives were to defend against the enemy in the past. Dzongs are used for administration offices and religious practice (MoWHS, 2014).

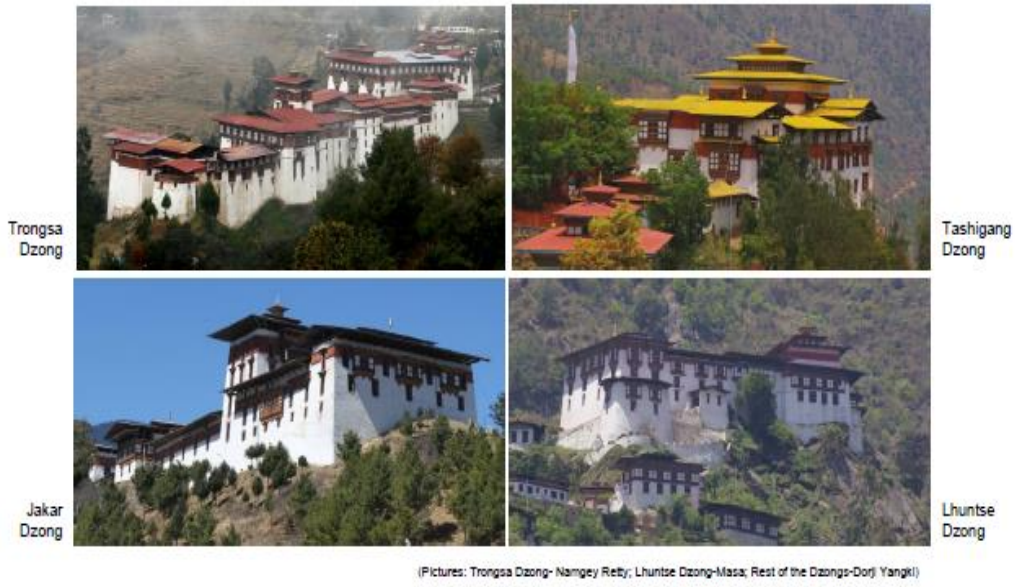


Figure 3 Ancient Dzongs in Eastern Bhutan

Source: Bhutanese Architecture Guidelines,2014

2.3.2 Phodrang (Palaces)

The outlook of Phodrang (Figure 4) is like the outlook of Dzongs. Today the palaces in Bhutan were constructed during the time of the first and second kings of Bhutan. The layout of the typical Phodrang has a king chamber in the center and main officers and attendants stay around the courtyard (MoWHS, 2014).

2.3.3 Yue Chim (Dwelling & Farmhouse)

The traditional farmhouse (Figure 5) in the village displays the secular architecture of Bhutan. A Bhutanese home is used for many purposes like a social, economic, and religious unit. The farmhouse provides a home for family and shelter for livestock (MoWHS, 2014). The difference between urban buildings and rural buildings is that the earlier use modern construction materials while later use local traditional materials (Energy, 2015).

2.3.4 Urban Buildings

A Bhutanese building (Figure 6) is now modified using other new materials like bricks, cement, sand, steel. The timber post and beam are now replaced by a concrete beam and column. The wooden timber floor is now replaced by the slab. The outlook and design of Rabsel remain the same in almost all buildings but cornices are now replaced by bricks or precast concrete (MoWHS, 2014).

Figure 4 Phodrang

Source: Bhutanese Architecture Guidelines, 2014

Figure 5 Farmhouse

Source: Bhutanese Architecture Guidelines, 2014

Figure 6 Urban Buildings

Source: Bhutanese Architecture Guidelines, 2014

2.4 Elements in Bhutanese Architecture

The detail elements of Bhutanese architecture features are briefly explained in following subsection.

2.4.1 Cornices

The term cornices mean the following elements like Bogh, Phana, Pem, Choetse, Dhung, Tshechu Kha-Nyim, Norbu Horzhu and their combination is for Thobthang.

2.4.2 Rabsel Element

The Rabsel (Figure 7) elements add the beauty of Bhutanese architecture. It consists of multiple windows and panels with timber frames. ‘Rab’ in Dzongkha mean ‘good’ and ‘Sel; means ‘clarity’. The Rabsel provides light and clarity into a building through its multiple windows opening. The Rabsel is usually projected outside the superstructure wall (MoWHS, 2014).

2.4.3 Bogh and Phana

The Bogh is an end projection of the Cham or interior timber joist for ceiling or upper floor levels. The Phana made with timber cornice which has an out look like pig nose laid over the Bogh (MoWHS, 2014).

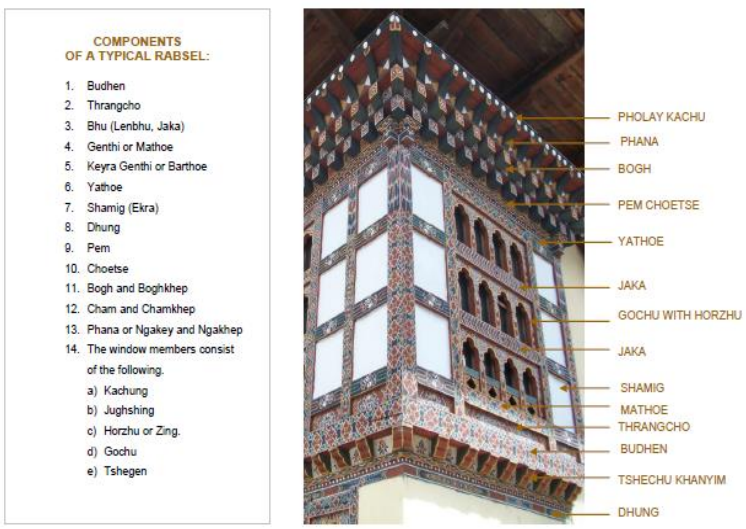


Figure 7 Components of Typical Rabsel

Source: Bhutanese Architecture Guidelines, 2014

2.4.4 Pem and Choetse

The Pem and Choetse are usually found together over the Beam (Dhung) and below the Bogh and Phana components. The Pem painted on timber portrays lotus flower, while Choetse over the Pem painting represents a stack of prayer books (MoWHS, 2014).

2.4.5 Tshechu Kha-Nyim

The Tshechu Kha-Nyim is the special-shaped projection floor joist that cantilevers beyond a wall to provide support to a Rabsel (MoWHS, 2014).

2.4.6 Jadhang Tazi

Jadhang Tazi (Figure 8) is one architectural element of Bhutanese building which is commonly called traditional balcony railings, landing railings, roof barriers railings and stair hand railing balusters. ‘Ja’ in Dzongkha means ‘bird’ and ‘Dhang’ means ‘timber perch’ (for the bird to rest on). ‘Ta’ means action to look down from the balcony and ‘zi’ means an honorific reference of the same action to look (MoWHS, 2014).

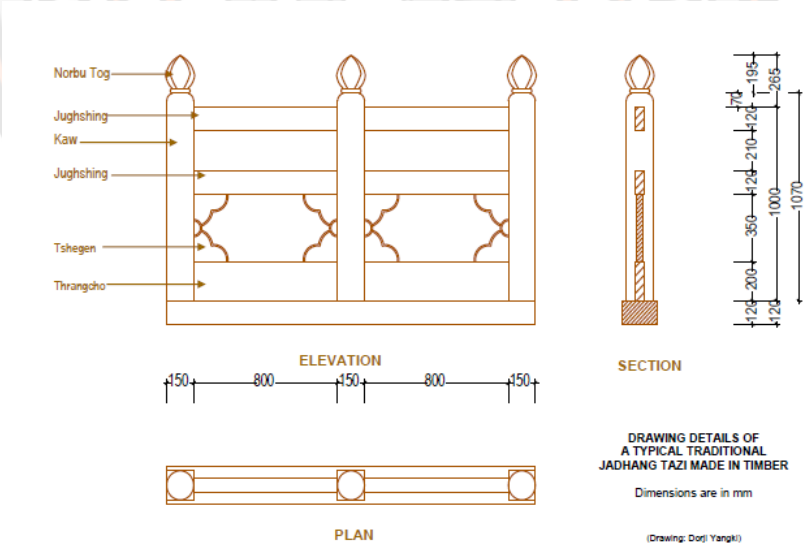


Figure 8 Jadhang Tazi

Source: Bhutanese Architecture Guidelines, 2014

2.4.7 Mago (Doors)

Mago means the main door of the building. The position of the door (Figure 9) is usually fixed based on the various Buddhist astrological instructions in relation to the function of the building and the date of the owners of the building. The size of the door depends on the size of building design, size, and significance. The Mago door will have Pem, Choetse, Zumchu and Bogh for Dzong or Lhakhang but not necessary for ordinary lining house (MoWHS, 2014).

Figure 9 Door

Source: Bhutanese Architecture Guidelines, 2014

2.4.8 Payab Gochu (Windows)

The Payab Gochu (Figure 10) is the Bhutanese traditional window that is embedded within the faced walls of the building. The elements of the window are shown below. The general practice followed is to incorporate one layer of Bogh above the Payab Gochu. The incorporation of detailed window features depends upon the significance of the buildings or the budget available (MoWHS, 2014). Table 1 shows the recommended sizes of elements for cornices.

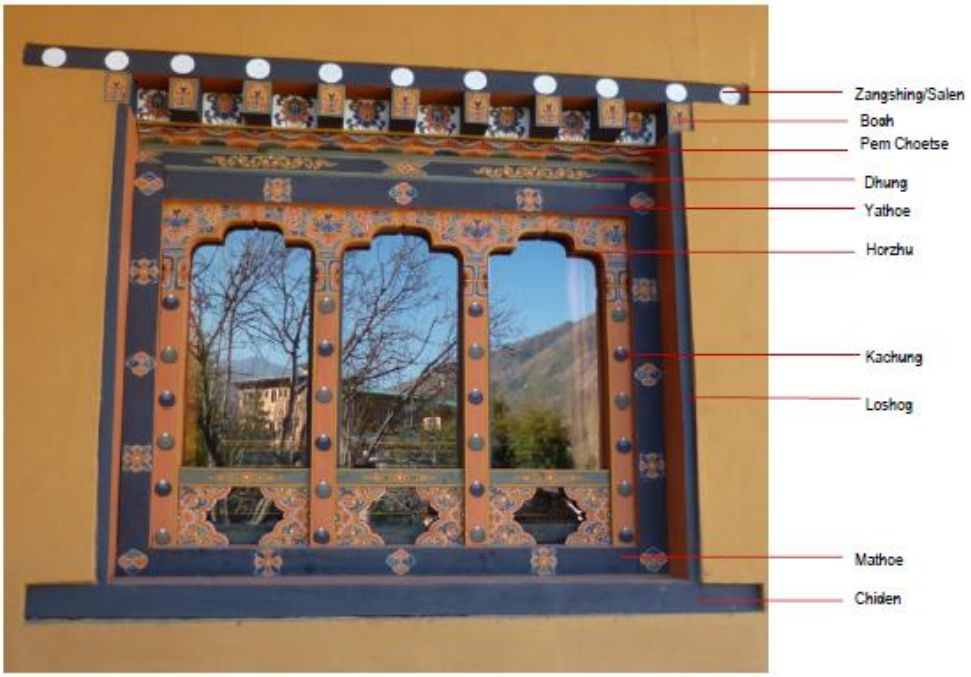


Figure 10 Payab Gochu (window)

Source: Bhutanese Architecture Guidelines, 2014

2.5 Roof, Wall and Foundation

The Bhutan building's roof can be classified into three types based on shapes and form. It consists of a gable roof, hipped roof and lean-to roof. Roofing materials used are either timber shingles or corrugated galvanized iron (CGI) sheets. The wall of the building is made up of rammed earth, stone or rubble and bricks (Energy, 2015).

2.6 Building Information Modelling (BIM)

The knowledge of building information modelling (BIM) in the architecture, engineering, and construction industry has boost considerably over the past years. Building information modelling is a virtual design that helps in communication among stakeholders. BIM is used as an educational tool that assists project teams before the onset of the task on-site (Lu, Peng, Shen, & Li, 2013). BIM is not only

capable of enhancing visualization but also cost estimates, simulation, facility management (FM) and construction project lifecycle. The early simulation and visualization facilities help to avoid reworks and conflicts with owners and decision-makers (Li et al., 2014).

Table 1 Recommended Sizes of Elements for Cornices

SL.No	Members	Minimum(mm)		Maximum(mm)	
		B (Breadth)	T (Thickness)	B (Breadth)	T (Thickness)
1	Budhen	150	125	200	175
2	Yathoe	125	150	175	200
3	Barthoe	125	150	175	200
4	Mathoe	125	150	175	200
5	Thrangcho	200	50	300	50
6	Zumbhu	150	150	200	200
7	Lenbhu	125	150	175	200
8	Jaka	125	150	175	200
9	Kachen	90	50	125	75
10	Horzhu	a	50	a	75
11	Dhung	125	150	150	175
12	Bogh/Cham	125	150	150	175
13	Phana	125	150	150	175
14	Bogh/Phakhep	b	35	b	35-50
15	Pem Choetse	b	50	b	75-100
16	Norbu Bagum	b	75	b	75-100
17	Norbu Horzhu Tshechu	b	50	b	75-100
18	Khanym	125	150	175	200
19	Jang Dhung	125	150		175
20	Zhu	300	175	450	200
21	Drey	200	200	300	300
22	Gyetsa	150	175	175	

Source: Bhutanese Architecture Guidelines, 2014

2.7 Building Energy Consumption

The Nearly – Zero Energy Buildings (nZEBs) is defined as reducing the energy demand to the lowest and afterwards replacing energy demands with renewable energy. The study was carried out to examine the model building in four climate zones of Greece using dynamic simulation software tools. The result reflected that the efficient constructive solution of every climate zone is impacted by various combinations of parameters. The right combination of parameters can save up to 30% of energy and can reduce the energy demand of building up to less than 50 kWh/m^2 (Charisi, 2017). Substantial works have been done in the field of energy modelling and building monitoring to progress in design and operation. But energy intake of the building increases continuously due to several reasons like flawed control strategies, lack of equipment, occupancy behavior, and inaccurate weather data (Menassa et al., 2014). Most of the countries work towards the improvement of building energy efficiency to solve the energy and environmental issues. Developed countries can save more energy than underdeveloped countries. All governments try to frame the policy that will have thermal efficiency regulation and support low energy consumption houses. The energy performance of a building can be calculated theoretically by knowing the elements of the envelope (Mangematin, Pandraud, & Roux, 2012).

The study was also carried out in Egypt to find out the energy simulation in the residential building using Energy Plus Software. The result reflected the energy saving of about 40% by the air conditioner by using thermal insulation of thickness 0.05m in walls and roof (An-Naggar, Ibrahim, & Khalil, 2017).The rate of energy consumption in the construction sector, both industrial and residential, is one of the most significant difficulties we face globally.

In Mashhad and Tabri, the installation of double-walled windows with UPVC profiles resulted in a 26 percent reduction in window loads as compared to single-walled windows. When compared to using an insulator on the exterior surface of the construction wall, using an insulator in the innermost layer of the wall requires 25% less overall energy. The walls also account for a large amount of the cooling loads and play an important role in reducing energy consumption (Gohari, 2019).

2.8 Types of Fuel used in Bhutan

The typical household size ranged from a single individual to a family of seven. The average number of people per household was 4.4. Electricity is widely used for lighting and other residential uses such as heating and cooling, whilst LPG is widely used for cooking. And none of the households used room cooling systems other than the ceiling fans. Figure 11 shows the different types of space heating systems commonly used in Bhutan. The most common water heating system used by families is the commercial water boiler, followed by immersion heaters, geysers (storage water heaters), and Bukhari. The average household paid Nu 100–200 per month on power in the summer and Nu 200–300 per month in the winter (Nu: Ngultrum; Bhutanese currency; 1 US $45 Nu) (T. Lhendup, Lhundup, & Wangchuk, 2010).

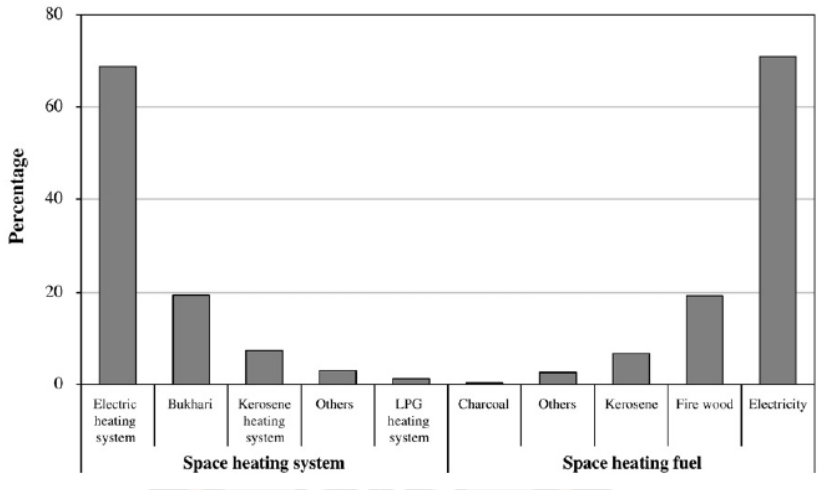


Figure 11 Choice of the Cooking Appliance and Main Fuel (% of Users)

Source: T. Lhendup et al. 2010

2.9 Heat Gain and Heat Loss

Heat loss is defined as heat loss only while heat gain is defined as heat gain plus latent heat gain. The amount of heat that each zone gains from the warm outdoor air and sun are a sensible heat gain. The latent heat gain is the additional work the cooling equipment must do to condense and remove the water vapor in hot/humid

indoor air. Total heat gain is the combination of sensible heat gain plus latent heat gain.

Thermal insulation thicknesses of 0.05m in walls and roofs can save up to 40% of the energy used by air conditioners (An-Naggar et al., 2017). The study also found that by upgrading the building envelope, energy consumption can be lowered by up to 15.92 percent (S. Lhendup & Lhendup, 2017). In hotter climates, shade devices are ideal because they limit solar heat intake and aid cooling(Charisi, 2017). One of the most important aspects of the indoor environment is the room's temperature. When the temperature in the office rises to 21-22 degrees Celsius, people's productivity rises (Seppanen, Fisk, & Lei, 2006).

2.10 Life Cycle Cost

The purpose of life cycle cost (LCC) is to estimate the overall cost of a property from construction to demolition and to be used in the construction industry for decision-making (Petrović, Zhang, Eriksson, & Wallhagen, 2021). LCC assists decision makers to understand the operation cost and installation costs for sustainable materials when making the building more sustainable (Emekci & Tanyer, 2018). LCCA is a method of assessing a building's economic performance over its whole life cycle (Ozbay, Parker, & Jawad, 2003). Usually the sustainable buildings have a higher initial construction cost than conventional buildings (Kibert, 2016). However, due to the incorporation of cost-cutting factors, this increased expenditure can be quickly repaid in a sustainable construction in a short period of time (Kibert, 2016). Buildings have a lengthy life cycle, and they consume a lot of energy over that time by using HVAC systems, equipment, and lighting systems (Juan, Gao, & Wang, 2010).

CHAPTER III

METHODOLOGY

3.1 Introduction

In this study, the elements of Bhutanese architecture features were first created in the Open Building Designer workspace. These features must be created in Open Building Designer because there is no catalogue for Bhutanese architecture features. The Bhutanese architecture features such as Bogh, Pem, Dung, Phana etc. can be modelled in the workspace and assign families and parts to them. The base model was created in software called Open Building Designer. The windows and cornices created in the workspace was placed in the model since there is no similar window in the database. The Bhutanese residential building with various attributes were created in an open building designer. The alternatives of building models have been modelled based on wall and floor attributes which can be directly altered from the wall and floor catalogue once the base model is created. The attributes of materials can be changed during energy simulation. The Open Building Designer has special tools which can be directly used during the creation of models. This study was aimed to calculate the heat gain and heat loss with different building alternatives. The analytical space model can be directly exported from Open Building Designer to simulate the energy consumption and calculate heat gain and heat loss. The cost estimate of building alternatives was done separately in excel incorporating Bhutan Schedule Rate. After that the present worth of individual building alternatives were computed using present worth method including initial land cost, construction cost and operating and maintenance costs. B-C ratio was also computed for the building alternatives. The overall methodology framework is given in Figure 12.

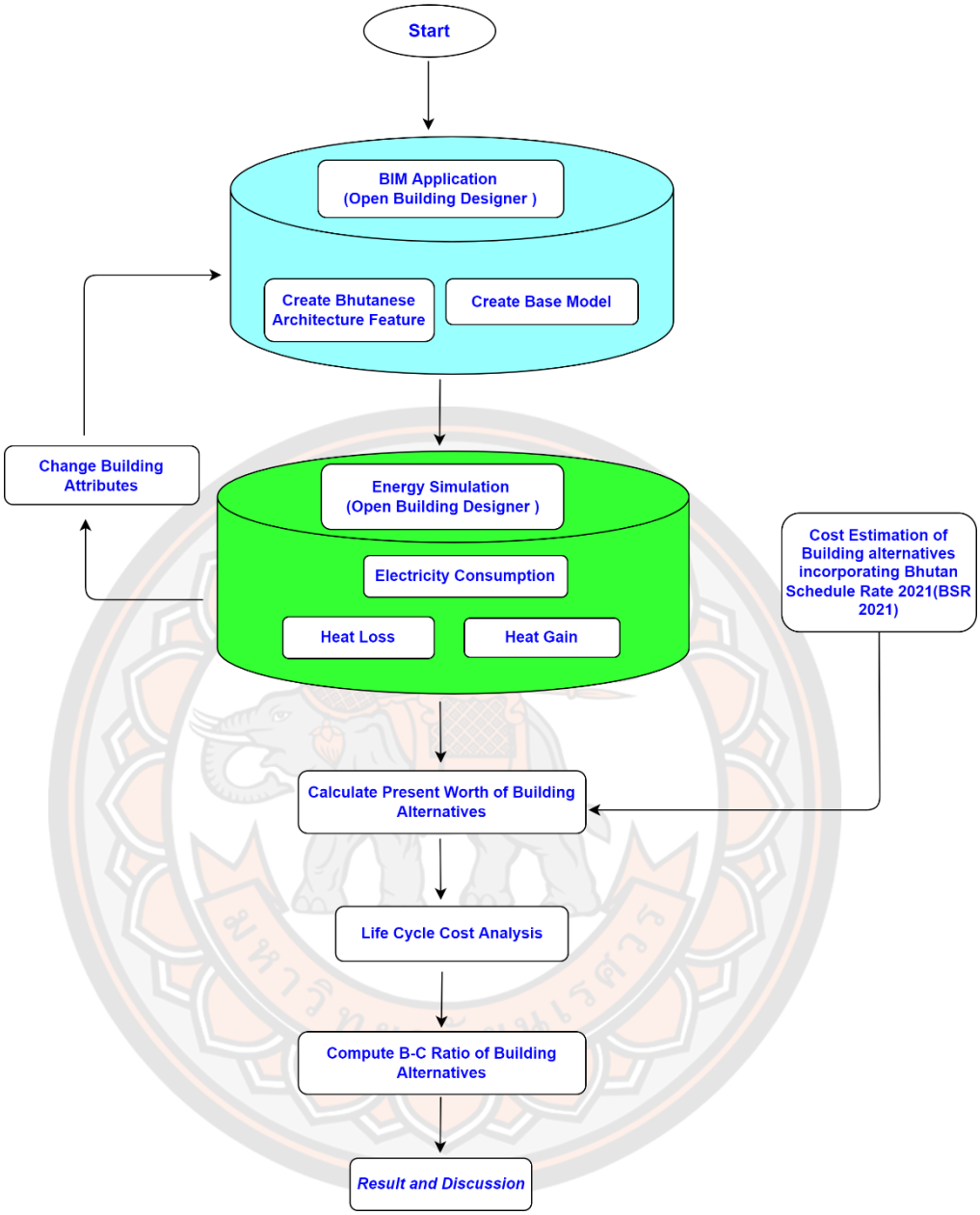


Figure 12 Overall Methodology Framework

3.2 Modelling of Bhutanese Traditional Architecture Elements in Open Building Designer.

Bhutan's traditional architecture is one of the most magnificent manifestations of a country's old culture. Bhutanese traditional art is characterized by harmonious proportions and graceful patterns that reflect and mirror the Bhutanese people's basic

daily lives with the breath-taking surroundings of calm valleys and soaring mountains (MoWHS, 2014).

3.3 Door Modelling in Open Building Designer

Door is created on modelling using the solid menu. The slab object is used to create the main part of the door like side frame, top frame, lock rail, shutters and top bottom and side rails. The chamfer is used to trim the shutter so that it can be easily fixed in rails. The following Figure 13 shows the traditional Bhutanese door created in Open Building Designer.

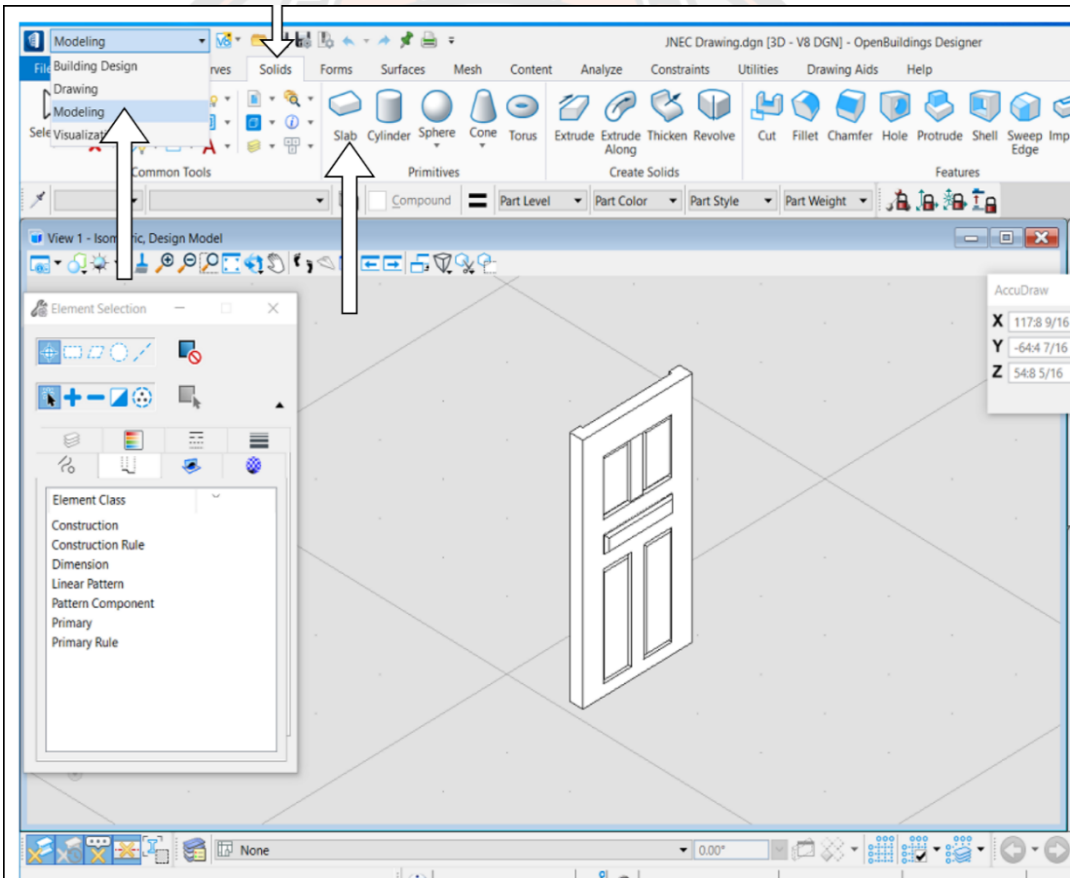


Figure 13 Traditional Bhutanese Door Created in Open Building Designer.

3.3.1 Window

The Bhutanese window is made up of Zangshing, Bogh, Yathoe, Horzhu, Kachung, Loshong, Mathoe and Chiden. The fillet and chamfer tools are used to make the shape of Horzhu. Other components of the window are easily made using slab and extrude tools. Figure 14 shows the Bhutanese traditional window created in Open Building Designer.

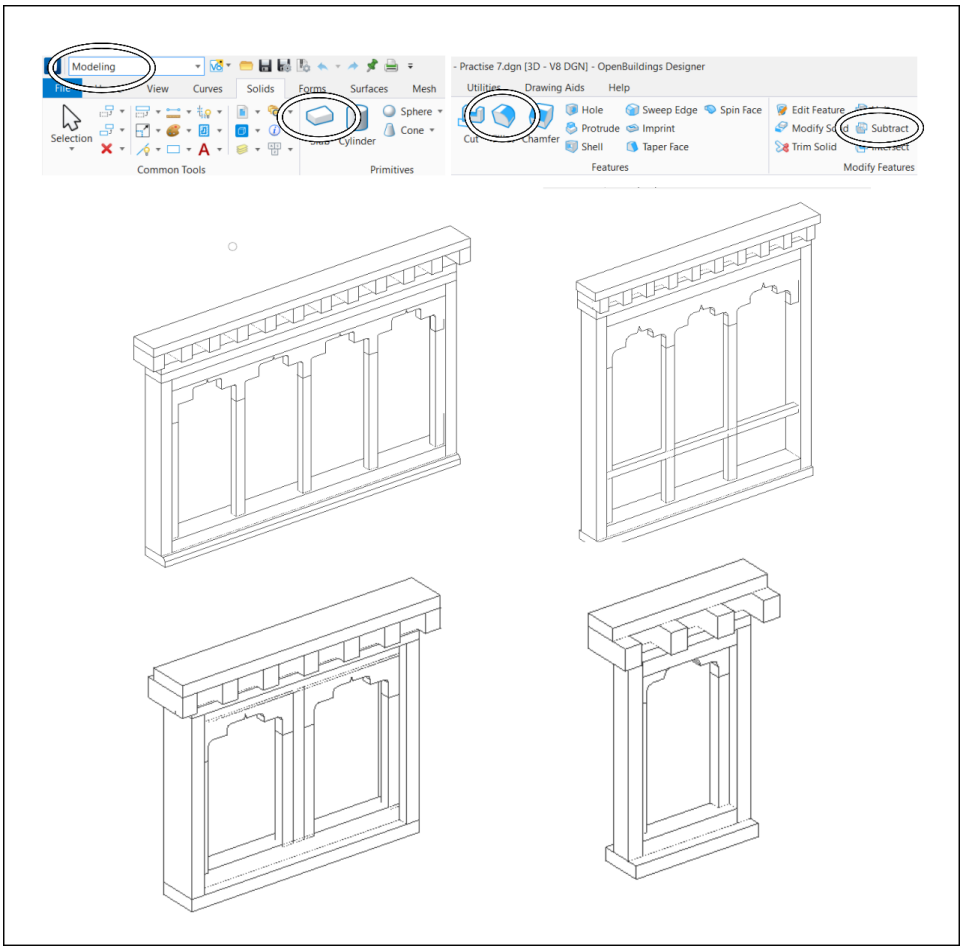


Figure 14 Bhutanese Traditional Window Created in Open Building Designer

3.3.2 Dung, Phana, Bogh, Pem, Tshechu Khaynim, Jathang Tazi.

Dung and Pem (Figure 15) are two traditional elements that are placed together in a building above window and door. Dung and Pem are created in Open Building Designer using Slab object and pattern is drawn using chamfer tool. Phana

and Tshechu Khaynim is also created using slab object, subtract tool and chamfer tool. Jathang Tazi which is called hand railing is created by using same object tools like Dung, Phana, Pem.

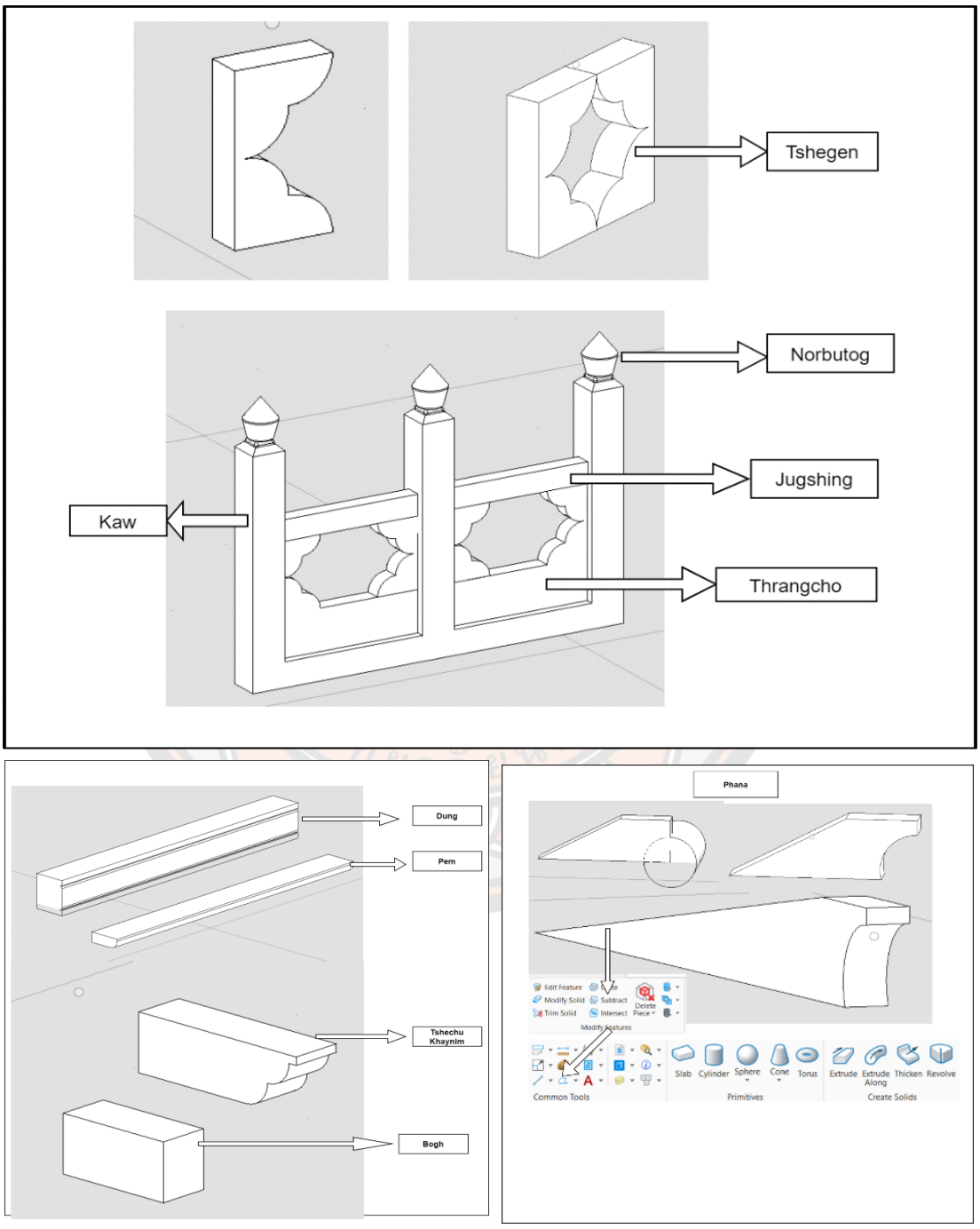


Figure 15 Jadhang Tazi, Pem, Dung, Bogh, Phana

3.4 Develop the Base Model (building) using Open Building Designer

Open Building Designer is the latest updated version of AECOsim Building Designer. Like AECOsim Building Designer, Open Building Designer can be also used to create 3D models. The 3D geometry can be easily placed by selecting the developed object from a menu or by entering a value using the "AccuDraw" tool.

3.4.1 Floor Manager

To model a 3D building by using Open Building Designer, the floor manager setting is important because this allows users to easily choose floor lever and work on it. Below are steps to create a floor manager setup **(**Figure 16**)**.

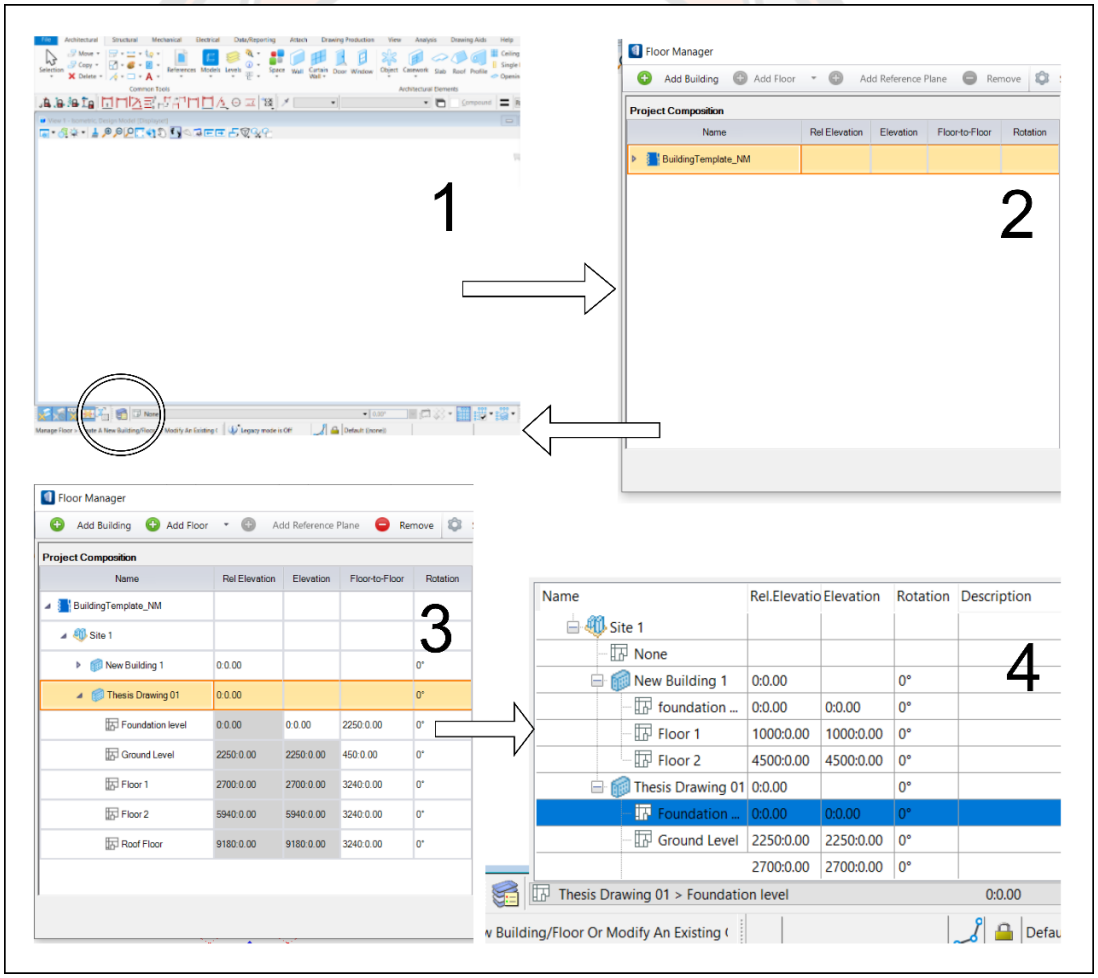


Figure 16 Floor Manager Setup

1. Open the created new file in open Building Designer. Click to floor manager which is located below workspace as shown in picture 1.

2. After clicking on floor manager, a new window will pop up as shown in the picture 2. Click on add building menu to add a new building and rename it.

3. In picture 3, add the number of floors as per the requirement in the project. Put the floor height value in the floor-to-floor column. The values in the real elevation column will be auto updated. Click apply.

4. Choose the floor level to start building modelling as shown in picture 4.

3.4.2 Grid Manager

The grid set up in the Open Building Designer is important because it helps the user to easily place the BIM object like footing, beam, column, wall etc. The following step shows the setup of the grid layout in Open Building Designer **(**Figure 17).

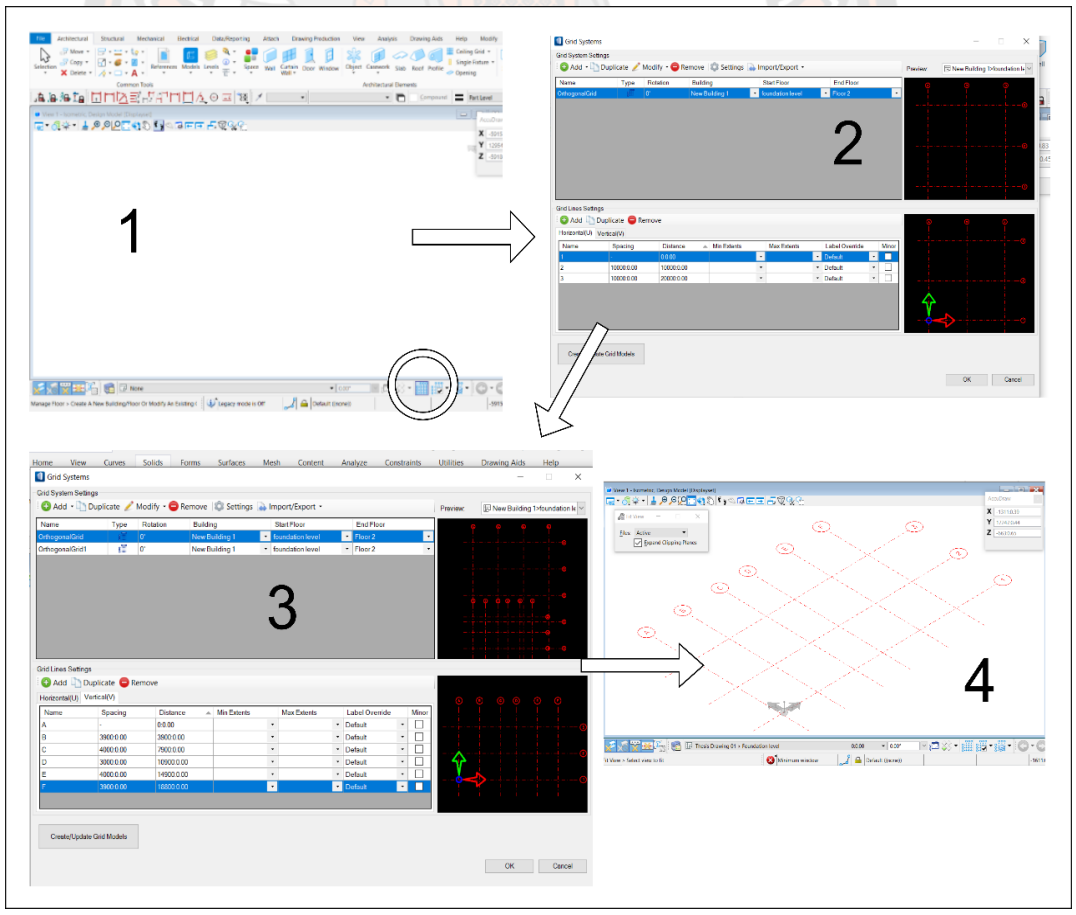


Figure 17 Grid Manager Setup

1. In picture 1, click on grid manager.

2. A new window will pop up as shown in picture 2. Under Grid System Settings, choose the building type by name and set up the start and end floor.

3. In picture 3, click on the vertical and horizontal add menu to add horizontal and vertical grids as per the requirements.

4. Click ok and check the grid setting in the workspace as shown in picture 4.

3.4.3 Assigning Levels in New Object

When new objects are created in Open Building Designer, the levelling of the object is essential for the user to recognize the elements. The following shows the steps for levelling of a new object (Figure 18).

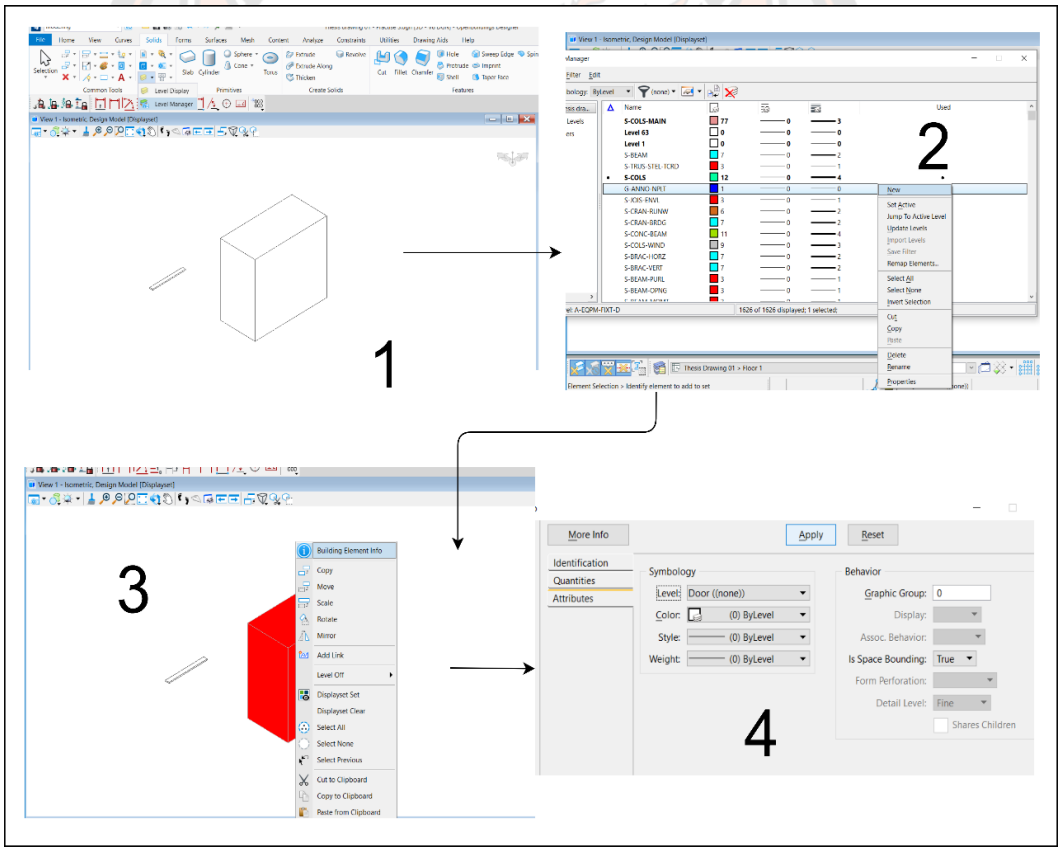


Figure 18 Assigning Levels in a New Object

1. Create any new object as shown in picture 1. The picture will not have a level name.

2. Click on the level manager to create the level name. The new window will pop up and click on new and named it.

3. Go to building element information to assign the level name as shown in picture

4. In picture 4, click on the attribute and select the given name. After that object will be auto updated with the level name.

3.4.4 Family and Parts

To assign the family and parts in the newly created object, the following is the steps as shown in Figure 19

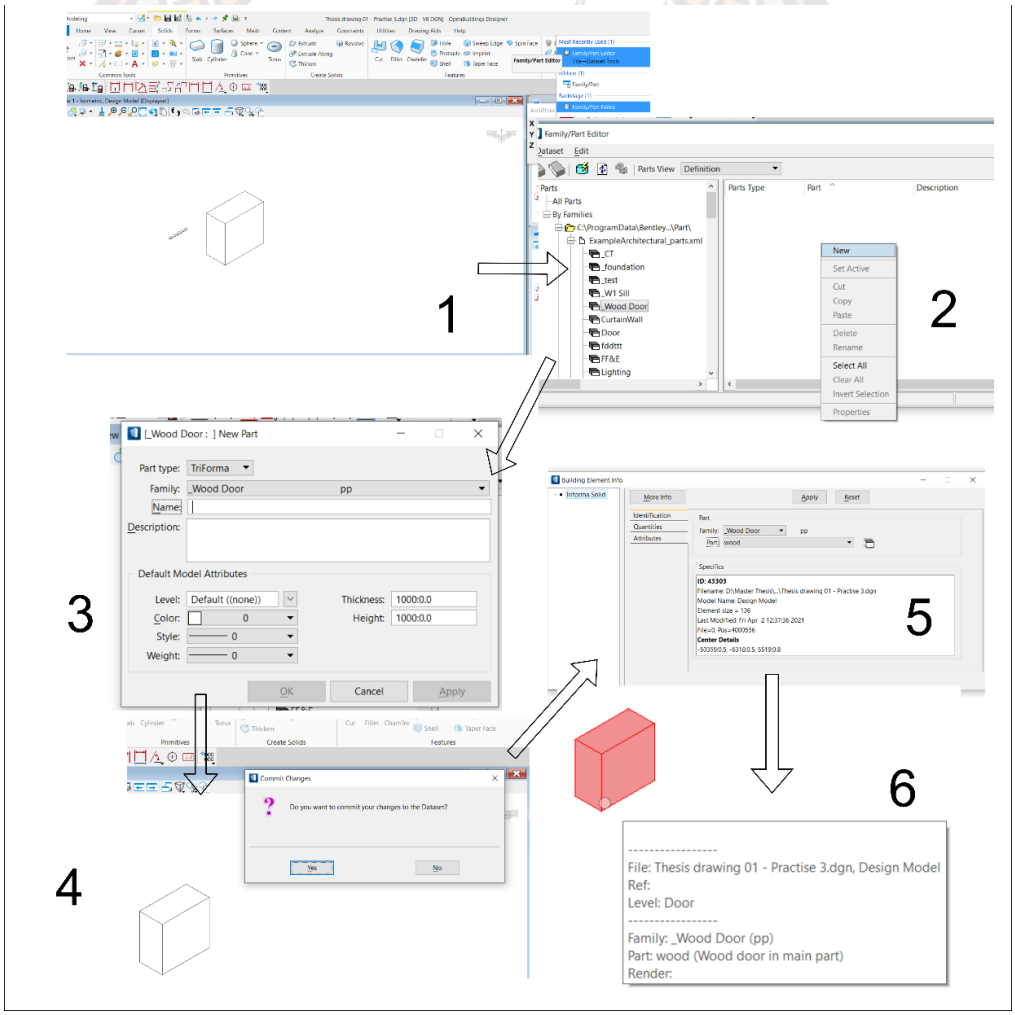


Figure 19 Family and Part Setup

1. Create a new object in the Open Building Designer workspace. Go to family and parts editor.

2. The new window pop's up as shown in picture 2. To create a family, go to new and name the object.

3. Click on the family name that was created in step 2 and give the part name for it.

4. Save it in the database as shown in picture 4.

5. Click on an object to select it and go to modify element information. Search the family and part name created in the database and apply it.

3.5 Modelling of Base Model in BIM

What makes Bhutanese building typical is its unique design of windows, doors, and cornices. The components like footing, column, beam, roofing, wall etc. can be easily created using the developed object from the database. However, the Bhutanese windows, doors, cornices must be modelled manually in the workspace and place in the wall since there is no developed object. The base model is a typical Bhutanese building that is two-storied. Each floor can accommodate two families each. The floor plan of the ground floor is shown in Figure 20.

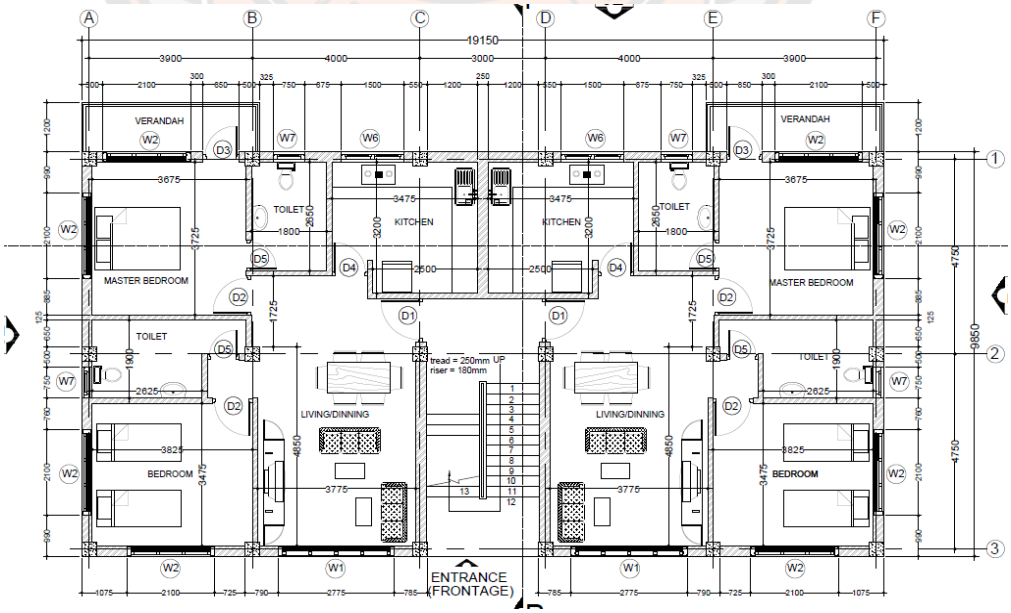


Figure 20 Ground Floor Plan of Base Model

3.6 Footing, Columns, Slabs, and Beams

Beams and columns can be directly placed using beam and column tools under structural tools. The table pops up as soon as the beam and column tools are selected. User has numerous options to choose types of materials, shapes, and other features. Similarly, the dimension of beams and footing can be computed manually as per the drawing. Slabs can be placed on beams by selecting slab tools present in architecture or structural tools. The designer can manually input the thickness of the slab and place it using any method like boundary, line, or shape. Figure 21 shows the beam, column, footing, and slabs created in Open Building Designer.

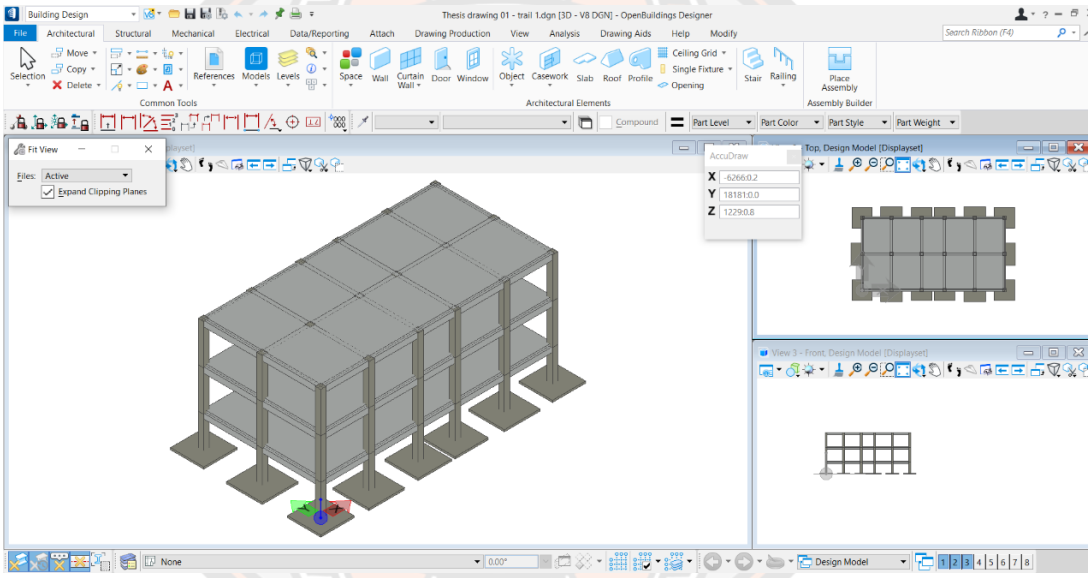


Figure 21 Beam, Column, Footing, and Slabs Created in Open Building Designer

3.7 External and Internal Wall

Like beam and column, the external and internal walls (Figure 22) can also be placed using wall tools available in designer tools. To place a wall, go to the wall and click on place wall. After that, the wall property panel will pop up and select the height and width of the wall. Choose any placing option available in place option. The wall can be placed by line, from the element, from shape, or grid.

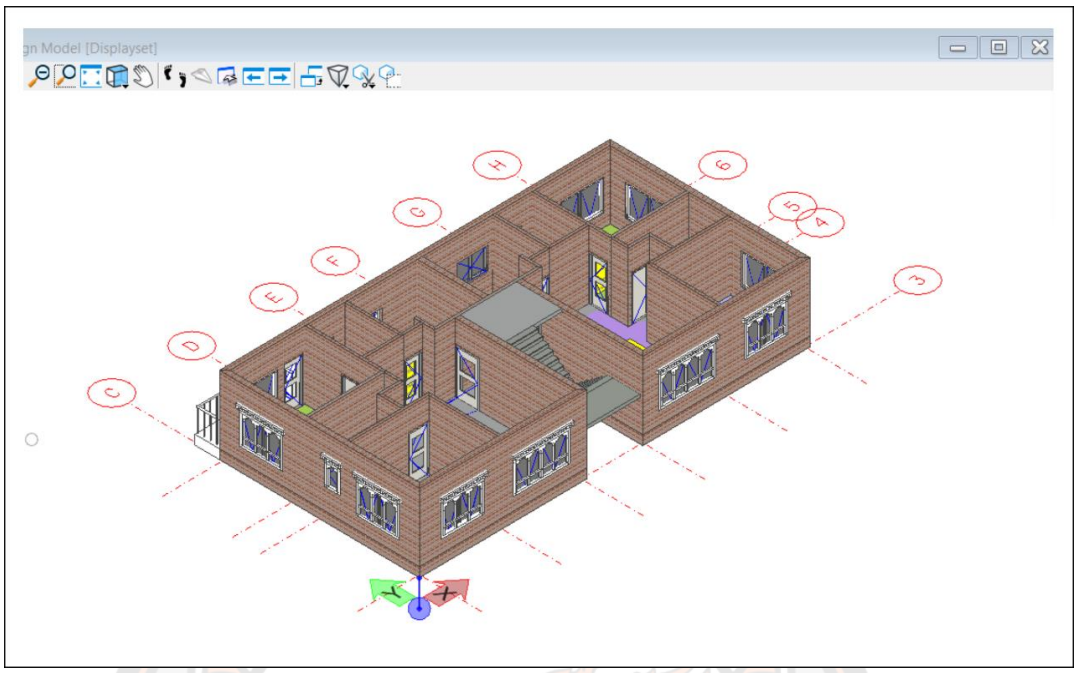


Figure 22 External Wall and Partition Wall Created in Open Building Designer

3.8 Door and Window

To place door and window (Figure 23) go to building design and choose door and window from architecture tools. For the Bhutanese building, the windows available in the catalogue are completely different so they cannot be used directly. So, the window must be modelled separately using a modelling tool. However, doors available in open building designer can be directly used for Bhutanese building as it has the same features. The windows modelled separately in a workspace cannot be placed directly. To place the modelled window the user must use the place block tool and cut solids by curve features.

3.9 Roofing

The roof is directly place using roof tools from architectural tools. Figure 24 shows the complete model created in Open Building Designer. The model consists of the multi-family house of the two-storied house. One unit house consists of two bedrooms, one sitting room, two toilets and a kitchen. The dimension of the model is as per the dimension of the project. The model consists of windows on all sides of

room spaces. The window is made up of 6mm thick plain glass embedded in a brick wall. Both external and internal walls are of brick plastered on both sides with 20mm thickness. The ground floor was constructed with stone soling and concrete with top plaster finishing. The first floor was constructed by an RCC slab of 150 mm thickness.

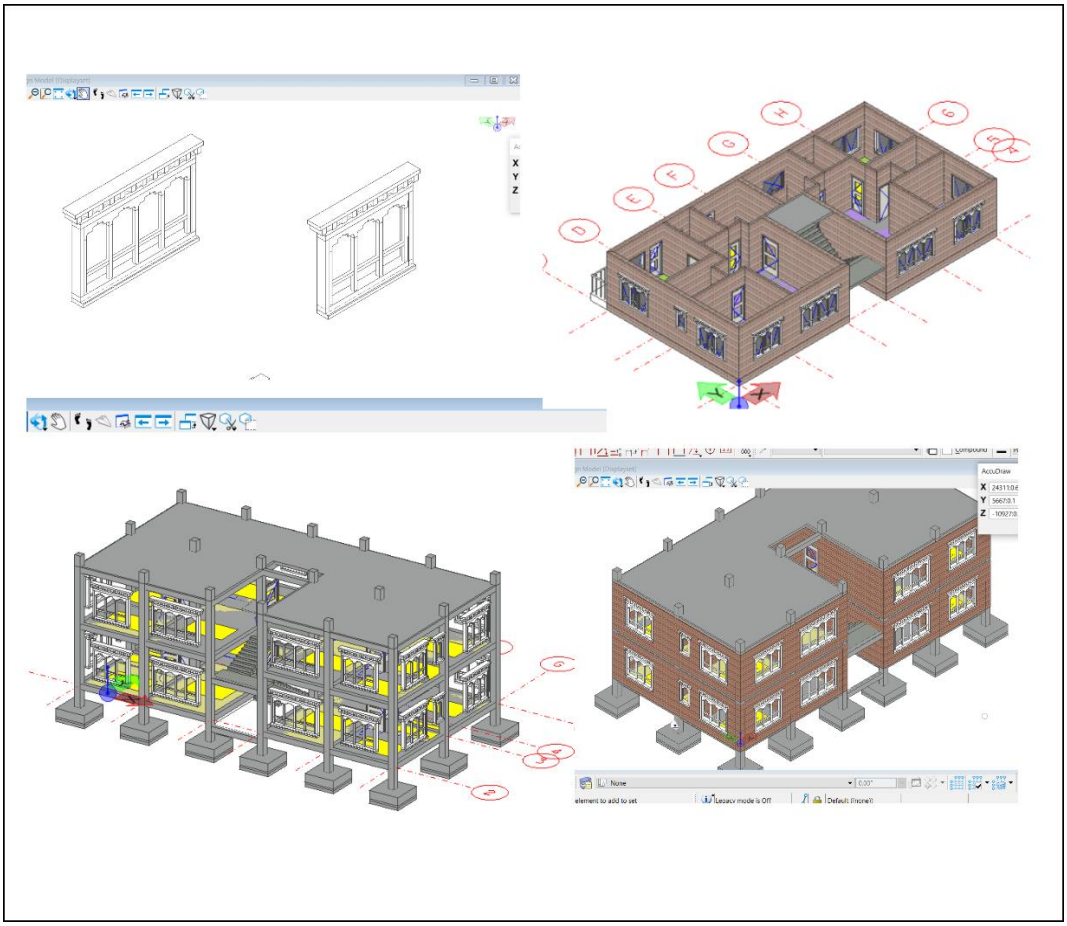


Figure 23 Windows and Doors Placed in Wall

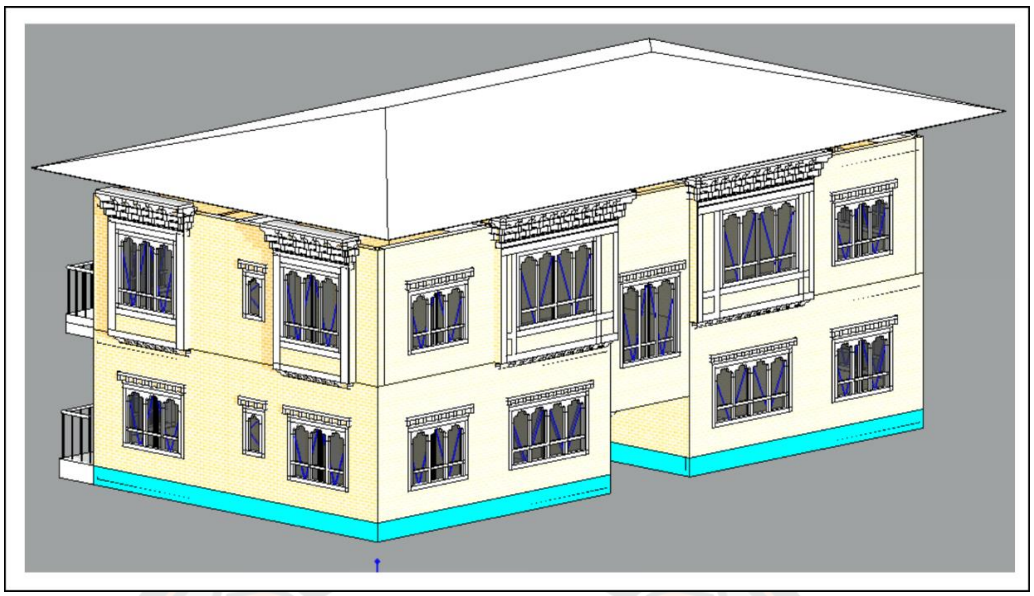


Figure 24 Two Storied Base Model Created in Open Building Designer

3.10 Model Alternatives

The model's alternatives (Figure 25) are classified based on wall attributes and floor attributes. Bhutanese walls can be either made up of brick or stone while Bhutanese building floors are usually constructed with timber flooring or RCC slab. On different models, the energy simulation can be performed to check the overall energy consumption and heat gain and heat loss calculation. Similarly, the windows consist of wooden framed, or aluminium framed with plain glasses. Estimation can be performed on various alternatives to compare the cost of different attributes. Table 2 shows the different alternatives of houses.

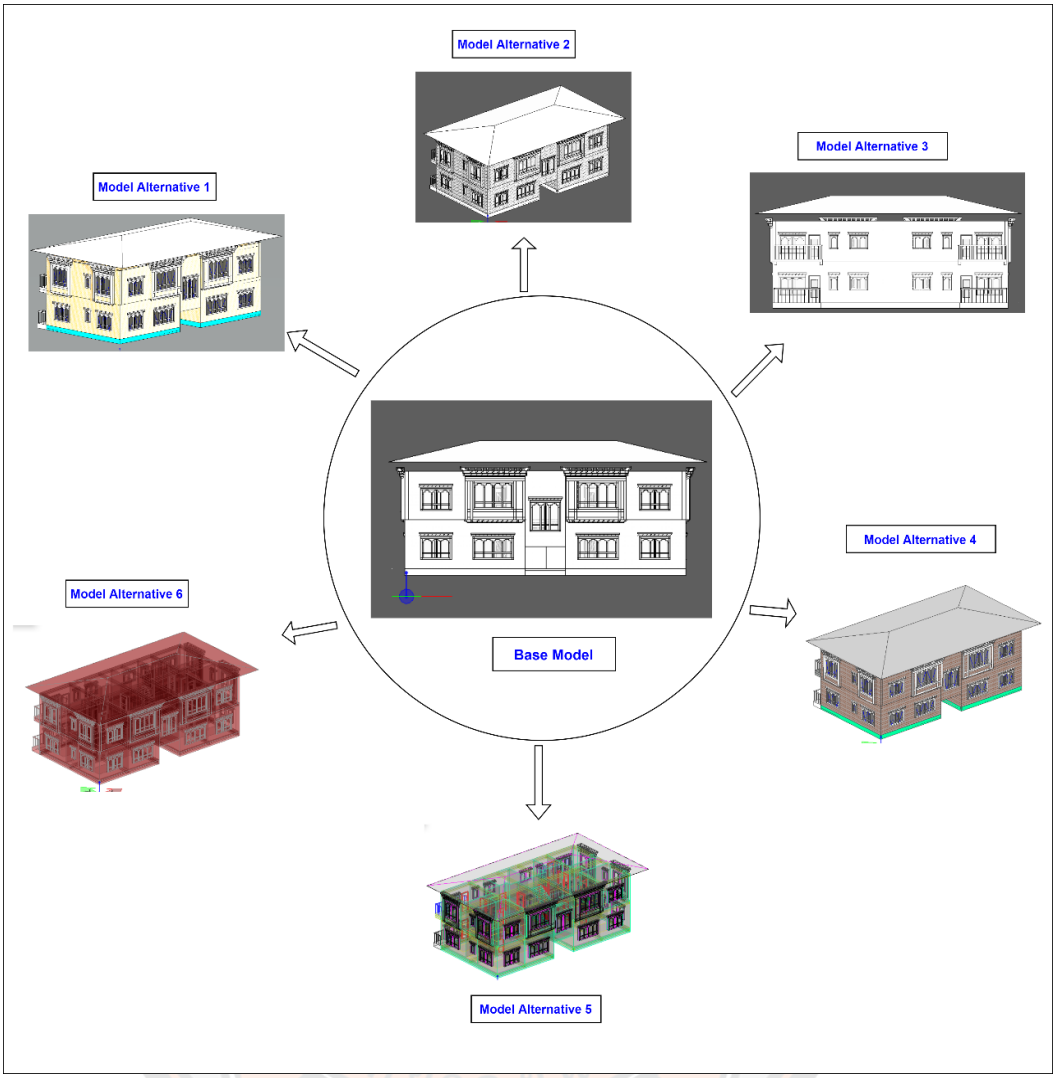


Figure 25 Model Alternatives

3.11 Thermal Properties of Building Alternative 1 (Wall)

Figure 26 shows the cross-sectional view of concrete block wall for building alternative 1. It was constructed with concrete block of 250mm and 20mm plastering on both inside and outside. The detail thermal properties of wall are given below.

1. Density = 1400 kg/m^3
2. Conductivity = 0.51 W/ (m.^{0}C)
3. Specific heat = 1000 J/ (kg. Δk)
4. Surface emissivity = 0.84
5. Absorption coefficient = 0.70
6. Admittance = 4.34 W / ($m^2\Delta^0$C)

Table 2 Building Model Alternatives and its Construction Type

SL/No	Building Alternative	Main Attributes
		Model Alternative 1 (A1)
1	Floor	Concrete slab flooring
2	Wall	Concrete block wall
3	Roof	Medium weight roof (CGI)
		Model Alternative 2 (A2)
1	Floor	Timber flooring
2	Wall	Stone masonry wall
3	Roof	Medium weight pitch roof (CGI)
		Model Alternative 3 (A3)
1	Floor	Concrete slab flooring
2	Wall	Brick wall
3	Roof	Medium weight roof(CGI)
		Model Alternative 4 (A4)
1	Floor	Concrete slab flooring
2	Wall	Brick 105mm, airgap 25mm,EPS insul, 25mm,aer conc blk(500) 150mm,lgt plast. 13mm.
3	Roof	Medium weight roof (CGI)
		Model Alternative 5 (A5)
1	Floor	Concrete slab flooring
2	Wall	Brick 105mm,airgap 50mm,aer conc blk(500) 150mm,lgt plast 13mm.
3	Roof	Medium weight roof (CGI)
		Model Alternative 6 (A6)
1	Floor	Concrete slab flooring
2	Wall	Brick 105mm, airgap 50mm,lgt agg conc blk 100mm,dense plast 13mm.
3	Roof	Medium weight roof (CGI)

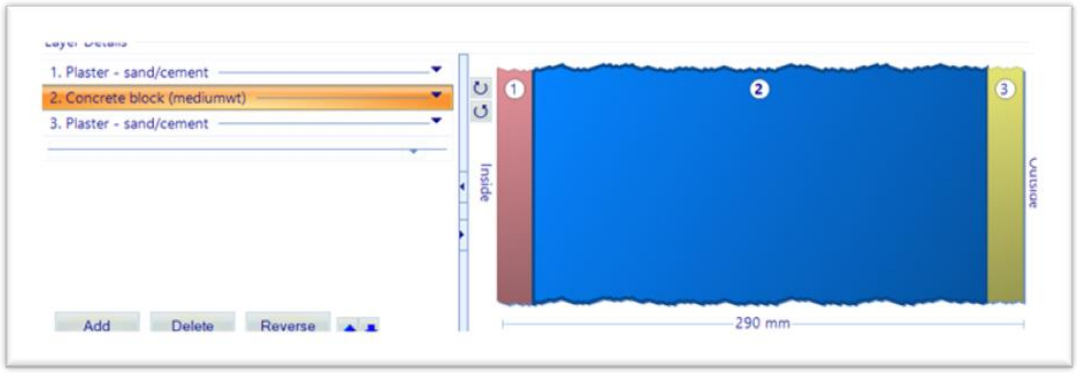


Figure 26 Cross-Sectional View of Building Alternative 1(Wall)

3.12 Thermal Properties of Building Alternative 2 (Wall)

Figure 27 shows the cross-sectional view of stone masonry wall for building alternative 2. It was constructed with sandstone of 300mm. The detail thermal properties of wall are given below.

1. Density = 700 kg/m^3
2. Conductivity = 0.20 W/ (m.^{0}C)
3. Specific heat = 712 J/ (kg. Δk)
4. Surface emissivity = 0.84
5. Absorption coefficient = 0.70
6. Admittance = 3.35 W / ($m^2\Delta^0$C)

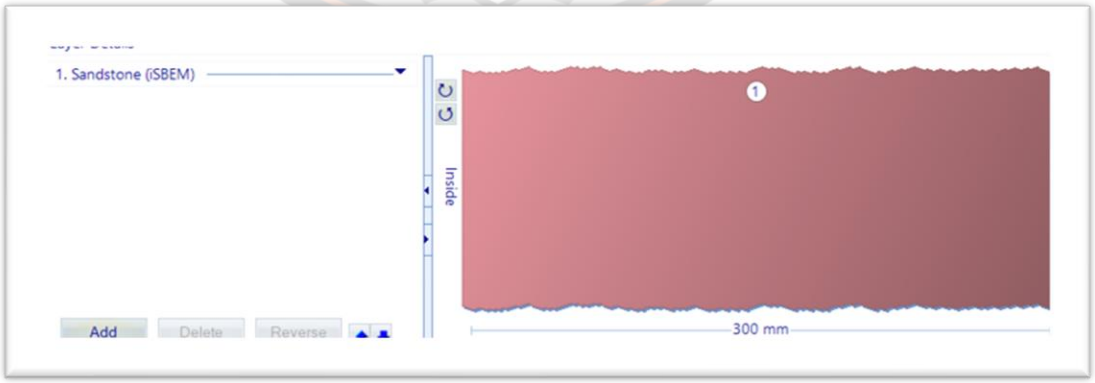


Figure 27 Cross-Sectional View of Building Alternative 2 (Wall)

3.13 Thermal Properties of Building Alternative 3 (Wall)

Figure 28 shows the cross-sectional view of brick wall for building alternative 3. It was constructed with concrete block of 250mm and 20mm plastering on both inside and outside. The detail thermal properties of wall are given below.

1. Density = 2360 kg/m^3
2. Conductivity = 1.40 W/ (m.^{0}C)
3. Specific heat = 1030 J/ (kg. Δk)
4. Surface emissivity = 0.84
5. Absorption coefficient = 0.70
6. Admittance = 4.41 W / (m^2Δ^{0}C)

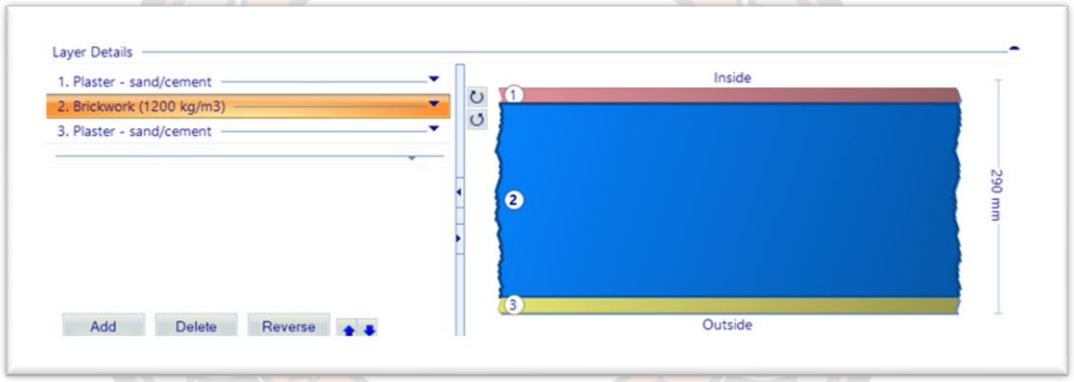


Figure 28 Cross-Sectional View of Building Alternative 3 (Wall)

3.14 Thermal Properties of Building Alternative 4 (Wall)

Figure 29 shows the cross-sectional wall of building alternative 4. It was constructed with aerated auto-cleaved concrete block, polystyrene exp, open cell, air gap, brick wall and plastering with total thickness of 318. The detail thermal properties of aerated auto-cleaved concrete block wall are given below.

1. Density = 500 kg/m^3
2. Conductivity = 0.18 W/ (m.^{0}C)
3. Specific heat = 1050 J/ (kg. Δk)
4. Surface emissivity = 0.84
5. Absorption coefficient = 0.70
6. Admittance = 2.24 W / (m^2Δ^{0}C)

The detail thermal properties of polystyrene exp, open cell is given below.

1. Specific heat = 1200 J/ (kg. Δk)

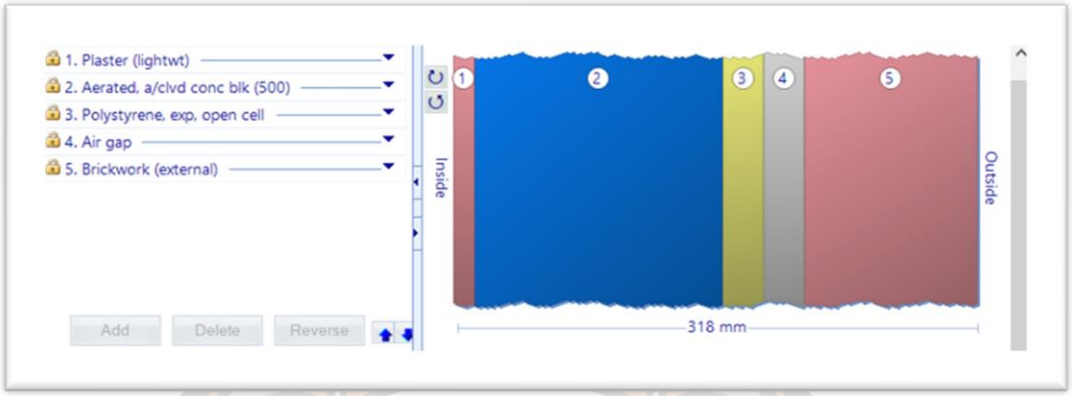


Figure 29 Cross-Sectional View of Building Alternative 4 (Wall)

3.15 Thermal Properties of Building Alternative 5 (Wall)

Figure 30 shows the cross-sectional wall of building alternative 5. It was constructed with aerated auto-cleaved concrete block, air gap, brick wall and plastering with total thickness of 318. The detail thermal properties of aerated auto-cleaved concrete block wall are given below.

1. Density = 500 kg/m^3
2. Conductivity = 0.18 W/ (m.^{0}C)
3. Specific heat = 1050 J/ (kg. Δk)
4. Surface emissivity = 0.84
5. Absorption coefficient = 0.70
6. Admittance = 2.29 W / ($m^2\Delta^0$C)

3.16 Thermal Properties of Building Alternative 6 (Wall)

Figure 31 shows the cross-sectional wall of building alternative 6. It was constructed with concrete block wall, air gap, brick wall and plastering with total thickness of 318. The detail thermal properties of concrete block wall are given below.

1. Density = 600 kg/m^3
2. Conductivity = 0.19 W/ (m.^{0}C)
3. Specific heat = 1000 J/ (kg. Δk)
4. Surface emissivity = 0.84
5. Absorption coefficient = 0.70
6. Admittance = 3.03 W / ($m^2\Delta^0$C)

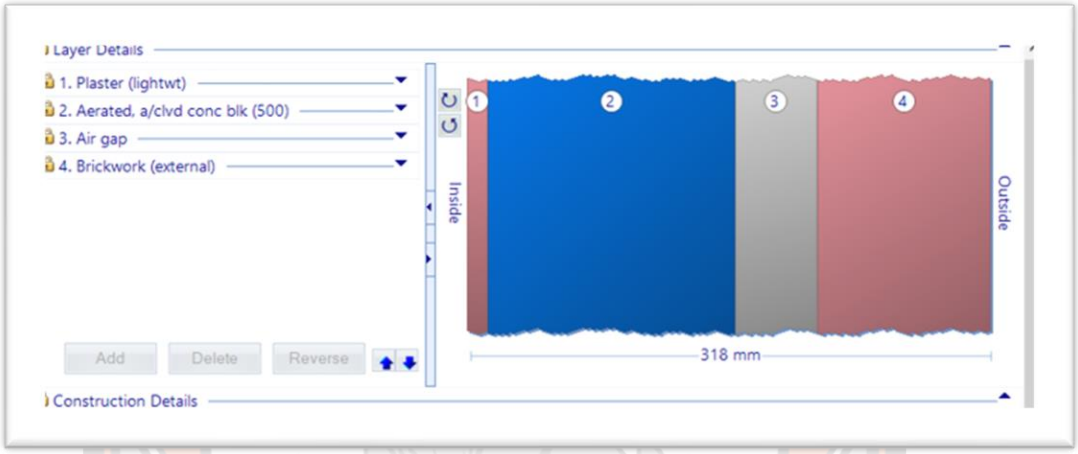


Figure 30 Cross-Sectional View of Building Alternative 5 (Wall)

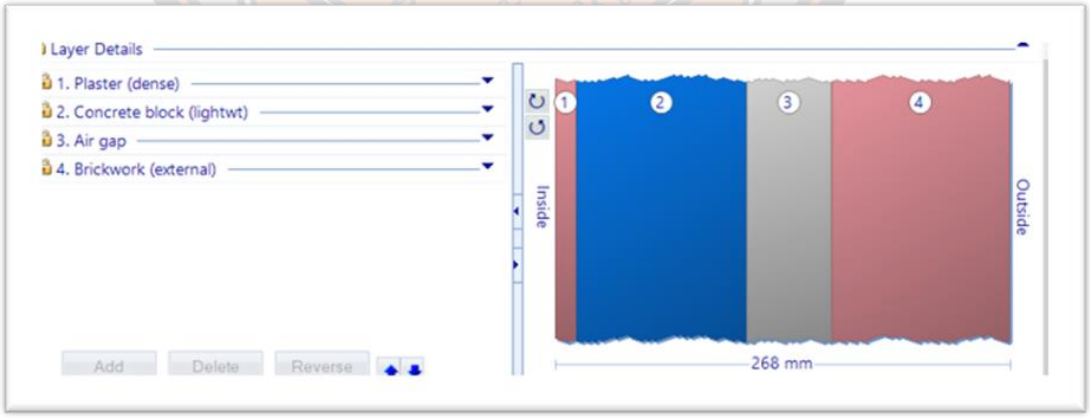


Figure 31 Cross-Sectional View of Building Alternative 6 (Wall)

3.17 Thermal Properties of Concrete Slab Flooring

Figure 32 shows the cross-sectional view of concrete slab flooring. It was constructed with concrete block of 150mm and 20mm plastering on both inside and outside. The detail thermal properties of concrete slab are given below.

1. Density = 2360 kg/m^3
2. Conductivity = 1.40 W/ (m.^{0}C)
3. Specific heat = 1030 J/ (kg. Δk)
4. Surface emissivity = 0.84
5. Absorption coefficient = 0.70
6. Admittance = 4.41 W / (m^2Δ^{0}C)

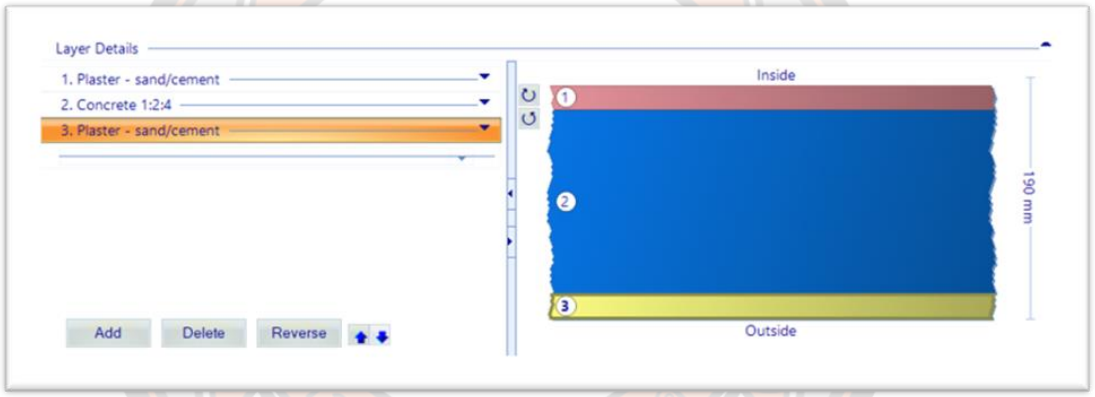


Figure 32 Cross-Sectional View of Concrete Slab Flooring

3.18 Thermal Properties of Timber Flooring

Figure 33 shows the cross-sectional view of timber flooring. It was constructed with softwood and air gap. The detail thermal properties of softwood are given below.

1. Density = 500 kg/m^3
2. Conductivity = 0.14 W/ (m.^{0}C)
3. Specific heat = 1760 J/ (kg. Δk)
4. Surface emissivity = 0.84
5. Absorption coefficient = 0.70
6. Admittance = 2.04 W / (m^2Δ^{0}C)

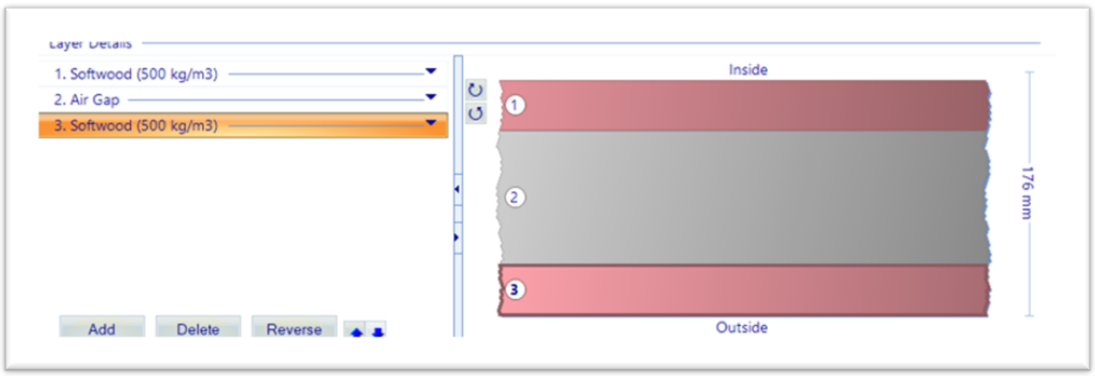


Figure 33 Cross-Sectional View of Concrete Slab Flooring

3.19 Energy Modelling

Modelling begins with setting up new work set by assigning the name of the file, description, and templates. The new project will be created with several subfolders and library files. Figure 34 shows the flow chart to create an energy model in an open building energy simulator. The subfolders are Designs, Drawings, EnergySim, Output, Sheets, Standards and Supplements. After that, the project site and site properties are set in the project tree. In this phase, the building data is defined in the project by setting building location, building type and climate zone. In the next step, the building properties and dimension is set. The floor is added to the project tree by referencing the background drawing which will automatically trace to create a 3D drawing. Once the floor is defined rooms can be defined. So, the rooms are added to the model to define surfaces that makeup space. Once the room is created the exposed surfaces like external wall, partition wall, floors, roof, windows, doors are automatically generated graphically in the project tree. The properties of each room can be changed by clicking on room properties. Window and doors can be added directly by using add tools from the energy simulator. Windows and doors can be also modified with the project tree as per the requirement. The roof can be also modelled in the model by exporting from the design file.

3.20 Simulation in Open Building Designer Energy Simulator

The energy simulator has got various tools that can be used to simulate the building as per the users' requirements. Energy simulators can be used for daylighting

analysis, heat loss and heat gain calculation, summer heat calculation and energy consumption simulation etc. Once the energy model is created then the overall electricity consumption of the building can be computed by running a simulation tap. Similarly, heat gain and heat loss can be also calculated from the CIBSE heat gain tool and CIBSE heat loss tool. Here, CIBSE stands for Chartered Institution of Building Services Engineers. In this study, the CIBSE energy standard was used because the building type was low-rise building. The Heating Ventilation, and Air Conditioning (HVAC) system was not included in the simulation because it is not used in Bhutanese homes (T. Lhendup et al., 2010).

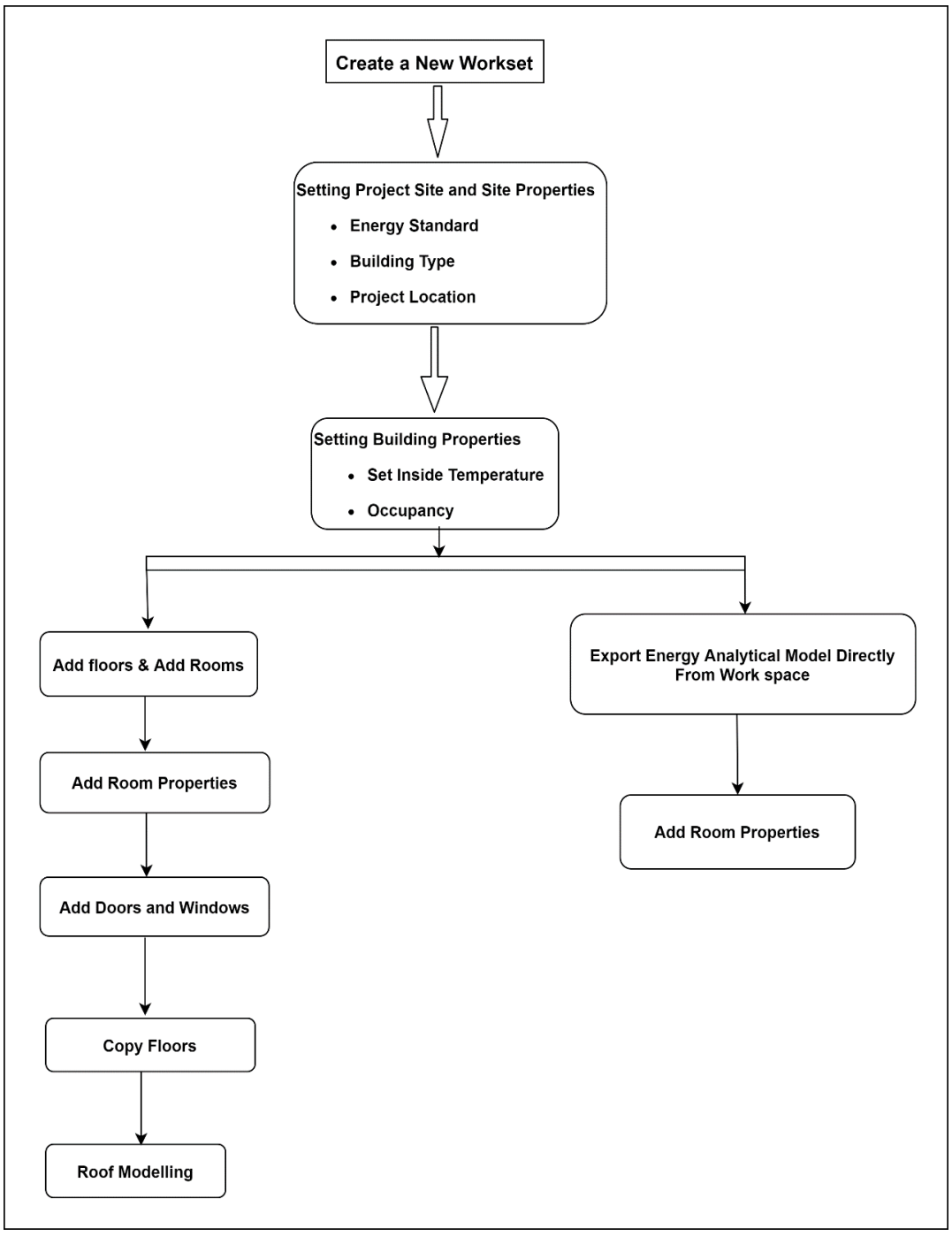


Figure 34 Flow Chart to Create Energy Model in Open Building Designer (Energy Simulator)

3.21 Heat Gain Calculations in Open Building Designer Energy Simulator

Heat gain can be calculated from the CIBSE heat gain tool. After running the CIBSE heat gain, the result presents a summary of the report, full report, and graph. A summary report will give the summary report of the entire project while a full report will give a room-by-room report of each room. The report will have peak room load, time of the peak, maximum temperature, and airflow. Repeat the calculation by changing the room properties. But in this study was the result presentation was limited to the summary of overall heat gain from models.

3.22 Heat Loss Calculation in Open Building Designer (Energy Simulator)

Heat loss can be calculated from the CIBSE heat loss tool. After running the CIBSE heat loss, the result presents a summary of the report, full report, and graph. The result will present heat loss from floor, partition, wall, glazing and infiltration.

3.23 Cost Estimation of Building Models

Cost estimation of models will be done in separate excel referring the 3D modelling and 2D drawing. The detail cost estimate will be performed in excel since it can achieve high level of accuracy. After that, the quantity can be multiplied with the basic unit rate of the Bhutan Schedule Rate (BSR) to get the overall cost of buildings.

3.24 Present Worth of Building

The current worth approach was used to compute the present value of building options. Outgoing operation and maintenance costs are considered when evaluating the current value of a facility. These costs include annual water use, annual energy consumption, and repair and replacement costs. By adding the building construction cost and the land value, the present existing beginning value of the building was computed.

3.25 Life Cycle Cost of Building

The previous study on ‘life cycle cost awareness in the Bhutanese construction industry’ found out that about 52 percent of the respondents (engineers, architects,

contractors, consultants) do not have any idea on LCC. The main problem faced while implementing LCC was due to lack of experiences and absence of input-cost data (Duba, Tobgay, Wangdi, & Wangmo). So, therefore, this study was carried out to find out the rough life cycle cost of present value of Bhutanese residential building. It is difficult to find out the exact LCC for building, for example, the land price depends on its location and demand on that area and moreover the land price keep on increasing due to land shortage. Another challenge is with collection of maintenance and operation cost as there is no proper data. In this study the data was collected from the relevant government documents and through agencies. For this study the LCC modules are presented in Table 3.

Table 3. LCC Modules According to EN 16627 Standard.

Pre-construction stage	Costs of purchase/rent the land	A0
Production stage	Raw material supply	A1
	Transport	A2
	Manufacturing	A3
Construction process stage	Transport to the building site	A4
	Installation into building	A5
Use stage	Use/application	B1
	Maintenance	B2
	Repair	B3
	Replacement	B4
	Refurbishment	B5
	Operational energy use	B6
	Operational water use	B7
End-of-life stage	Deconstruction/Demolition	C1
	Transport	C2
	Waste processing	C3
	Disposal	C4

Source: Life Cycle Cost Analysis of a Single-Family House in Sweden

3.25.1 Pre-construction Stage (A0)

The land selected for this study is in Thimphu the capital city of Bhutan. The land price per decimal for each location is given in Table 4. For this study, the land location was chosen as an urban hub (UH) in Thimphu. The land price for the urban hub area in Thimphu is Nu.349812.33 per decimal. The total of minimum 10 decimal land is required for this type of building construction.

Table 4 Land Compensation Rate in Thimphu

SL/No	Land Use As Per Thimphu Structural Plan(TSP) 2002 - 2027		Land Value (Nu/sq.ft)	Land Value (Nu/decimal)
1	Urban Core (UC)	Sub-Precinct - 1A	2944.96	1282823.85
2		Sub-Precinct 1	2996.18	1305133.83
3		Sub-Precinct 2	2740.09	1193583.93
4		Sub-Precinct 2A	2740.09	1193583.93
5		Sub-Precinct 2B	2612.05	1137808.98
6		Sub-Precinct 3	2612.05	1137808.98
7		Sub-Precinct 4	2612.05	1137808.98
8		Sub-Precinct 4A	2612.05	1137808.98
9	Urban Hub	UH	803.06	349812.33
10	Neighborhood Node	UN	803.06	349812.33
11	Urban Village Precinct	UV - 1	483.41	210574.05
12		UV2 - MD	432.70	188485.86
13		UV2 - I	432.70	188485.86
14		UV2 - II	432.70	188485.86
15		UV2 - LD	371.86	161980.04
16		UV - 3	334.67	145782.03
17	Endowment Precinct	EN	432.70	188485.86
18	Institutional Precinct	I	425.94	185540.77
19	Environment Precinct	E - 1	196.07	85407.66
20		E - 2	226.49	98660.57
21		E - 3	314.39	136946.76
22		E - 4	341.43	148727.13
23	Heritage Precinct	H	365.09	159034.95
24	Dzong	D	280.58	122221.30
25	Royal Precinct	R	280.58	122221.30

SL/No	Land Use As Per Thimphu Structural Plan(TSP) 2002 - 2027		Land Value (Nu/sq.ft)	Land Value (Nu/decimal)
26	Defense Precinct	M	385.38	167870.22
27	Traditional	TV	469.89	204683.87
28	Green Spaces	G1 and G2	365.09	159034.95

Source: Land compensation rate-2017, Bhutan

3.25.2 Production and Construction Stage (A1 - A5)

The Appendix A, Appendix B, Appendix C, Appendix D, Appendix E, and Appendix F contains a detailed estimate of the overall construction costs for building alternatives A1, A2, A3, A4, A5, and A6 respectively. The total cost for each building model alternative is shown in Table 5.

Table 5 Total Construction Costs for Building Model Alternatives

S/No	Building models	Total construction cost (Nu.)
1	Alternative 1	5528767
2	Alternative 2	2399006
3	Alternative 3	5540489
4	Alternative 4	5931027
5	Alternative 5	5848604
6	Alternative 6	5704716

3.25.3 Use Stage (B1 - B7)

The expense is divided into three sections at this point. Repair or replacement costs are the first step, followed by operational energy use and finally operational water use. It was impossible to obtain the building's upkeep and replacement expenses because no relevant records were kept. However, for this analysis, a similar residential building with approximate replacement prices was chosen, as shown in Appendix G. The energy simulator was used to compute operational energy use, and the monthly operational water use rate was obtained from Samdrup Jongkhar Thromde (city).

3.25.4 End – of – life Stage (C1 - C4)

The demolition cost of building alternative 1, building alternative 4, building alternative 5 and building alternative 6 is shown in Appendix H. Similarly, the demolition cost for building alternative 2 and building alternative 3 are shown in Appendix I and Appendix J respectively.

3.26 Evaluation of Project (Residential Building) using Conventional B-C Ratio with Present Worth Method

Since the base model which was selected for this study is a four units family apartment that can be rented out, this can be considered as a mini project because it involves certain amount of initial investment but is also a self-liquidating project. So, therefore, the B-C ratio can be applied on this project. The benefit-cost ratio approach involves calculating a benefit-to-cost ratio, as the name implies. Although there are many B-C ratio formulas for calculating project benefits, the traditional B-C ratio with PW was employed in this study. The formula for conventional B-C ratio with PW is given below.

$$\textbf{B - C} = \frac{PW(benefits\ of\ the\ proposal\ project)}{PW(Total\ costs\ of\ the\ proposed\ project)} = \frac{PW(B)}{I + PW(O\&M)}$$

Where PW(.) = present worth of (.)

B = benefits of the proposal project.

I = initial investment in the proposal project,

O&M = operating and maintenance costs of the proposal project.

A project is acceptable when the B-C ratios, as defined is greater than or equal to 1.

CHAPTER IV

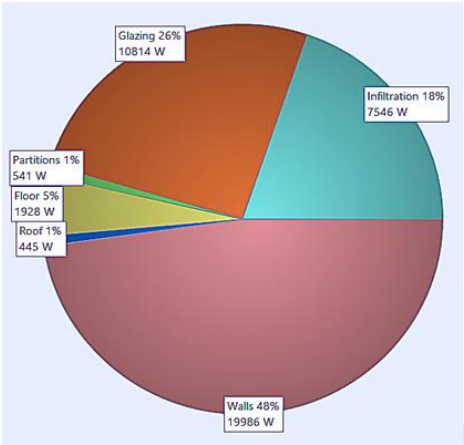
RESULT AND DISCUSSION

4.1 Annual Energy Consumption

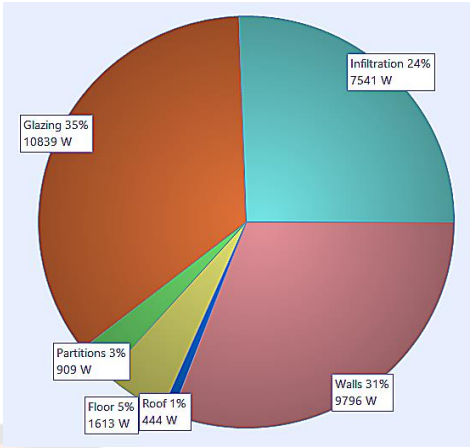
The simulation was carried out on all model alternatives to find out the energy consumption of the building. The inside temperature was set to 22^0C in all scenarios. The simulation was set for one year from January 1, 2020, to December 31, 2020. The annual energy consumption was 15301 kWh per year which was the same for all models. Thus, each family unit consumes 319 kWh per month. The study also revealed that the average monthly power consumption of the sample households was 300 kWh in Bhutan [3]. Since only difference of 19 kWh was observed, it is therefore, Open Building designer can be reliable to calculate the energy consumption of buildings.

4.2 CIBSE Heat Loss Calculation for Building Model Alternatives

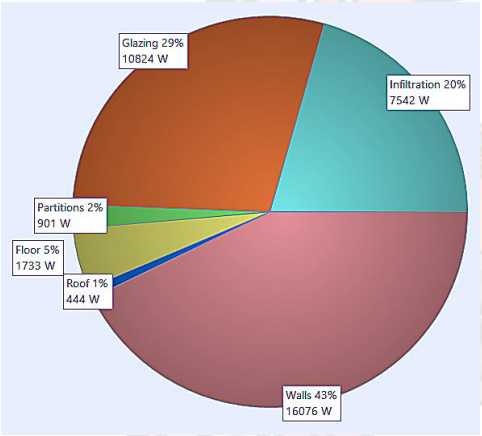
The design day was set on January 21, and the CIBSE heat loss tool was used to simulate the heat loss from all the models. The heat loss from the structure occurs through the walls, roof, floor, partitions, glazing and infiltration. Figure 35 depicts the total heat loss from six individual models. The highest heat loss happens through walls and glazing in building alternative 1, whereas the least occurs through roof and partition. Building alternative 2 loses the most heat through glazing and the least through the roof. Building alternative 3 loses the most heat via the walls and the least through the roof. While building alternatives 4, 5, and 6 have the most heat loss through glazing and the least through the roof. The detail heat losses comparison from different models' alternatives are shown in Table 6. The heat losses from the building model alternatives are depicted in Figure 36. The plots show that heat loss variation was observed from the walls, but that heat losses from the roof, floor, partitions, glass, and infiltration did not differ significantly. Since heat loss was particularly noticeable in walls, a single graph was created to compare the heat loss of the diverse alternatives. Figure 37 displays the heat losses from the various types of walls used in the models. The largest heat loss was seen in wall alternative 1, followed by wall alternative 3, and the least heat loss was observed in wall alternative 4.



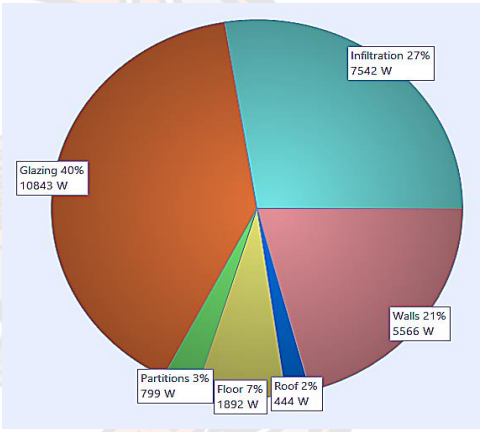
(a) Building Alternative 1 (A1).



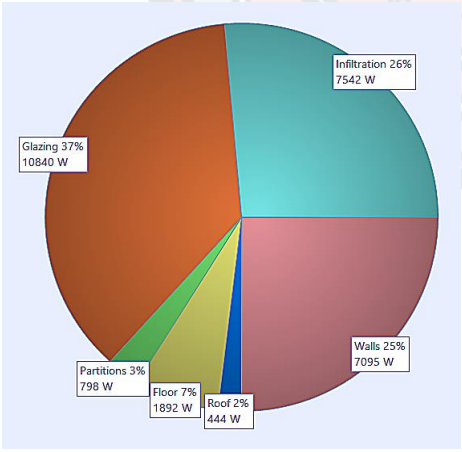
(b) Building Alternative 2 (A2)



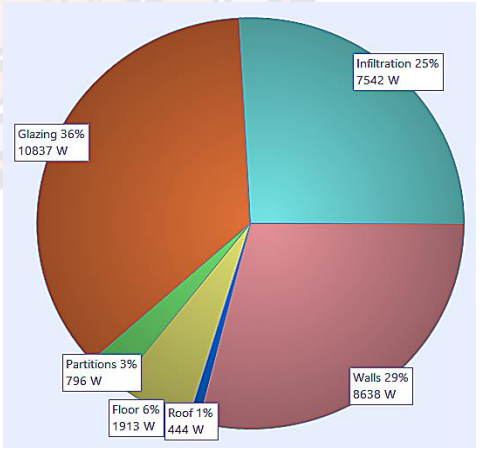
(c) Building Alternative 3 (A3)



(d) Building Alternative 4 (A4)



(e) Building Alternative 5 (A5)



(f) Building Alternative 6 (A6)

Figure 35 Total Heat Loss from Building Models (a) A1, (b) A2, (c) A3, (d) A4, (e) A5, (f) A6

Table 6 Heat Losses from Building Alternatives

Heat losses	Alternative 1(W)	Alternative 2(W)	Alternative 3(W)	Alternative 4(W)	Alternative 5(W)	Alternative 6(W)
Walls	19986	9796	16076	5566	7095	8638
Roof	445	444	444	444	444	444
Floor	1928	1613	1733	1892	1892	1913
Partitions	541	909	901	799	798	796
Glazing	10814	10839	10824	10843	10840	10837
Infiltration	7546	7541	7542	7542	7542	7542
Total	**41260**	**31142**	**37520**	**27086**	**28611**	**30170**

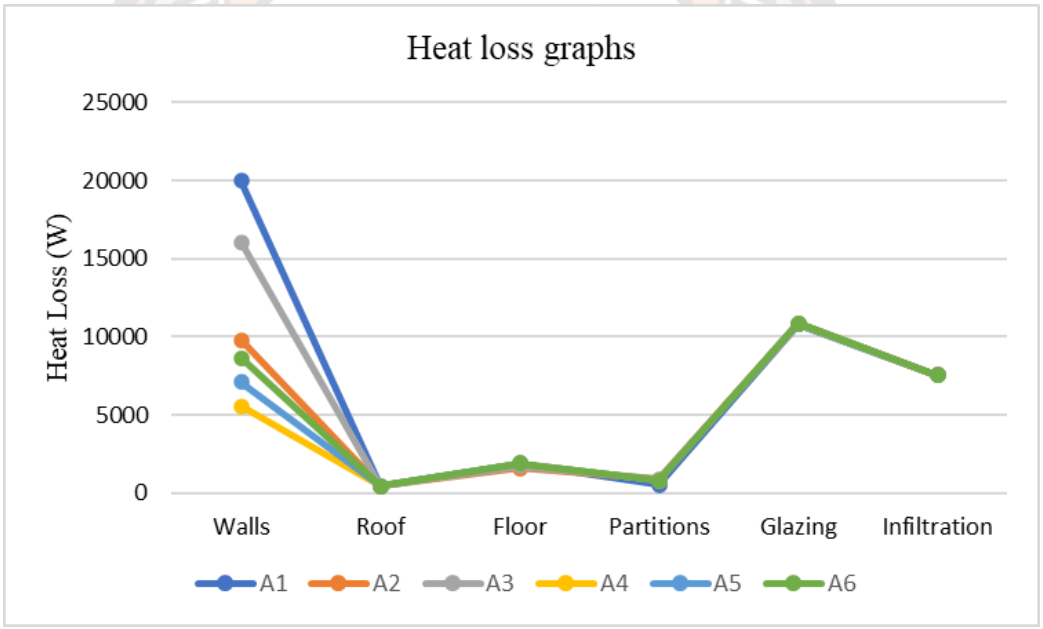


Figure 36 Graphs Showing the Heat Loss Variation from Building Alternatives

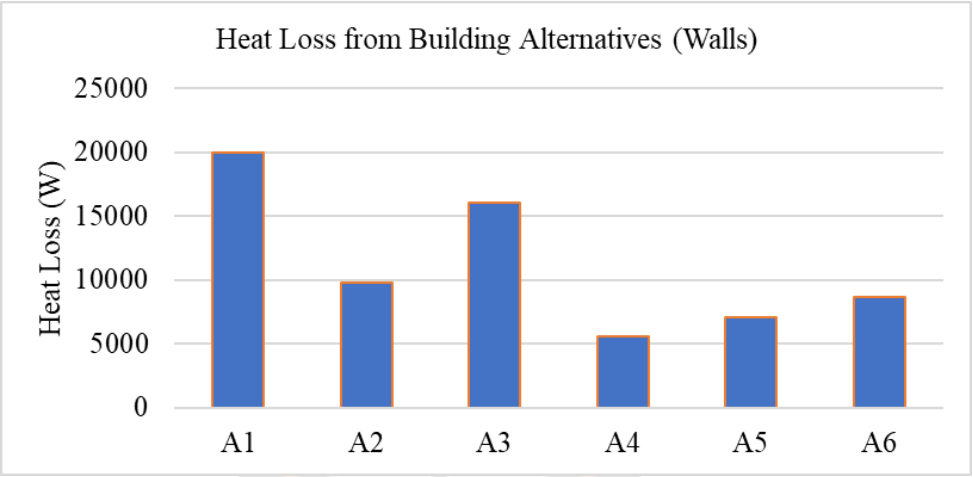


Figure 37 Graph Showing the Heat Losses from Building Alternatives (walls)

The overall heat loss from individual models were added to compare the heat saved in percentage. The heat saved in percentage from individual models are shown in Figure 38. To compare the thermal energy saving, the alternative building 1 was used as the base cases. The model alternatives 4 and 5 can save the maximum energy of 27% and 25% respectively. While from the Figure 39 it was evident that the model constructed with brick wall/concrete block wall and slab flooring can save minimum energy of 7%.

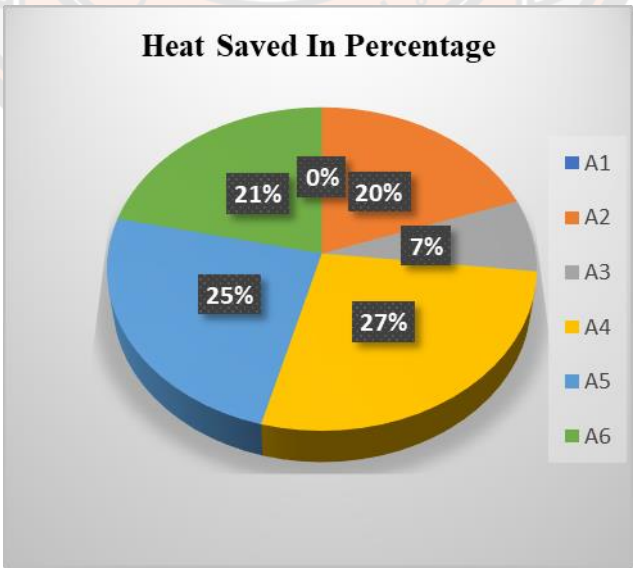


Figure 38 The Heat Saved in Percentage from Individuals Models

4.3 CIBSE Heat Gain Calculation

The design day was set on July 21, and the heat gain simulation was carried out using the CIBSE heat gain tool. Each graph in each model reflects the heat gain in terms of solar, fabric, casual, convective, and latent heat gain. The total heat gain graph in red was plotted across 24 hours.

4.3.1 Building Alternative 1

The overall heat gain in building alternative 1 is depicted in Figure 39. The total heat growth graph was given in red, and it demonstrates that in 24 hours, heat had dropped to zero KW.

4.3.2 Building Alternative 2

The entire heat gain in building alternative 2 is depicted in Figure 40. The entire heat gain graph was given in red, and it reveals that the heat is over 0 KW for around 5 hours out of every 24 hours.

4.3.3 Building Alternative 3

Figure 41 depicts the complete heat gain in building alternative 3. The entire heat gain graph was colored red, and it shows that the heat is more than 0 KW for about 2 hours out of every 24 hours.

4.3.4 Building Alternative 4

The entire heat gain in building alternative 4 is depicted in Figure 42. The entire heat gain graph was shown in red, and it showed that the heat was over 0 KW for around 6 hours out of 24 hours.

4.3.5 Building Alternative 5

The entire heat gain in building alternative 5 is depicted in Figure 43. The entire heat gain graph was given in red, and it reveals that the heat is over 0 KW for around 5 hours out of every 24 hours.

4.3.6 Building Alternative 6

The entire heat gain in building alternative 6 is depicted in Figure 44. The entire heat gain graph was given in red, and it reveals that the heat is over 0 KW for around 5 hours out of every 24 hours.

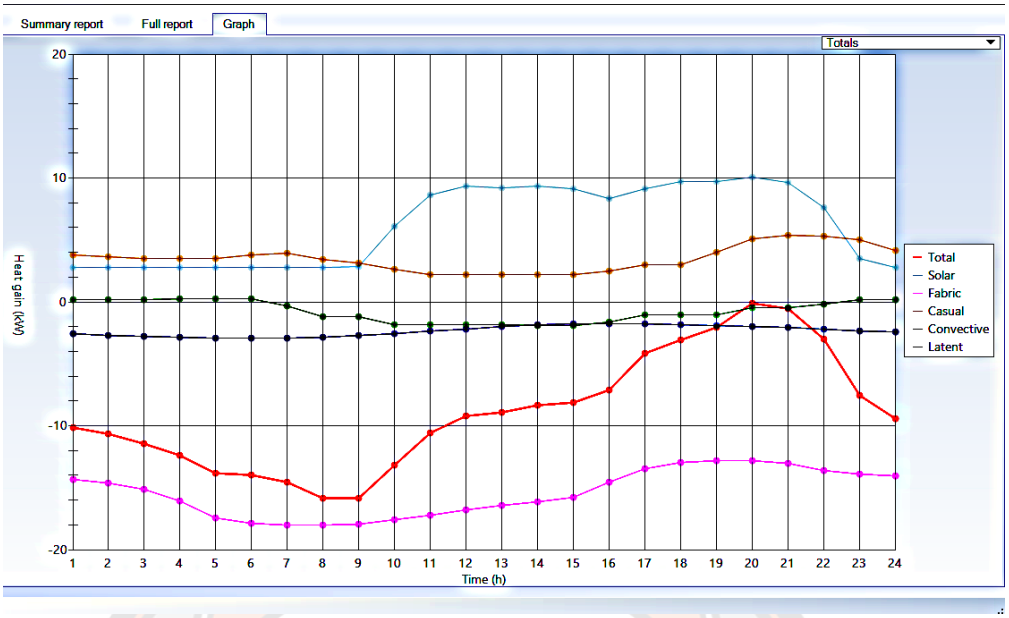


Figure 39 Heat Gain Graphs (A1)

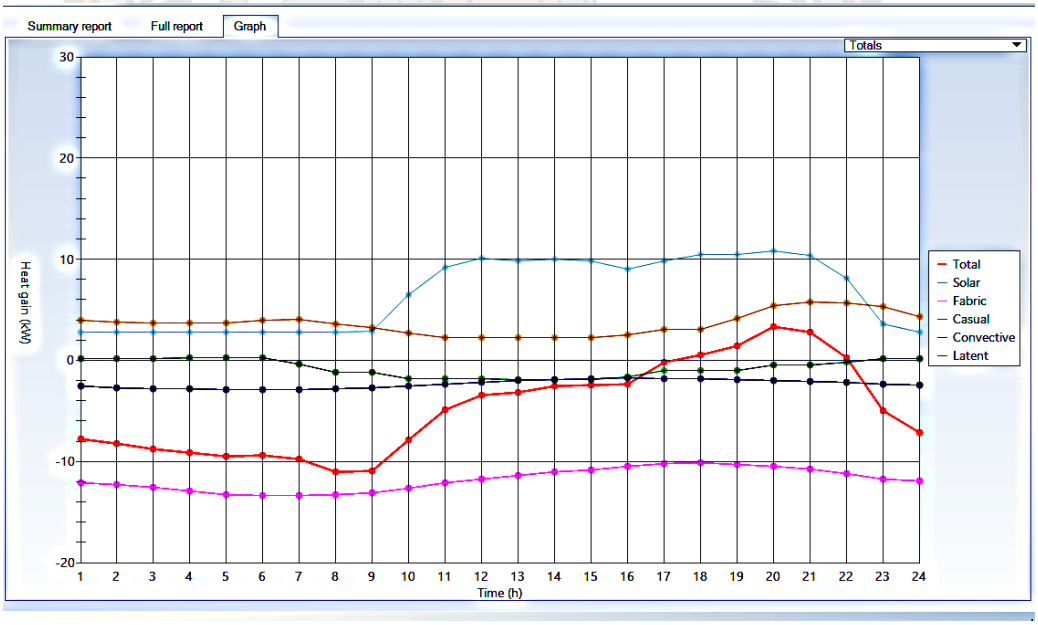


Figure 40 Heat Gain Graphs (A2)

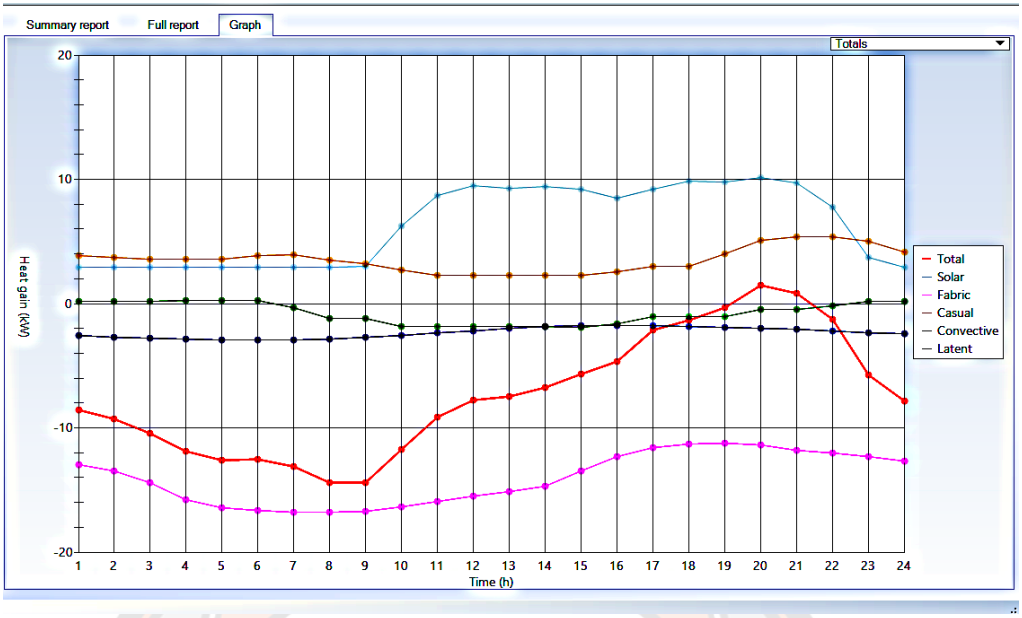


Figure 41 Heat Gain Graphs (A3)

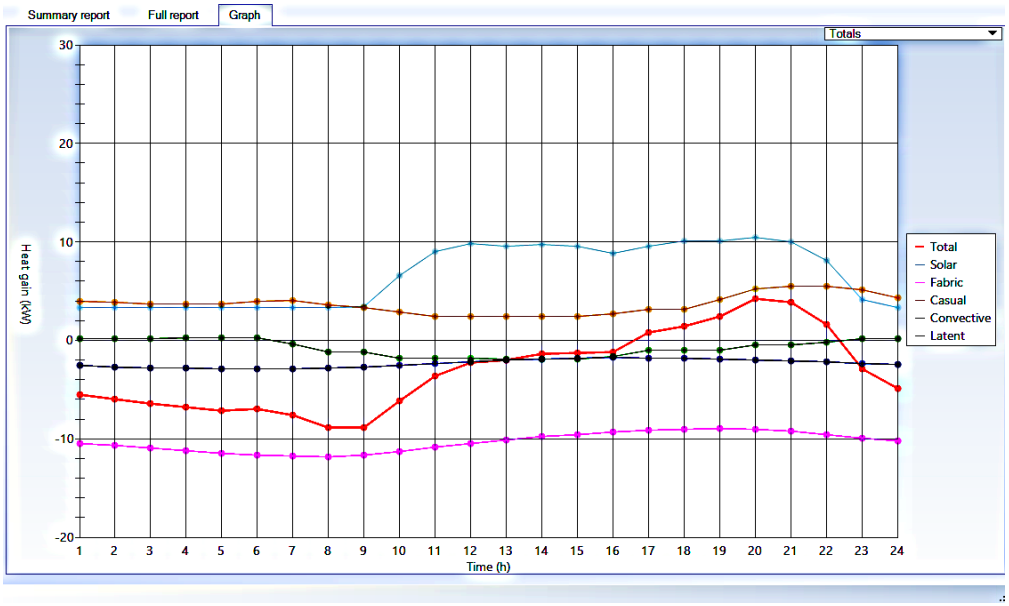


Figure 42 Heat Gain Graphs (A4)

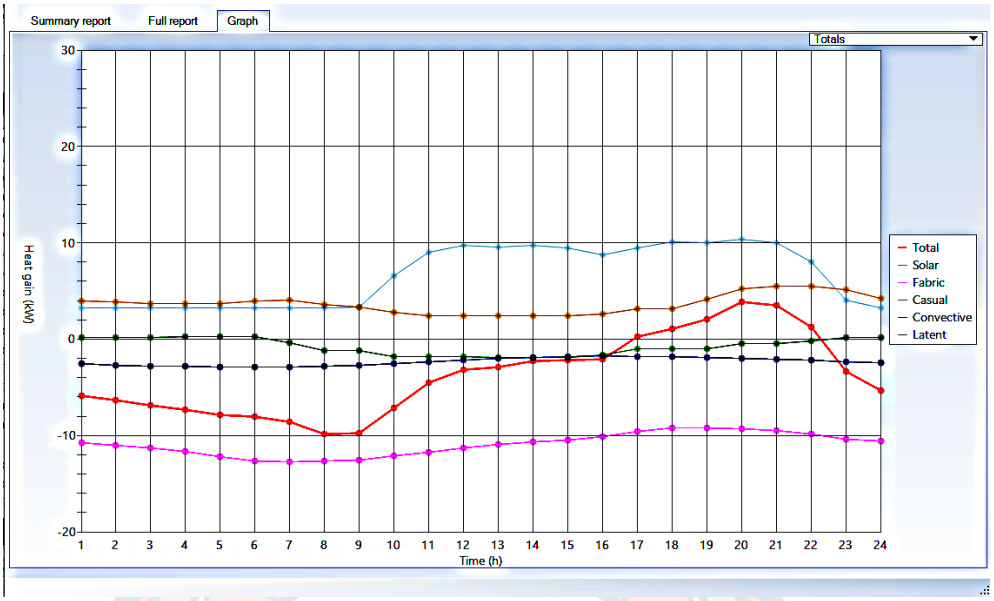


Figure 43 Heat Gain Graphs (A5)

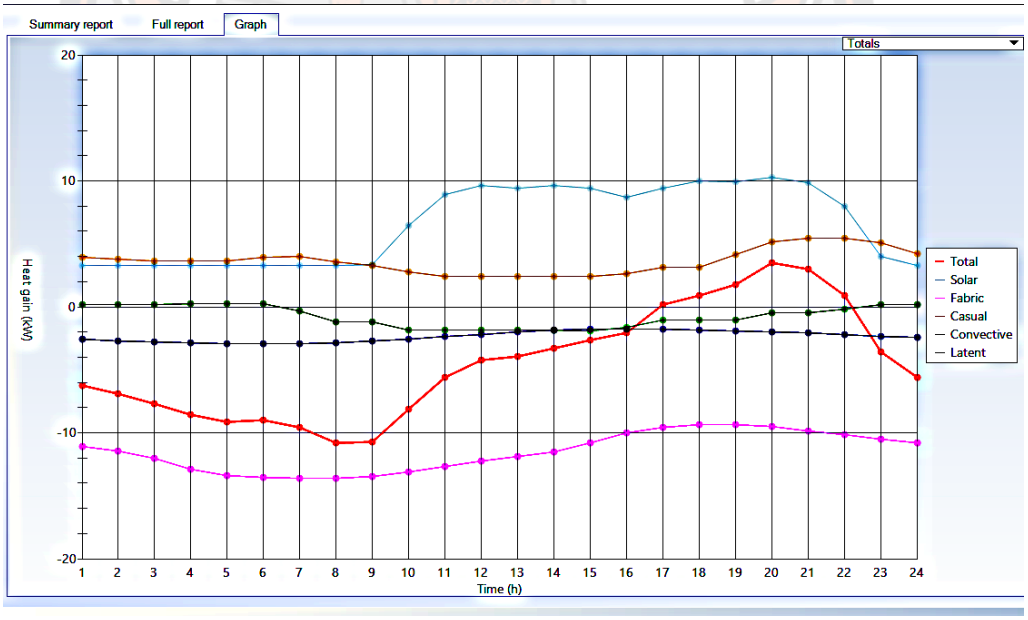


Figure 44 Heat Gain Graphs (A6)

4.4 Heat Loss from Building Alternative 1 (Dining Room/ Sitting Room)

The Figure 45 shows the heat loss from the building alternative 1 from the dining room. So, from the figure the heat loss from the wall is 1471W which is equivalent to 1.471 kWh. The 1.471 kWh is the daily energy loss from the wall from the dining room. So, converting this daily loss into year, it will be 529.56 kWh. Since, it has four units, the total energy loss will be 2118.24 kWh. Here, the energy loss is considered as equivalent to the energy consumption. The electricity price is Nu.2.45 Nu/kWh.

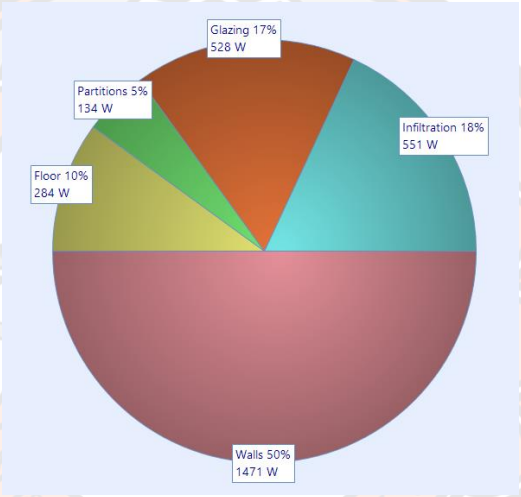


Figure 45 Heat Loss from Dining Room (A1)

The annual energy consumption for building alternative 1 is 15301.43 kWh without including the energy consumption by electric heater. Therefore, adding the equivalent energy required by each dining room lost in the form of energy. The total energy lost is 2118.24 kWh which is annually, but the electric heater is used for only six months due to cold weather.

Total energy consumption = Annual energy consumption + energy used by electric heater.

Total energy consumption = 15301.43 kWh + 1059.12 kWh

Total energy consumption = 16360 kWh (Nu. 40,082)

4.5 Heat Loss from Building Alternative 2 (Dining Room/ Sitting Room)

The Figure 46 shows the heat loss from the building alternative 2 from the dining room. So, from the figure the heat loss from the wall is 604 W which is equivalent to 0.604 kWh. The 0.604 kWh is the daily energy loss from the wall from the dining room. So, converting this daily loss into year, it will be 217.44 kWh. Since, it has four units, the total energy loss will be 869.76 kWh. Here, the energy loss is considered as equivalent to the energy consumption. The electricity price is Nu.2.45 Nu/kWh.

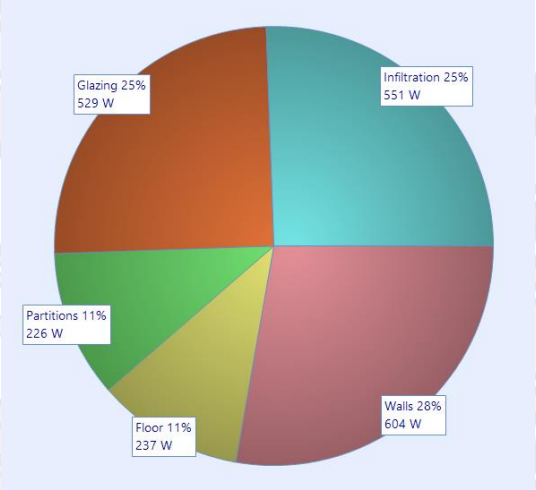


Figure 46 Heat Loss from Dining Room (A2)

The annual energy consumption for building alternative 2 is 15301.43 kWh without including the energy consumption by electric heater. Therefore, adding the equivalent energy required by each dining room lost in the form of energy. The total energy lost is 869.76 kWh which is annually, but the electric heater is used for only six months due to cold weather.

Total energy consumption = Annual energy consumption + energy used by electric heater.

Total energy consumption = 15301.43 kWh + 434.88 kWh

Total energy consumption = 15736.31 kWh (Nu. 38,553)

4.6 Heat Loss from Building Alternative 3 (Dining Room/ Sitting Room)

The Figure 47 shows the heat loss from the building alternative 3 from the dining room. So, from the figure the heat loss from the wall is 1142 W which is equivalent to 1.142 kWh. The 1.142 kWh is the daily energy loss from the wall from the dining room. So, converting this daily loss into year, it will be 411.12 kWh. Since, it has four units, the total energy loss will be 1644.48 kWh. Here, the energy loss is considered as equivalent to the energy consumption.

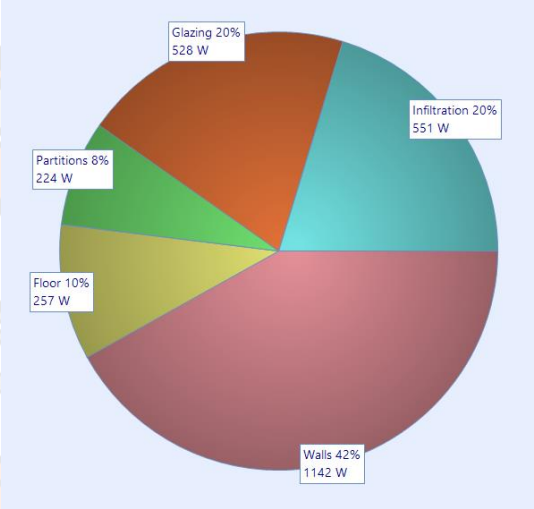


Figure 47 Heat Loss from Dining Room (A3)

The annual energy consumption for building alternative 3 is 15301.43 kWh without including the energy consumption by electric heater. Therefore, adding the equivalent energy required by each dining room lost in the form of energy. The total energy lost is 1644.48 kWh which is annually, but the electric heater is used for only six months due to cold weather.

Total energy consumption = Annual energy consumption + energy used by electric heater.

Total energy consumption = 15301.43 kWh+ 822.24 kWh

Total energy consumption = 16123.67 kWh (Nu. 39,502)

4.7 Heat Loss from Building Alternative 4 (Dining Room/ Sitting Room)

The Figure 48 shows the heat loss from the building alternative 4 from the dining room. So, from the figure the heat loss from the wall is 241 W which is equivalent to 0.241 kWh. The 0.241 kWh is the daily energy loss from the wall from the dining room. So, converting this daily loss into year, it will be 86.76 kWh. Since, it has four units, the total energy loss will be 347.04 kWh. Here, the energy loss is considered as equivalent to the energy consumption.

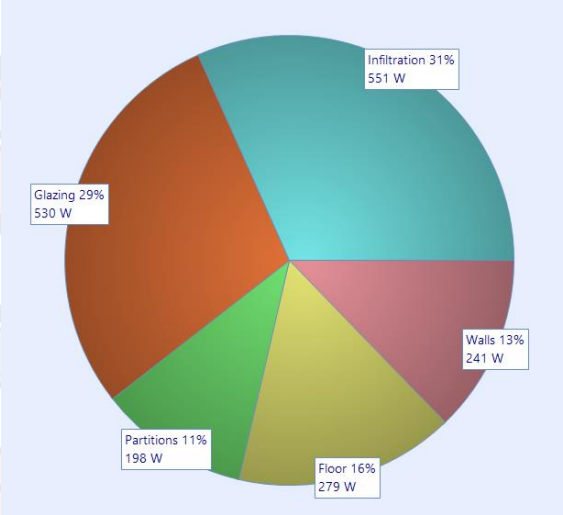


Figure 48 Heat Loss from Dining Room (A4)

The annual energy consumption for building alternative 4 is 15301.43 kWh without including the energy consumption by electric heater. Therefore, adding the equivalent energy required by each dining room lost in the form of energy. The total energy lost is 347.04 kWh which is annually, but the electric heater is used for only six months due to cold weather.

Total energy consumption = Annual energy consumption + energy used by electric heater.

Total energy consumption = 15301.43 kWh+ 173.52 kWh

Total energy consumption = 15474.95 kWh (Nu. 37,914)

4.8 Heat Loss from Building Alternative 5 (Dining Room/ Sitting Room)

The Figure 49 shows the heat loss from the building alternative 5 from the dining room. So, from the figure the heat loss from the wall is 372 W which is equivalent to 0.372 kWh. The 0.372 kWh is the daily energy loss from the wall from the dining room. So, converting this daily loss into year, it will be 133.92 kWh. Since, it has four units, the total energy loss will be 535.68 kWh. Here, the energy loss is considered as equivalent to the energy consumption.

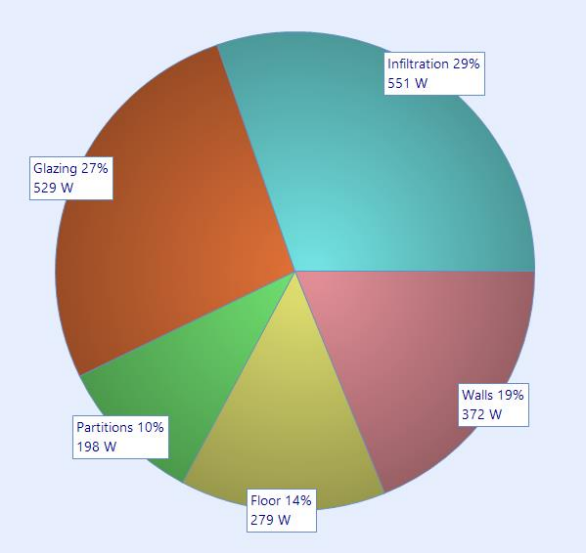


Figure 49 Heat Loss from Dining Room (A5)

The annual energy consumption for building alternative 5 is 15301.43 kWh without including the energy consumption by electric heater. Therefore, adding the equivalent energy required by each dining room lost in the form of energy. The total energy lost is 535.68 kWh which is annually, but the electric heater is used for only six months due to cold weather.

Total energy consumption = Annual energy consumption + energy used by electric heater.

Total energy consumption = 15301.43 kWh+ 267.84 kWh

Total energy consumption = 15569.27 kWh (Nu. 38,145)

4.9 Heat Loss from Building Alternative 6 (Dining Room/ Sitting Room)

The Figure 50 shows the heat loss from the building alternative 6 from the dining room. So, from the figure the heat loss from the wall is 504 W which is equivalent to 0.504 kWh. The 0.504 kWh is the daily energy loss from the wall from the dining room. So, converting this daily loss into year, it will be 181.44 kWh. Since, it has four units, the total energy loss will be 725.76 kWh. Here, the energy loss is considered as equivalent to the energy consumption.

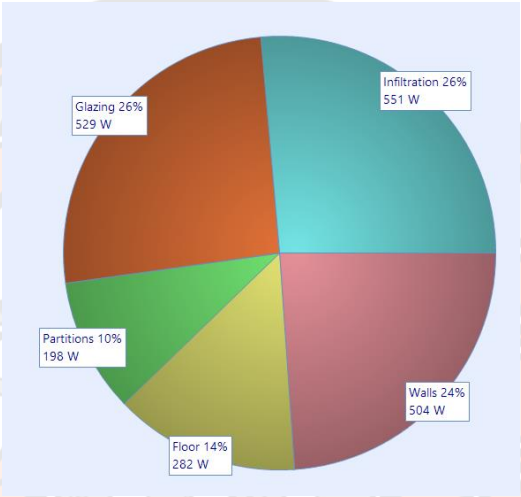


Figure 50 Heat Loss from Dining Room (A6)

The annual energy consumption for building alternative 6 is 15301.43 kWh without including the energy consumption by electric heater. Therefore, adding the equivalent energy required by each dining room lost in the form of energy. The total energy lost is 725.76 kWh which is annually, but the electric heater is used for only six months due to cold weather.

Total energy consumption = Annual energy consumption + energy used by electric heater.

Total energy consumption = 15301.43 kWh+ 362.88 kWh

Total energy consumption = 15664.31 kWh (Nu. 38,378)

Figure 51 shows the total annual electricity consumption in amount by six building alternatives. The building alternative 4 has the lowest annual electricity followed by the building alternative 5, and 6. While the building alternative 1 and the building alternative 3 has the highest electricity consumption amount to Nu. 40,082 and Nu. 39,502 respectively.

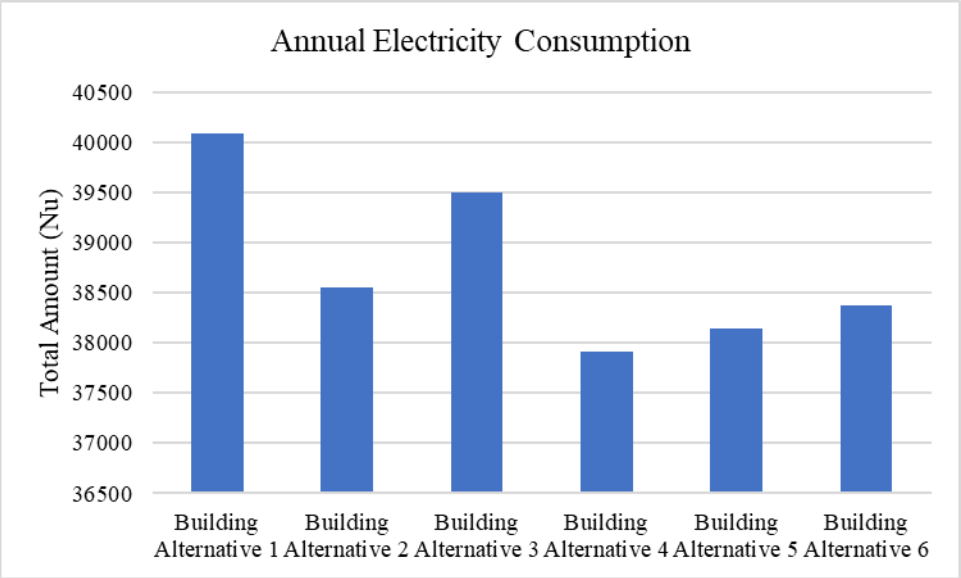


Figure 51 The Annual Electricity Consumed Annually by Six Building Alternatives

4.10 Cost Estimates of Building Alternatives

The overall building cost for model alternative 1 is shown in Table 7. Model alternative 1's entire building cost, including painting, was found to be Nu. 5528767.10. A significant amount of money is spent on beam and column, flooring, roofing, and foundation during the construction phase.

Table 7 Construction Costs for Building Alternative 1

S/No	Items	Amount
1	Substructure (Foundation and plinth wall, including reinforcement and concrete)	646990.78
2	Concrete block wall (Including Plastering)	423323.75
3	Flooring (including reinforcement)	946940.86
4	Window and Doors	234336.12
5	Cornices	51805.85
6	Beam and Column (including reinforcement)	2029502.34
7	Roofing	755885.15
8	Painting	165550.23
10	Staircase and plinth protection	212458.78
11	Plumbing item (kitchen sink, European pot etc.)	61973.24
	Total Amount (Nu)	**5528767**

Table 8 shows the overall construction cost of model alternative 2. The total amount incurred for construction of model alternative 2 is Nu. 2399006.48. The significant amount of money is spent in foundation, roofing, and windows and doors.

Table 8 Construction Costs for Building Alternative 2

S/No	Items	Amount
1	Substructure (Foundation and plinth wall, including reinforcement and concrete)	318030.69
2	Stone (Random rubble masonry)	89557.67
3	Flooring (Timber Flooring)	484391
4	Window and Doors	234336.12
5	Cornices	76823.6
	Roofing	755885.15
7	Painting	165550.23
8	Staircase and plinth protection	212458.78
10	Plumbing item (kitchen sink, European pot etc.)	61973.24
	Total Amount (Nu)	**2399006**

The overall building cost for model alternative 3 is shown in Table 9. Model alternative 3's entire building cost, including painting, was found to be Nu. 5540489.40. A significant amount of money is spent on beam and column, wall, flooring, roofing, and foundation during the construction phase.

Table 9 Construction Costs for Building Alternative 3

S/No	Items	Amount
1	Substructure (Foundation and plinth wall, including reinforcement and concrete)	646990.78
2	Wall (Brick wall)	435046.05
3	Flooring (including reinforcement)	946940.86
4	Window and Doors	234336.12
5	Cornices	51805.85
6	Beam and Column (including reinforcement)	2029502.34
7	Roofing	755885.15
8	Painting	165550.23
10	Staircase and plinth protection	212458.78
11	Plumbing item (kitchen sink, European pot etc.)	61973.24
	Total Amount (Nu)	**5540489**

The overall building cost for model alternative 4 is shown in Table 10. Model alternative 4's entire building cost, including painting, was found to be Nu. 5931026.58. A significant amount of money is spent on beam and column, wall, flooring, roofing, and foundation during the construction phase.

Table 10 Construction Costs for Building Alternative 4

S/No	Items	Amount
1	Substructure (Foundation and plinth wall, including reinforcement and concrete)	646990.78
2	Brick 105mm, airgap 25mm,EPS insul, 25mm,aer conc blk(500) 150mm,lgt plast. 13mm.	825583.23
3	Flooring (including reinforcement)	946940.86
4	Window and Doors	234336.12

S/No	Items	Amount
5	Cornices	51805.85
6	Beam and Column (including reinforcement)	2029502.34
7	Roofing	755885.15
8	Painting	165550.23
10	Staircase and plinth protection	212458.78
11	Plumbing item (kitchen sink, European pot etc.)	61973.24
	Total Amount (Nu)	**5931027**

The overall building cost for model alternative 5 is shown in Table 11. Model alternative 5's entire building cost, including painting, was found to be Nu. 5848603.77. A significant amount of money is spent on beam and column, wall, flooring, roofing, and foundation during the construction phase.

Table 11 Construction Costs for Building Alternative 5

S/No	Items	Amount
1	Substructure (Foundation and plinth wall, including reinforcement and concrete)	646990.78
2	Brick 105mm,airgap 50mm,aer conc blk(500) 150mm,lgt plast 13mm.	743160.42
3	Flooring (including reinforcement)	946940.86
4	Window and Doors	234336.12
5	Cornices	51805.85
6	Beam and Column (including reinforcement)	2029502.34
7	Roofing	755885.15
8	Painting	165550.23
10	Staircase and plinth protection	212458.78
11	Plumbing item (kitchen sink, European pot etc.)	61973.24
	Total Amount (Nu)	**5848604**

The overall building cost for model alternative 6 is shown in Table 12. Model alternative 6's entire building cost, including painting, was found to be Nu. 5704716.46. A significant amount of money is spent on beam and column, wall, flooring, roofing, and foundation during the construction phase.

Table 12 Construction Costs for Building Alternative 6

S/No	Items	Amount
1	Substructure (Foundation and plinth wall, including reinforcement and concrete)	646990.78
2	Brick 105mm, airgap 50mm,lgt agg conc blk 100mm,dense plast 13mm.	599273.11
3	Flooring (including reinforcement)	946940.86
4	Window and Doors	234336.12
5	Cornices	51805.85
6	Beam and Column (including reinforcement)	2029502.34
7	Roofing	755885.15
8	Painting	165550.23
10	Staircase and plinth protection	212458.78
11	Plumbing item (kitchen sink, European pot etc.)	61973.24
	Total Amount (Nu)	**5704716**

4.11 Cost Comparison among Building Alternatives

The cost comparison bar charts were plotted for all the building model alternatives as shown in Figure 52. Building alternative 4 requires maximum construction cost while building alternative 2 requires minimum construction cost. Figure 53 shows the cost comparison between concrete slab flooring and timber flooring. The materials and construction costs for concrete slab flooring are much higher than timber flooring. The different types of walls were used in building model alternatives. The cost comparison was made among these alternatives. In comparison to alternatives 4, 5, and 6, alternative 1, alternative 2, and alternative 3 have the lowest construction costs (see Figure 54).

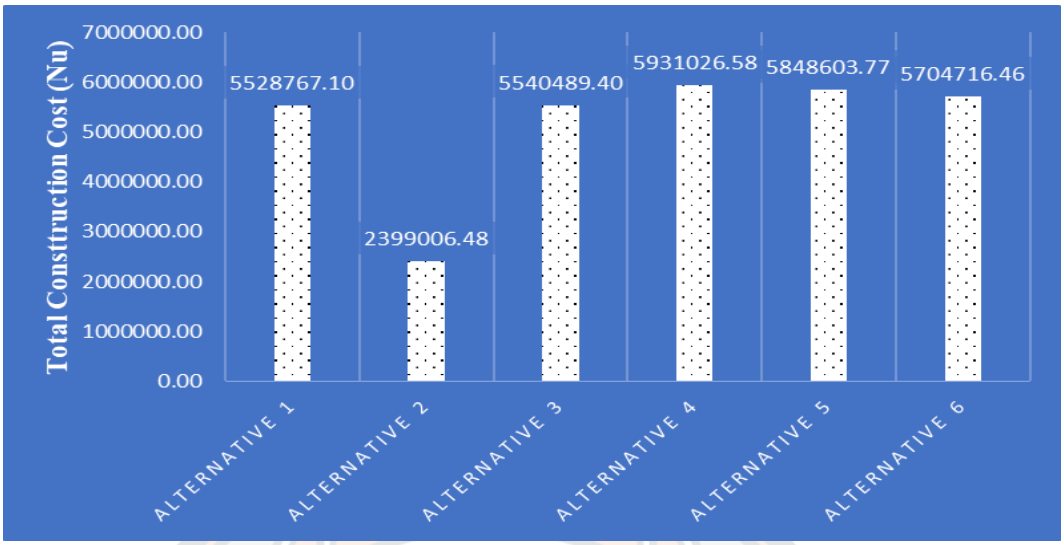


Figure 52 Bar Chart Showing Total Construction Costs for Building Model Alternatives

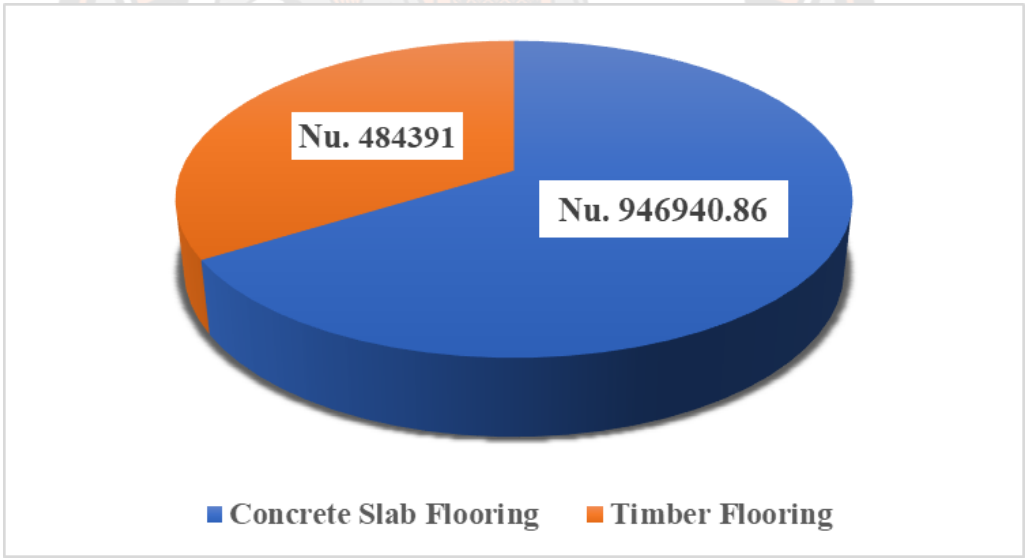


Figure 53 Cost Comparison between Concrete Slab Flooring and Timber Flooring

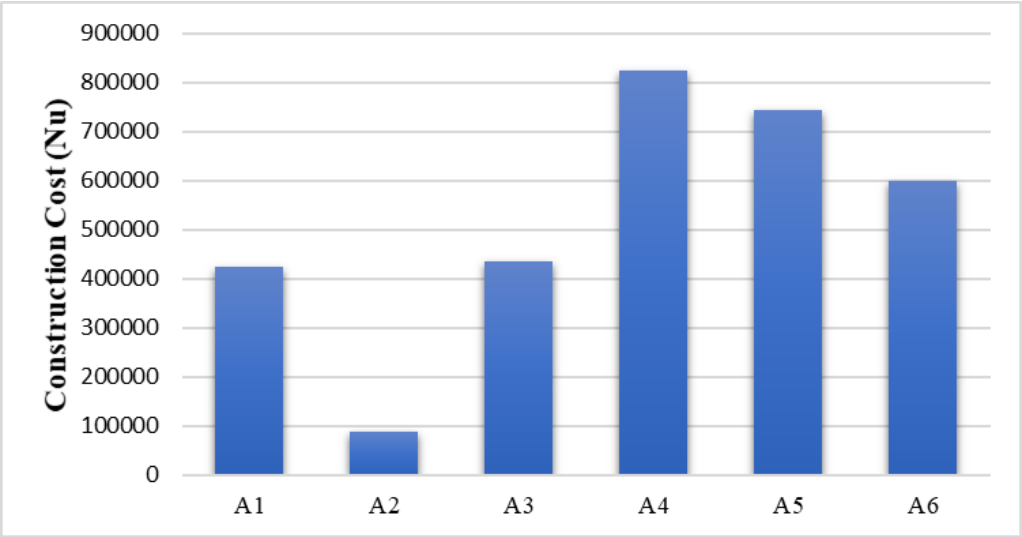


Figure 54 Bar Charts Showing Comparative Construction Costs for Walls

4.12 Life Cycle Cost of Building Alternatives Without Loan (Owner)

In this study the life cycle cost of building alternatives were calculated without taking the loan from the bank. The owner can earn the interest of 5% for deposit of money in the bank. The 5% interest rate was used for the calculation of the operational and maintenance cost of the buildings and present worth of the building.

4.13 Present Equivalent Value of Annual Water Consumption

Cash flow diagram for building alternative 1 is shown in Figure 55. The value of A is Nu. 4860, N equals to 20 years, and i = 5% per year. Here the water consumption per person per day was taken 75L and total of 5 person from each unit was taken. Therefore, water consumption per year was 1620 cum. To find the present equivalent amount, the Appendix K was used.

$$P_{W20} = A\ (P/A, i\%, N)$$

$$P_{W20} = \text{Nu. } 4860\ (P/A, 5\%, 20)$$

$$P_{W20} = \text{Nu. } 4860\ (12.4622)$$

$$P_{W20} = \textbf{Nu. 60,566}$$

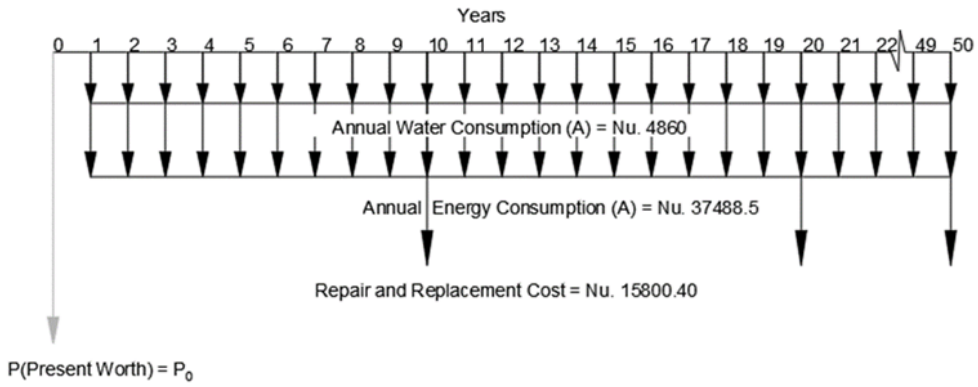


Figure 55 Present Worth Cash Flow Diagram for Building Alternative 1

4.14 Present Equivalent Value of Repair and Replacement Cost

Here, in this calculation the F_{10} is equal to P_{10}. The value of F_{10} is Nu. 15,800.40, N equals to 10 years, 20 years and i' is 5%. To find the present equivalent amount, the Appendix K was used.

$$P_R = F_x\ (P/F, i\%, N)$$

$$P_{R20} = F_{10}\ (P/F, 5\%, 10) + F_{20}\ (P/F, 5\%, 20)$$

$$P_{R20} = \text{Nu. } 15{,}800.40\ (0.6139) + \text{Nu. } 15{,}800.40\ (0.3769)$$

$$P_{R20} = \textbf{Nu. 15,655}$$

4.15 Present Equivalent Value of Annual Energy Consumption for Building Alternative 1

The value of A is Nu. 40,082, N equals to 20 years and i is 5%. To find the present equivalent amount, the Appendix K was used.

$$P_{E20} = A\ (P/A, i\%, N)$$

$$P_{E20} = \text{Nu. } 40{,}082\ (P/A, 5\%, 20)$$

$$P_{E20} = \text{Nu. } 40{,}082\ (12.4622)$$

$$P_{E20} = \textbf{Nu. 4,99,510}$$

4.16 Present Equivalent Value of Annual Energy Consumption for Building Alternative 2

The value of A is Nu. 38,553, N equals to 20 years and i is 5%. To find the present equivalent amount, the Appendix K was used.

P_{E20} = A (P/A, i%, N)

P_{E20}= Nu. 38,553 (P/A, 5%, 20)

P_{E20} = Nu. 38,553 (12.4622)

P_{E20} = **Nu. 4,80,455**

4.17 Present Equivalent Value of Annual Energy Consumption for Building Alternative 3

The value of A is Nu. 39,502, N equals to 30 years and i is 5%. To find the present equivalent amount, the Appendix K was used.

P_{E20} = A (P/A, i%, N)

P_{E20}= Nu. 39,502 (P/A, 5%, 20)

P_{E20} = Nu. 39,502 (12.4622)

P_{E20} = **Nu. 4,92,281**

4.18 Present Equivalent Value of Annual Energy Consumption for Building Alternative 4

The value of A is Nu. 37,914, N equals to 20 years and i is 5%. To find the present equivalent amount, the Appendix K was used.

P_{E20} = A (P/A, i%, N)

P_{E20}= Nu. 37,914 (P/A, 5%, 20)

P_{E20} = Nu. 37,914 (12.4622)

P_{E20} = **Nu. 4,72,492**

4.19 Present Equivalent Value of Annual Energy Consumption for Building Alternative 5

The value of A is Nu. 38,145, N equals to 20 years and i is 5%. To find the present equivalent amount, the Appendix K was used.

P_{E20} = A (P/A, i%, N)

P_{E20}= Nu. 38,145 (P/A, 5%, 20)

P_{E20} = Nu. 38,145 (12.4622)

P_{E20} = **Nu. 4,75,371**

4.20 Present Equivalent Value of Annual Energy Consumption for Building Alternative 6

The value of A is Nu. 38,378, N equals to 20 years and i is 5%. To find the present equivalent amount, the Appendix K was used.

P_{E20} = A (P/A, i%, N)

P_{E20}= Nu. 38,378 (P/A, 5%, 20)

P_{E20} = Nu. 38,378 (12.4622)

P_{E20} = **Nu.4,78,274**

4.21 Life Cycle Cost of Building Alternatives for the Return Period of 20 Years (i = 5%)

Demolition and disposal cost for building alternative 1 is Nu. 3,71,656 and scrap value is Nu. 2,76,438.

$$\boldsymbol{LCCP_{01} = P_{A1} + P_{W20} + P_{E20} + P_{R20} + P_{D1} - P_{S1}}$$

$$\boldsymbol{LCCP_{01}} = \text{Nu. } 55,28,767 + \text{Nu. } 60,566 + \text{Nu. } 4,99,510 + \text{Nu. } 15,655 + 3,71,656 - 2,76,438$$

$$\boldsymbol{LCCP_{01} = \text{Nu. } 61,99,716}$$

Demolition and disposal cost for building alternative 2 is Nu. 23,4,475 and scrap value is Nu. 47,980.13.

$$\boldsymbol{LCCP_{02} = P_{A2} + P_{W20} + P_{E20} + P_{R20} + P_{D2} - P_{S2}}$$

$$\boldsymbol{LCCP_{02}} = \text{Nu. } 23,99,006 + \text{Nu. } 60,566 + \text{Nu. } 4,80,455 + \text{Nu. } 15,655 + 2,34,475 - 47,980$$

$$\boldsymbol{LCCP_{02} = \text{Nu. } 31,42,177}$$

Demolition and disposal cost for building alternative 3 is Nu. 3,71,656 and scrap value is Nu. 2,7,7024.

$$\boldsymbol{LCCP_{03} = P_{A3} + P_{W20} + P_{E20} + P_{R20} + P_{D3} - P_{S3}}$$

$$\boldsymbol{LCCP_{03}} = \text{Nu. } 55,40,489 + \text{Nu. } 60,566 + \text{Nu. } 4,92,281 + \text{Nu. } 15,655 + 3,71,656 - 2,77,024$$

$$\boldsymbol{LCCP_{03} = \text{Nu. } 62,03,623}$$

Demolition and disposal cost for building alternative 4 is Nu. 3,71,656 and scrap value is Nu. 3,05,145.

$$\boldsymbol{LCCP_{04} = P_{A4} + P_{W20} + P_{E20} + P_{R20} + P_{D4} - P_{S4}}$$

$$\boldsymbol{LCCP_{04}} = \text{Nu. } 59,31,027 + \text{Nu. } 60,566 + \text{Nu. } 4,72,492 + \text{Nu. } 15,655 + 3,71,656 - 3,05,145$$

$$\boldsymbol{LCCP_{04} = \text{Nu. } 65,46,251}$$

Demolition and disposal cost for building alternative 5 is Nu. 3,71,656 and scrap value is Nu. 2,90,290.

$$\boldsymbol{LCCP_{05} = P_{A5} + P_{W20} + P_{E20} + P_{R20} + P_{D5} - P_{S5}}$$

$$\boldsymbol{LCCP_{05}} = \text{Nu. } 58,48,604 + \text{Nu. } 60,566 + \text{Nu. } 4,75,371 + \text{Nu. } 15,655 + 3,71,656 - 2,90,290$$

$$\boldsymbol{LCCP_{05} = \text{Nu. } 64,81,562}$$

Demolition and disposal cost for building alternative 6 is Nu. 3,71,656 and scrap value is Nu. 2,83,095.

$$\boldsymbol{LCCP_{06} = P_{A6} + P_{W20} + P_{E20} + P_{R20} + P_{D6} - P_{S6}}$$

$$\boldsymbol{LCCP_{06}} = \text{Nu. } 57,04,716 + \text{Nu. } 60,566 + \text{Nu. } 4,78,274 + \text{Nu. } 15,655 + 3,71,656 - 2,83,095$$

$$\boldsymbol{LCCP_{06} = \text{Nu. } 63,47,772}$$

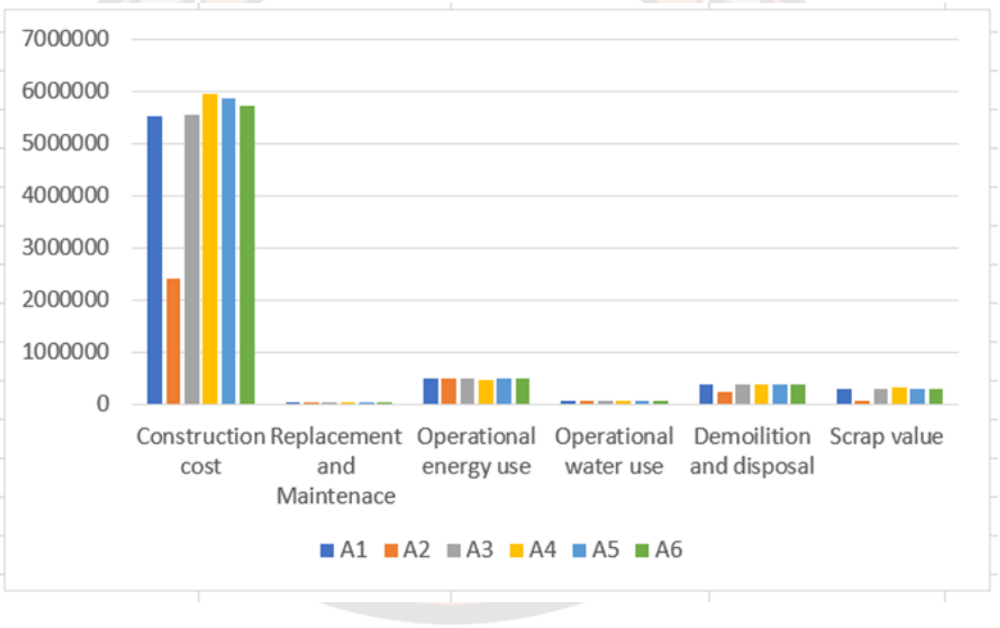


Figure 56 Life Cycle Cost of Building Alternatives (i = 5%)

Building alternative 4 has the highest present value of Nu. 65,46,251 and followed by building alternative 5 with Nu. 64,81,562. Building alternative 2 has the lowest present value of Nu. 31,42,177. The comparative present worth of individual building alternatives are depicted in Figure 56 till 20 years from now. The data shows that a large portion of a residential building's budget is spent on building construction

and good amount in operational energy use. The specific amount of money is also spent for operational water use and demolition.

4.22 Life Cycle Cost of Building Alternatives with Loan (Owner)

In this study the life cycle cost of building alternatives were calculated by taking the full loan from the bank. The owner pays the interest rate of 10% to the bank. The 10% interest rate was used for the calculation of the operational and maintenance cost of the buildings and present worth of the building.

4.23 Present Equivalent value of Annual Water Consumption

The value of A is Nu. 4860, N equals to 20 years, and i = 10% per year. Here the water consumption per person per day was taken 75L and total of 5 person from each unit was taken. Therefore, water consumption per year was 1620 cum. To find the present equivalent amount, the Appendix L was used.

$$P_{W20} = A\ (P/A, i\%, N)$$

$$P_{W20} = \text{Nu. } 4860\ (P/A, 10\%, 20)$$

$$P_{W20} = \text{Nu. } 4860\ (8.5136)$$

$$P_{W20} = \textbf{Nu. 41,376}$$

4.24 Present Equivalent value of Repair and Replacement Cost

Here, in this calculation the F_{10} is equal to P_{10}. The value of F_{10} is Nu. 15,800.40, N equals to 10 years, 20 years and i' is 10%. To find the present equivalent amount, the Appendix L was used.

$$P_R = F_x\ (P/F, i\%, N)$$

$$P_{R20} = F_{10}\ (P/F, 5\%, 10) + F_{20}\ (P/F, 10\%, 20)$$

$$P_{R20} = \text{Nu. } 15{,}800.40\ (0.3855) + \text{Nu. } 15{,}800.40\ (0.1486)$$

$$P_{R20} = \textbf{Nu. 8,439}$$

4.25 Present Equivalent Value of Annual Energy Consumption for Building Alternative 1

The value of A is Nu. 40,082, N equals to 20 years and i is 10%. To find the present equivalent amount, the Appendix L was used.

P_{E20} = A (P/A, i%, N)

P_{E20}= Nu. 40,082 (P/A, 10%, 20)

P_{E20} = Nu. 40,082 (8.5136)

P_{E20} = **Nu. 3,41,242**

4.26 Present Equivalent Value of Annual Energy Consumption for Building Alternative 2

The value of A is Nu. 38,553, N equals to 20 years and i is 10%. To find the present equivalent amount, the Appendix L was used.

P_{E20} = A (P/A, i%, N)

P_{E20}= Nu. 38,553 (P/A, 10%, 20)

P_{E20} = Nu. 38,553 (8.5136)

P_{E20} = **Nu. 3,28,225**

4.27 Present Equivalent Value of Annual Energy Consumption for Building Alternative 3

The value of A is Nu. 39,502, N equals to 30 years and i is 10%. To find the present equivalent amount, the Appendix L was used.

P_{E20} = A (P/A, i%, N)

P_{E20}= Nu. 39,502 (P/A, 10%, 20)

P_{E20} = Nu. 39,502 (8.5136)

P_{E20} = **Nu. 3,36,304**

4.28 Present Equivalent Value of Annual Energy Consumption for Building Alternative 4

The value of A is Nu. 37,914, N equals to 20 years and i is 10%. To find the present equivalent amount, the Appendix L was used.

P_{E20} = A (P/A, i%, N)

P_{E20}= Nu. 37,914 (P/A, 10%, 20)

P_{E20} = Nu. 37,914 (8.5136)

P_{E20} = **Nu. 3,22,784**

4.29 Present Equivalent Value of Annual Energy Consumption for Building Alternative 5

The value of A is Nu. 38,145, N equals to 20 years and i is 10%. To find the present equivalent amount, the Appendix L was used.

$$P_{E20} = A\ (P/A, i\%, N)$$

$$P_{E20} = \text{Nu. } 38{,}145\ (P/A, 10\%, 20)$$

$$P_{E20} = \text{Nu. } 38{,}145\ (8.5136)$$

$$P_{E20} = \textbf{Nu. 3,24,751}$$

4.30 Present Equivalent Value of Annual Energy Consumption for Building Alternative 6

The value of A is Nu. 38,378, N equals to 20 years and i is 10%. To find the present equivalent amount, the Appendix L was used.

$$P_{E20} = A\ (P/A, i\%, N)$$

$$P_{E20} = \text{Nu. } 38{,}378\ (P/A, 10\%, 20)$$

$$P_{E20} = \text{Nu. } 38{,}378\ (8.5136)$$

$$P_{E20} = \textbf{Nu.3,26,735}$$

4.31 Life Cycle Cost of Building Alternatives for the Return Period of 20 Years (i=10%)

Demolition and disposal cost for building alternative 1 is Nu. 3,71,656 and scrap value is Nu. 2,76,438.

$$\boldsymbol{LCCP_{01} = P_{A1} + P_{W20} + P_{E20} + P_{R20} + P_{D1} - P_{S1}}$$

$$\boldsymbol{LCCP_{01}} = \text{Nu. } 55{,}28{,}767 + \text{Nu. } 41{,}376 + \text{Nu. } 3{,}41{,}242 + \text{Nu. } 8{,}439 + 3{,}71{,}656 - 2{,}76{,}438$$

$$\boldsymbol{LCCP_{01} = \text{Nu. } 60{,}15{,}042}$$

Demolition and disposal cost for building alternative 2 is Nu. 23,4,475 and scrap value is Nu. 47,980.13.

$$\boldsymbol{LCCP_{02} = P_{A2} + P_{W20} + P_{E20} + P_{R20} + P_{D2} - P_{S2}}$$

$$\boldsymbol{LCCP_{02}} = \text{Nu. } 23{,}99{,}006 + \text{Nu. } 41{,}376 + \text{Nu. } 3{,}28{,}225 + \text{Nu. } 8{,}439 + 2{,}34{,}475 - 47{,}980$$

$$\boldsymbol{LCCP_{02} = \text{Nu. } 29{,}63{,}541}$$

Demolition and disposal cost for building alternative 3 is Nu. 3,71,656 and scrap value is Nu. 2,7,7024.

$$\boldsymbol{LCCP_{03} = P_{A3} + P_{W20} + P_{E20} + P_{R20} + P_{D3} - P_{S3}}$$

$$\boldsymbol{LCCP_{03}} = \text{Nu. } 55{,}40{,}489 + \text{Nu. } 41{,}376 + \text{Nu. } 3{,}36{,}304 + \text{Nu. } 8{,}439 + 3{,}71{,}656 - 2{,}77{,}024$$

$$\boldsymbol{LCCP_{03} = \text{Nu. } 60{,}21{,}240}$$

Demolition and disposal cost for building alternative 4 is Nu. 3,71,656 and scrap value is Nu. 3,05,145.

$$\boldsymbol{LCCP_{04} = P_{A4} + P_{W20} + P_{E20} + P_{R20} + P_{D4} - P_{S4}}$$

$$\boldsymbol{LCCP_{04}} = \text{Nu. } 59{,}31{,}027 + \text{Nu. } 41{,}376 + \text{Nu. } 3{,}22{,}784 + \text{Nu. } 8{,}439 + 3{,}71{,}656 - 3{,}05{,}145$$

$$\boldsymbol{LCCP_{04} = \text{Nu. } 63{,}70{,}137}$$

Demolition and disposal cost for building alternative 5 is Nu. 3,71,656 and scrap value is Nu. 2,90,290.

$$\boldsymbol{LCCP_{05} = P_{A5} + P_{W20} + P_{E20} + P_{R20} + P_{D5} - P_{S5}}$$

$$\boldsymbol{LCCP_{05}} = \text{Nu. } 58{,}48{,}604 + \text{Nu. } 41{,}376 + \text{Nu. } 3{,}24{,}751 + \text{Nu. } 8{,}439 + 3{,}71{,}656 - 2{,}90{,}290$$

$$\boldsymbol{LCCP_{05} = \text{Nu. } 63{,}04{,}536}$$

Demolition and disposal cost for building alternative 6 is Nu. 3,71,656 and scrap value is Nu. 2,83,095.

$$\boldsymbol{LCCP_{06} = P_{A6} + P_{W20} + P_{E20} + P_{R20} + P_{D6} - P_{S6}}$$

$$\boldsymbol{LCCP_{06}} = \text{Nu. } 57{,}04{,}716 + \text{Nu. } 41{,}376 + \text{Nu. } 3{,}26{,}735 + \text{Nu. } 8{,}439 + 3{,}71{,}656 - 2{,}83{,}095$$

$$\boldsymbol{LCCP_{06} = \text{Nu. } 61{,}69{,}827}$$

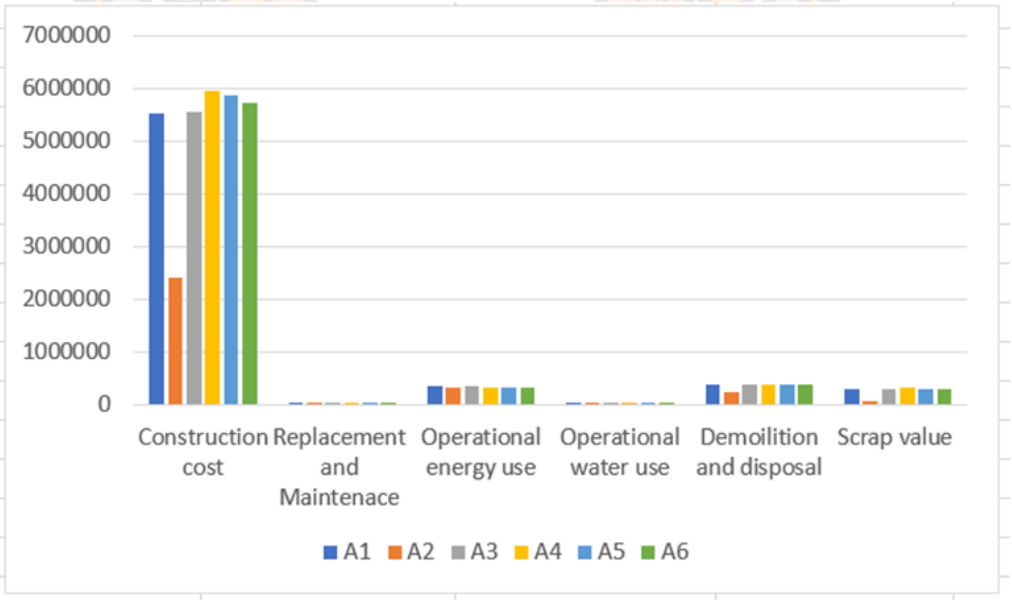


Figure 57 Life Cycle Cost of Building Alternatives (i = 10%)

Building alternative 4 has the highest present value of Nu. 63,70,137 and followed by building alternative 5 with Nu. 63,04,536. Building alternative 2 has the lowest present value of Nu. 29,63,541. The comparative present worth of individual building alternatives are depicted in Figure 57 till 20 years from now. The data shows that a large portion of a residential building's budget is spent on building construction and good amount in operational energy use. The specific amount of money is also spent for operational water use and demolition.

4.32 Rental Calculation of Building Alternatives from LCC (Without Loan)

The rental income for the building alternatives were calculated by using the values from the calculated life cycle costs which was calculated without loan. For the calculation, N was taken 20 years and i is 5%. Here A_{IX} is the annul rental income for building alternative 1. To find the present equivalent amount, the Appendix K was used.

1. Rental income for building alternative 1.

$$LCCP_{01} = A_{I1} \text{ (P/A, 5\%, 20)}$$

$$A_{I1} = \text{Nu. } 61,99716 / (12.4622 \text{ x } 4 \text{ x} 12)$$

$$A_{I1} = \text{Nu. } 10,364$$

2. Rental income for building alternative 2.

$$LCCP_{02} = A_{I2} \text{ (P/A, 5\%, 20)}$$

$$A_{I2} = \text{Nu. } 31,42,177 / (12.4622 \text{ x } 4 \text{ x} 12)$$

$$A_{I2} = \text{Nu. } 5,252$$

3. Rental income for building alternative 3.

$$LCCP_{03} = A_{I3} \text{ (P/A, 5\%, 20)}$$

$$A_{I3} = \text{Nu. } 62,03,623 / (12.4622 \text{ x } 4 \text{ x} 12)$$

$$A_{I3} = \text{Nu. } 10,371$$

4. Rental income for building alternative 4.

$$LCCP_{04} = A_{I4} \text{ (P/A, 5\%, 20)}$$

$$A_{I4} = \text{Nu. } 65,46,251 / (12.4622 \text{ x } 4 \text{ x} 12)$$

$$A_{I4} = \text{Nu. } 10,944$$

5. Rental income for building alternative 5.

$$LCCP_{05} = A_{I5} \text{ (P/A, 5\%, 20)}$$

A_{I5} = Nu. 64,81,562 / (12.4622 x 4 x12)

A_{I5} = Nu. 10,835

6. Rental income for building alternative 6.

$LCCP_{06} = A_{I5}$ (P/A, 5%, 20)

A_{I6} = Nu. 63,47,772 / (12.4622 x 4 x12)

A_{I6} = Nu. 10,611

So, for the return period of 20 years it is evident that the building alternative 2 has the lowest monthly rent of Nu. 5,252 for each unit. Whereas the building alternative 4 and building alternative 5 has the highest monthly rent of Nu. 10,944 and Nu. 10,835 respectively.

4.33 Rental Calculation for Building Alternatives from LCC (With Loan)

The rental income for the building alternatives were calculated by using the values from the calculated life cycle costs with the loan. For the calculation, N was taken 20 years and i is 10%. Here A_{IX} is the annul rental income for building alternative 1. To find the present equivalent amount, the Appendix L was used.

1. Rental income for building alternative 1.

$LCCP_{01} = A_{I1}$ (P/A, 10%, 20)

A_{I1} = Nu. 60,15,042 / (8.5136 x 4 x12)

A_{I1} = Nu. 14,719

2. Rental income for building alternative 2.

$LCCP_{02} = A_{I2}$ (P/A, 10%, 20)

A_{I2} = Nu. 29,63,541 / (8.5136 x 4 x12)

A_{I2} = Nu. 7,252

3. Rental income for building alternative 3.

$LCCP_{03} = A_{I3}$ (P/A, 10%, 20)

A_{I3} = Nu. 60,21,240 / (8.5136 x 4 x12)

A_{I3} = Nu. 14,734

4. Rental income for building alternative 4.

$LCCP_{04} = A_{I4}$ (P/A, 10%, 20)

A_{I4} = Nu. 63,70,137 / (8.5136 x 4 x12)

A_{I4} = Nu. 15,588

5. Rental income for building alternative 5.

$$LCCP_{05} = A_{I5} \text{ (P/A, 10\%, 20)}$$

$$A_{I5} = \text{Nu. } 63{,}04{,}536 / (8.5136 \times 4 \times 12)$$

$$A_{I5} = \text{Nu. } 15{,}428$$

6. Rental income for building alternative 6.

$$LCCP_{05} = A_{I5} \text{ (P/A, 10\%, 20)}$$

$$A_{I5} = \text{Nu. } 61{,}69{,}827 / (8.5136 \times 4 \times 12)$$

$$A_{I5} = \text{Nu. } 15{,}097$$

So, from the above rental calculation the minimum of rent Nu. 7,252 must fixed for the building alternative 2. Whereas the building alternative 4 and building alternative 5 has the highest monthly rent of Nu. 15,588 and Nu. 15,428 respectively for the return period of 20 years.

4.34 B – C Ratio of Building Alternatives for the Return Period of 10 Years (Without Loan)

For the return period of 10 years, the present repair and replacement value is Nu. 9,700 and annual income is Nu. 5,28,000 for four units. The base rental income for building is Nu. 10,000 and rental income was incremented 10% after every 10 years. The B-C ratio was determined for the study period of 10 years and a MARR of 5%. The Appendix K was used for calculation. Figure 58 shows the cash flow diagram for the return period of 10 years.

$$\textbf{B-C} = \frac{PW(B)}{I + PW(O\&M)}$$

Present worth of annual rental income is given by following formula.

$$PW(B) = A_x \text{ (P/A, i\%, N)}$$

$$PW(O\&M) = P_{R(z)}$$

$$P_{R10} = F_{10} \text{ (P/F, 5\%, 10)}$$

$$P_{R10} = \text{Nu. } 15{,}800.40 \ (0.6139)$$

$$P_{R10} = \textbf{Nu. 9,700}$$

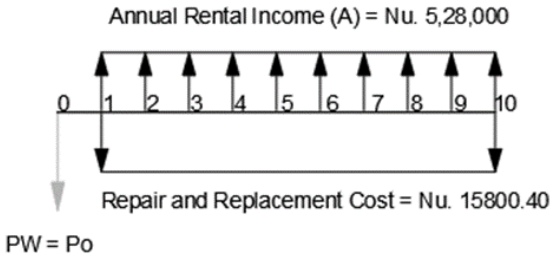


Figure 58 Cash Flow Diagram for the Return Period of 10 Years

Here, the A_x is the annual rental income after 10 years of return period. P_W (O&M) is present value of operation and maintenance, and $P_{R(z)}$ is the present value of repair and replacement. The Table 13 shows the B-C ratio for the monthly rent of Nu.11,000. The return period of 10 years is enough for building alternative 2 since the B-C ratio is greater than 1. But for the building alternative 1, building alternative 3, building alternative 4, building alternative 5 and building alternative 6 the B-C ratio is less than 1. So, therefore, 10 years of return period is not enough for owner to recover the initial investment.

Table 13 B-C Ratio for Building Alternatives for the Return Period of 10 Years

Building Alternatives	Monthly Rent (Nu)	B-C Ratio	Remarks
A1	11,000	0.73	Not acceptable
A2	11,000	1.69	Acceptable
A3	11,000	0.73	Not acceptable
A4	11,000	0.68	Not acceptable
A5	11,000	0.69	Not acceptable
A6	11,000	0.71	Not acceptable

4.35 B – C Ratio of Building Alternatives for the Return Period of 20 Years (Without Loan)

For the return period of 20 years, the present repair and replacement value is Nu. 15,655. The monthly rent was fixed Nu. 12,100. Applying the B-C ratio for the study period of 20 years and a MARR of 5% per year. The B-C ratio was determined

for the study period of 20 years and a MARR of 5%. The Appendix K was used for calculation. Figure 59 shows the cash flow diagram for the return period of 20 years.

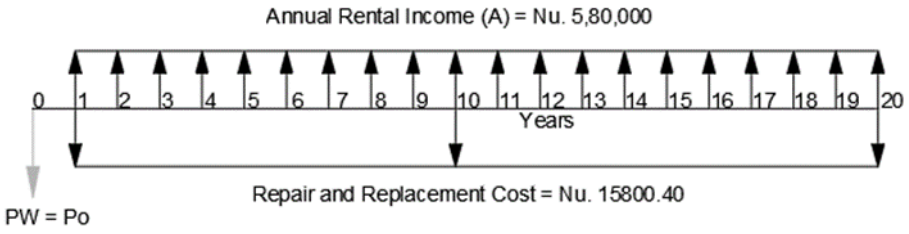


Figure 59 Cash Flow Diagram for the Return Period of 20 Years (i = 5%)

$$\textbf{B-C} = \frac{PW(B)}{I + PW(O\&M)}$$

Present worth of annual rental income is given by following formula.

$$PW(B) = A_x\ (P/A, i\%, N)$$

$$PW(O\&M) = P_{R(z)}$$

$$P_{R20} = F_{10}\ (P/F, 5\%, 10) + F_{20}\ (P/F, 5\%, 20)$$

$$P_{R20} = \text{Nu. } 15{,}800.40\ (0.6139) + \text{Nu. } 15{,}800.40\ (0.3769)$$

$$P_{R20} = \textbf{Nu. 15,655}$$

The Table 14 shows the B-C ratio for the monthly rent of Nu.12,100. The return period of 20 years is enough for all the building alternatives since the B-C ratio is greater than 1. So, therefore, the return period of 20 years is enough for owner to fully recover the initial investment if no loan is taken from the bank.

Table 14 B-C Ratio for Building Alternatives for the Return Period of 20 Years (i=5%)

Building Alternatives	Monthly Rent (Nu)	B-C Ratio	Remarks
A1	12,100	1.31	Acceptable
A2	12,100	2.99	Acceptable
A3	12,100	1.30	Acceptable

Building Alternatives	Monthly Rent (Nu)	B-C Ratio	Remarks
A4	12,100	1.28	Acceptable
A5	12,100	1.23	Acceptable
A6	12,100	1.26	Acceptable

4.36 B – C Ratio of Building Alternatives for the Return Period of 20 Years (with Loan)

For the return period of 20 years, the present repair and replacement value is Nu. 8,439. The base rental income for building is Nu. 10,000 and rental income was incremented 10% after every 10 years. The B-C ratio was determined for the study period of 20 years and a MARR of 10%. The Appendix L was used for calculation. Figure 60 shows the cash flow diagram for the return period of 20 years.

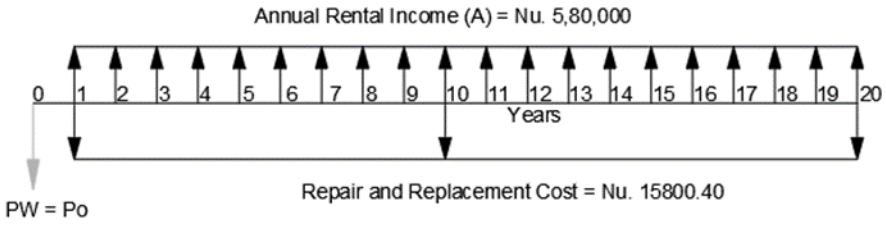


Figure 60 Cash Flow Diagram for the Return Period of 20 Years (i = 10%)

$$\textbf{B-C} = \frac{PW(B)}{I + PW(O\&M)}$$

Present worth of annual rental income is given by following formula.

$$PW(B) = A_x\ (P/A, i\%, N)$$

$$PW(O\&M) = P_{R(z)}$$

$$P_{R20} = F_{10}\ (P/F, 10\%, 10) + F_{20}\ (P/F, 10\%, 20)$$

$$P_{R20} = \text{Nu. } 15{,}800.40\ (0.3855) + \text{Nu. } 15{,}800.40\ (0.1486)$$

$$P_{R10} = \textbf{Nu. 8,439}$$

Here, the A_x is the annual rental income after 20 years of return period. P_W (O&M) is present value of operation and maintenance, and $P_{R(z)}$ is the present value of repair and replacement. The Table 15 shows the B-C ratio for the monthly rent of Nu.12,100. The return period of 20 years is enough for building alternative 2 since the

B-C ratio is greater than 1. But for the building alternative 1, building alternative 3, building alternative 4, building alternative 5 and building alternative 6 the B-C ratio is less than 1. So, therefore, 20 years of return period is not enough for owner to recover the initial investment if the owner has taken loan from bank.

Table 15 B-C Ratio for Building Alternatives for the Return Period of 20 Years (i=10%)

Building Alternatives	Monthly Rent (Nu)	B-C Ratio	Remarks
A1	12,100	0.89	Not acceptable
A2	12,100	2.05	Acceptable
A3	12,100	0.89	Not acceptable
A4	12,100	0.83	Not acceptable
A5	12,100	0.84	Not acceptable
A6	12,100	0.87	Not acceptable

4.37 B – C Ratio of Building Alternatives for the Return Period of 30 Years (with Loan)

For the return period of 30 years, the present repair and replacement value is Nu. 9,344. The base rental income for building is Nu. 10,000 and rental income was incremented 10% after every 10 years. The B-C ratio was determined for the study period of 30 years and a MARR of 10%. The Appendix L was used for calculation. Figure 61 shows the cash flow diagram for the return period of 30 years.

$$\textbf{B-C} = \frac{PW(B)}{I+PW(O\&M)}$$

Present worth of annual rental income is given by following formula.

$$PW(B) = A_x\ (P/A, i\%, N)$$

$$PW(O\&M) = P_{R(z)}$$

$$P_{R20} = F_{10}\ (P/F, 10\%, 10) + F_{20}\ (P/F, 10\%, 20) + F_{30}\ (P/F, 10\%, 30)$$

$$P_{R20} = \text{Nu. } 15{,}800.40\ (0.3855) + \text{Nu. } 15{,}800.40\ (0.1486) + \text{Nu. } 15{,}800.40\ (0.0573)$$

$$P_{R10} = \textbf{Nu. 9,344}$$

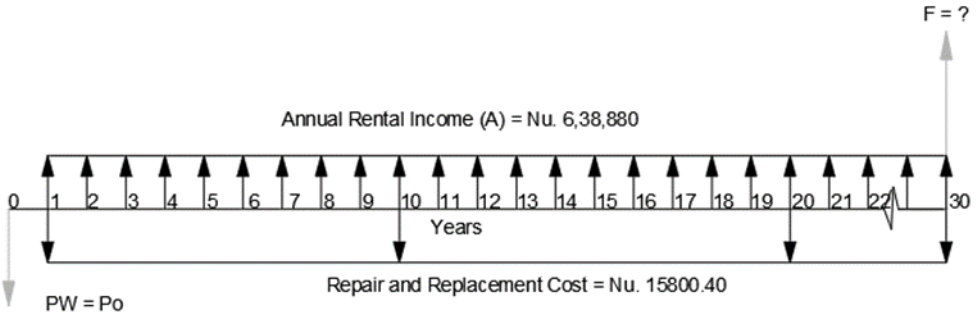


Figure 61 Cash Flow Diagram for the Return period of 30 Years (i = 10%)

Table 16 B-C Ratio for Building Alternatives for the Return Period of 30 Years (i=10%)

Building Alternatives	Monthly Rent (Nu)	B-C Ratio	Remarks
A1	13,310	1.08	Acceptable
A2	13,310	2.50	Acceptable
A3	13,310	1.08	Acceptable
A4	13,310	1.01	Acceptable
A5	13,310	1.02	Acceptable
A6	13,310	1.05	Acceptable

Here, the A_x is the annual rental income after 25 years of return period. P_W (O&M) is present value of operation and maintenance, and $P_{R(z)}$ is the present value of repair and replacement. The Table 16 shows the B-C ratio for the monthly rent of Nu.13,310. The return period of 30 years is enough for all the building alternatives since the B-C ratio is greater than 1. So, therefore, the return period of 30 years is enough for owner to fully recover the initial investment if loan is taken from the bank.

CHAPTER V

CONCLUSION

5.1 Study Summary

In this study the two storied Bhutanese residential apartment was sub-categorized into six alternatives which was classified based on floor and wall attributes. Each building alternative can accommodate total of four families. The simulation result has shown that each building alternatives can consume energy of 15301.43 kWh per year amounting to Nu. 37488.50. CIBSE heat loss tool was used for computing the heat loss from the building alternatives and it depicts that the heat lost occurs through the walls, roof, floor, partitions, glazing and infiltration. For the building alternative 1, building alternative 2, building alternative 3, the walls are constructed with concrete block wall, stone masonry wall and brick wall respectively. The result depicted that the brick wall and concrete block wall losses more heat while stone wall can retain maximum heat. While in building alternative 4, building alternative 5, and building alternative 6, the walls are constructed with insulated components like aerated concrete block, EPS insulation, air gap, lgt plast. It was observed that the walls with the better insulation can retain maximum heat and losses minimum heat. The heat loss comparison was done between the six building alternatives, and it was observed that heat loss from the walls varied greatly, but heat losses from the roof, floor, partitions, glass, and infiltration did not. Building alternatives 4 and 5 save the maximum energy of 27% and 25% respectively. The heat gain in building models was computed using CIBSE heat gain tool. It was observed from the heat gain result that the building receives heat in the form of solar, fabric, casual, convective, and latent heat. Building alternative 2 (building model constructed with stone wall and timber flooring) and building alternative 4 (building model constructed with concrete slab and well insulated wall) allows maximum heat inside the building structure while compared to building alternative 1(building model constructed with concrete slab flooring and concrete block wall) and building alternative 3 (building model constructed with concrete slab flooring and brick wall).

The total construction cost estimate for building alternatives were worked out in excel incorporating the Bhutan schedule rate. The result reflected that the building alternative 2 constructed with stone wall and timber flooring has a minimum construction cost of Nu. 2399006.48, while it was observed that the building alternative 1 (building model constructed with concrete slab flooring and concrete block wall) and building alternative 3 (building model constructed with concrete slab flooring and brick wall) have a total construction cost of Nu. 5528767.10 and Nu. 5540489.40 respectively.

Building alternative 2 has lower construction cost in terms of wall and flooring, while on building alternative 1 and building alternative 3 had higher cost. The cost was escalated in the building alternative 1 and building alternative 3 due to the use of modern materials like concrete, reinforcement, plastering work on walls, floor, and ceiling. The cost estimated result showed that the building alternative 4 and building alternative 5 have the highest construction cost of Nu. 5931026.58 and Nu. 5848603.77 respectively. The construction cost for stone masonry wall was Nu. 89557.67, whereas the construction cost of wall for building alternative 4 (Brick 105mm, airgap 25mm, EPS insul, 25mm, aer conc blk (500) 150mm, lgt plast. 13mm) was Nu. 825583.23. It was found out that the construction cost for building increases as the better insulated materials are being used but the energy performance for insulated walls is much better while compared to uninsulated walls. The study also revealed that a two-story residential building in Bhutan will cost Nu. 484391 for timber flooring and Nu. 946940.86 for concrete flooring.

The present worth of six building alternatives were computed using the present worth method for the return period of 20 years. Here, the assumption was that the owner had used the money from his saving. Present worth of annual water consumption and annual repair and replacement was Nu. 60,566 and Nu.15,655 respectively. Building alternatives 1, 2, 3, 4, 5, and 6 are currently worth Nu.61,99,716, Nu. 31,42,177, Nu. 62,03,623, Nu. 65,46,251, Nu. 64,81,562, and Nu. 63,47,772 for the return period of 20 years. As a result, it is evident that building alternative 2 has the lowest present value while building alternative 4 has the highest present value. The result shows that a large portion of a residential building's budget

is spent on building construction and good amount in operational energy use. The specific amount of money is also spent for operational water use and demolition.

B-C ratio was computed for six building alternatives. The return period of 20 years is enough for the building owner to fully recover the initial investment if no loan is taken from the bank. But if the owner takes the full loan for construction than minimum of 30 years is required for owner to fully pay the interest and initial investment.

5.2 Future Work

The research was confined to only two-story residential flats in this study; however, in the future, the researcher could concentrate on higher-story apartments with larger dimensions. The analysis also revealed that building alternative 2 has the lowest construction expenses, therefore the structure with timber flooring and stone walls will save the most money. It is preferable to choose this option if the building owner is constructing a two-story residential building. Building alternative two has the cheapest construction, saving up to 50% when compared to other building alternatives, and it has better heat performance that can retain more heat in winter thus improves the comfort of the people. Brick and concrete block walls without insulation are not advised in Bhutan's chilly regions since these types of walls can lose the most heat. However, if appropriate insulation is supplied, the brick wall is highly recommended. Timber flooring can be used in Bhutan since it is less expensive and has superior heat resistance.

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APPENDIX

APPENDIX A DETAIL ESTIMATE FOR BUILDING ALTERNATIVE 1

Sl. no	**BSR CODE**	**Item Description**	**No**	L	B	H	Qty.	Unit	**Rate**	**Amount**
1	**EW0001**	Surface dressing of ground, including removal of vegetations and inequalities < 150mm deep, disposal of rubbish within 50m in Ordinary Soil	1	21	11		**231**	*sq.m*	12.77	**2949.87**
2	**EW0030**	**Earth work** in excavation over areas, depth >300mm, width >1.5m, area >10 Sq.m on plan, including disposal of excavated earth within 50m lead and 1.5m liff & disposed soil to be neatly dressed. In ordinary Soil								
		Long Walls…..	3	20.40	1.6	1.6	156.67			
		Short Walls…..	6	7.90	1.6	1.6	121.34			
						Total	**278.02**	*cum*	162.02	**45044.15232**
3	**SM0005**	Providing & laying Random Rubble Masonry with hard stone in foundation & plinth In cement mortar 1:4								
		Stone soling for footing…..	18	1.6	1.6	0.15	6.91			
		Stone soling for external and Internal walls…..								
		Long Walls…..	2	19.6	0.8	0.15	4.70			
		Long wall front part…...	1	16.95	0.8	0.15	2.03			
		Short Walls…..	6	8.9	0.6	0.15	4.81			
						Total	**18.46**	*cum*	4970.70	**91739.2392**
4	**CW0006**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 40 mm nominal size)								
		P.C.C in footing level.	18	1.6	1.6	0.10	4.61			
		P.C.C for external and Internal walls…..								
		Long Walls…..	2	19.6	0.8	0.10	3.14			
		Long wall front part…...	1	16.95	0.8	0.10	1.36			
		Short Walls…..	6	8.9	0.6	0.10	3.20			

						Total	**12.30**	*cum*	5095.15	**62690.7256**
5	**SM0005**	Providing & laying Random Rubble Masonry with hard stone in foundation & plinth, In cement mortar 1:4								
		Long Walls…..	2	19.25	0.45	0.60	10.40			
		Long wall front part…...	1	16.60	0.45	0.60	4.48			
		Short Walls…..	6	9.10	0.40	0.60	13.10			
						Total	**27.98**	*cum*	4970.70	**139085.1567**
6	**BW0012**	Extra for concrete block brick work in superstructure above plinth level, up to floor two level								
		Long Wall…..	1	19.05	0.25	6.48	30.86			
		Long wall front part…...	1	16.49	0.25	6.48	26.71			
		Long walls at main entry…..	2	5.65	0.25	6.48	18.31			
		Short Walls…..	2	9.25	0.105	6.48	12.59			
		Internal Partition wall…..								
		Partition Walls 1…..	2	9.25	0.125	6.48	14.99			
		Partition Walls 2…..	2	3.68	0.125	6.48	5.95			
		Partition Walls 3…..	2	4.45	0.125	6.48	7.21			
		Partition Walls 4…..	2	3.68	0.125	6.48	5.95			
		Partition Walls 5…..	2	3.50	0.125	6.48	5.67			
		Partition Wall 6..…..	2	3.20	0.125	6.48	5.18			
		External front wall…...	1	3.85	0.25	5.02	4.83			
		Total quantity of concrete block bricks without deduction					**138.25**			
		Doors and Windows deduction								
		Doors……....								
		D1….	4	1.05	0.25	2.10	2.21			
		D2….	8	0.95	0.125	2.10	2.00			
		D3….	4	0.85	0.25	2.10	1.79			
		D4….	4	0.85	0.125	2.10	0.89			
		D5….	8	0.85	0.125	2.10	1.79			
		Windows & Cornices….....								
		W1…..	2	2.78	0.25	1.76	2.44			
		W2…..	12	2.10	0.25	1.76	11.09			
		W3…..	1	2.10	0.25	2.78	1.46			
		W4…..	2	2.76	0.25	2.01	2.77			

		W5…..	4	2.10	0.25	2.01	4.22			
		W6…..	4	1.50	0.25	1.36	2.04			
		W7…..	8	0.75	0.25	1.36	2.04			
						Total deduction	**34.72**			
		Total quantity of concrete block bricks after deduction…					**103.54**	*cum*	331.47	**34319.64556**
		Flooring work (First Floor)								
7	**EW0197**	Providing & laying dry earth bedding, including consolidating each deposited layer by watering, ramming and dressing	1	19.15	9.85	0.5	**94.31**	*cum*	213.30	**20117.12288**
8	**SM0072**	Providing and laying Hand packed stone filling or soling with stones								
		Master Bed Room…..	2	3.68	3.73	0.15	4.12			
		Bed Room…..	2	3.83	3.48	0.15	4.00			
		Common Toilet…..	2	1.90	2.63	0.15	1.50			
		Toilet…..	2	1.80	2.65	0.15	1.43			
		Kitchen…..	2	3.20	3.48	0.15	3.34			
		Dinning room…..	2	3.78	5.90	0.15	6.69			
						Total	**21.08**	*cum*	1697.03	**35769.89652**
9	**FL0051**	Pal cement concrete flooring 1:2:4, finished with floating coat of neat cement 20mm aggregates, 40mm thick								
		Master Bed Room…..	2	3.68	3.73		27.45			
		Bed Room…..	2	3.83	3.48		26.66			
		Common Toilet…..	2	1.90	2.63		9.99			
		Toilet…..	2	1.80	2.65		9.54			
		Kitchen…..	2	3.20	3.48		22.27			
		Dinning room…..	2	3.78	5.90		44.60			
						Total	**140.52**	*sq.m*	415.75	**58421.0237**
		Flooring work (Second Floor)								
10	**RC0014**	Providing & laying in position reinforced cement concrete work in suspended floor, roofs having slope upto 15o, landings,balconies, shelves and chajjas upto floor five level excluding the cost of centering, shuttering and reinforcement 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm								

		nominal size)								
		Flooring Slab	1	19.15	9.85	0.15	28.29			
		Balcony Slab	2	3.90	1.20	0.15	1.40			
		Roof Slab	1	19.15	9.85	0.14	26.41			
						Total	**56.11**	*cum*	6961.70	**390592.9662**
		Concrete Work in Footing, Beams, Columns								
11	**RC0010**	Providing & laying in position reinforced cement concrete work in plinth and skirting courses, fillets, columns , pillars, posts and struts upto floor five level excluding the cost of centering, shuttering and reinforcement.								
		Footing(500mm P.C.C)	18	1.60	1.60	0.50	23.04			
		Column….....	18	8.68	0.40	0.40	25.00			
						Total	**48.04**	*cum*	6795.46	**326443.0257**
12	**RC0018**	Providing & laying in position reinforced cement concrete work in beams, lintels, bands, plain window sills, staircases, spiral staircases upto floor five level excluding the cost of centering, shuttering and reinforcement								
		Beams ….	9	18.8	0.40	0.30	20.30			
		Beams ….	18	9.5	0.40	0.30	20.52			
						Total	**40.82**	*cum*	6790.57	**277218.2297**
		Plastering work								
13	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement 20mm plaster in C.M 1:4								
		Plastering on External wall	2	19.15	6.48		248.184			
			4	9.85	6.48		255.312			

			4	8	6.48		207.36			
			4	5.9	6.48		152.928			
						Total	**863.784**			
		Doors and Window Deduction								
		Windows & Cornices….....								
		W1…..	4	2.78		1.76	19.48			
		W2…..	24	2.10		1.76	88.70			
		W3…..	2	2.10		2.78	11.66			
		W4…..	4	2.76		2.01	22.19			
		W5…..	8	2.10		2.01	33.77			
		W6…..	8	1.50		1.36	16.32			
		W7…..	16	0.75		1.36	16.32			
		Doors….....								
		D1….	4	1.05		2.10	8.82			
						Total deduction	**217.26**			
			Total after deduction				**646.53**	*sq.m*	359.57	**232471.3898**
14	**PL0031**	Providing & laying 15mm cement plaster on rough side of single or half-brick wall C.M 1:4								
		Partition Walls 1…..	4	9.25		6.48	239.76			
		Partition Walls 2…..	4	3.68		6.48	95.26			
		Partition Walls 3…..	4	4.45		6.48	115.34			
		Partition Walls 4…..	4	3.68		6.48	95.26			
		Partition Walls 5…..	4	3.50		6.48	90.72			
		Partition Wall 6..…..	4	3.20		6.48	82.94			
						Total	**719.28**			
		Doors Deduction								
		D2….	16	0.95		2.10	31.92			
		D3….	8	0.85		2.10	14.28			
		D4….	8	0.85		2.10	14.28			
		D5….	16	0.85		2.10	28.56			
						Total	**89.04**			
			Total after deduction				**630.24**	*sq.m*	248.37	**156532.7088**
		Floor plastering								
15	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement. 20mm plaster in C.M 1:4								
		Master Bedroom	2	3.68	3.73		27.45			
		Bed Room	2	3.83	3.48		26.66			

		Toilet 1	2	2.63	1.9		9.99			
		Toilet 2	2	2.65	1.8		9.54			
		Dinning Room	2	5.9	3.78		44.60			
		Kitchen	2	3.2	3.48		22.27			
							140.52	*sq.m*	359.57	**50526.63257**
16	**PL0011**	Providing & laying 6mm cement plaster (in Ceiling) (C.M 1:4)								
		Master Bedroom	4	3.68	3.73		54.91			
		Bed Room	4	3.83	3.48		53.31			
		Toilet 1	4	2.63	1.9		19.99			
		Toilet 2	4	2.65	1.8		19.08			
		Dinning Room	4	5.9	3.78		89.21			
		Kitchen	4	3.2	3.48		44.54			
						Total	281.04	*sq.m*	160.79	**45188.29297**
		Traditional Cornices								
		Bhutan type Traditional Cornices in R.C.C 1:1.5:3, 20 mm aggregate including cost of formwork including finishing with 6mm thick plaster on the exposed surface with cement mortar 1:3, excluding reinforcement & decorative painting cost as per standard design (Measurement to be taken along the cornice and wall junction)								
17	**RC0031**	Multi-Storied building..at floor 2 level including the cost of lhanglag and at other floors where Lhanglag is provided								
		Rabsey 1	2	4.35			8.7	*m*	2843.55	**24738.885**
		Rabsey 2	4	2.10			8.4		2843.55	**23885.82**
18	**RC0003**	Providing & laying in position reinforced cement concrete excluding the cost of centering, shuttering and reinforcement - all work upto plinth level								
		R.C.C Bogh	120	0.3	0.125	0.1	0.45			

			20	0.3	0.125	0.1	0.08			
						Total	**0.53**	*cum*	6059.32	**3181.143**
		Traditional Painting								
19	**PT0100**	Providing, preparing and applying Sumdang painting (Not washable)								
		Rab….....	4	2.75	1		11			
			24	2.1	1		50.4			
			4	2.78	0.5		5.56			
			8	2.1	0.5		8.4			
			2	2.1	1		4.2			
			16	0.44	0.5		3.52			
			8	1.5	0.5		6			
			8	1.05	0.50		4.2			
			16	0.95	1.00		15.2			
			8	0.85	0.50		3.4			
			8	0.85	0.50		3.4			
			16	0.85	1.00		13.6			
						Total	**128.88**		1284.53	**165550.2264**
		Stair Case								
		Providing & laying in position reinforced cement concrete work in beams, lintels, bands, plain window sills, staircases, spiral staircases upto floor five level excluding the cost of centering, shuttering and reinforcement								
20	**RC0018**	1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Base Slab….	1	3.46	1.33	0.16	0.74			
		Riser and Tread….	16	1.33	0.02		0.48			
		Base Slab….	1	1.54	1.33	0.16	0.33			
						Total	1.54	*cum*	6790.57	**10476.49**
		Stair case landing	1	2.65	1.2	0.15	0.48			
			1	1.33	2.3	0.15	0.46			
						Total	0.94	*cum*	6790.57	**6354.95**
		Plinth Protection Wall								

21	**SM0072**	Providing and laying Hand packed stone filling or soling with stones								
		Length Wise….....	2	22.65	1.75	0.15	11.89			
		Breath Wise….....	2	9.85	1.75	0.15	5.17			
						Total	17.06	*cum*	1697.03	**28955.57438**
22	**CW0002**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level.								
		1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Length Wise….....	2	22.1	1.475	0.1	6.52			
		Breath Wise….....	2	9.85	1.475	0.1	2.91			
						Total	9.43	*cum*	6661.50	**62786.30288**
23	**CW0009**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level.1:4:8 (1 cement : 4 sand : 8 graded crushed stone 50 mm nominal size)								
			2	22.1	1.475	0.05	3.26			
			2	9.85	1.475	0.05	1.45			
						Total	4.71	*cum*	4372.85	**20607.60223**
24	**BW0002**	Providing & laying Second-Class Brick work in Foundation & Plinth. In cement mortar 1:4								
		Length Wise….....	4	22.65	0.125	0.325	3.68			
		Breath Wise….....	4	9.85	0.125	0.325	1.60			
			2	22.65	0.125	0.25	1.42			
			2	9.85	0.125	0.25	0.62			
						Total	7.31	*cum*	9310.91	**68086.02938**
25	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement 20mm plaster in C.M								

		1:4								
			4	22.65	0.2		18.12			
			4	9.85	0.2		7.88			
			2	22.65	0.25		11.33			
			2	9.85	0.25		4.93			
						Total	42.25	*sq.m*	359.57	**15191.8325**
		Column Reinforcement								
26	**RC0083**	Providing & fixing Thermo-Mechanically Treated reinforcement bar (Yield Strength 500 MPa) for R.C.C work including cutting, bending, binding and placing in position complete								
		20mm Dia main bar reinforcement @ 2.469kg/m	18	8	9.86	2.47	3505.58			
		25mm Dia main bar reinforcement @ 3.858kg/m	18	4	9.86	3.858	2738.87			
		8mm Dia stirrups reinforcement @ 0.395 kg/m	18	134	1.264	0.395	1204.26			
		Splicing								
		20mm Dia main bar reinforcement @ 2.469kg/m	18	4	2.35	2.469	417.75			
		25mm Dia main bar reinforcement @ 3.858kg/m	18	2	2.35	3.858	326.39			
		Beam Reinforcement								
		Plinth &Roof Beam reinforcement								
		20mm Dia main bar reinforcement @ 2.469kg/m	12	2	21.1	2.469	1250.30			
		16mm Dia main bar reinforcement @ 1.58kg/m	12	2	21.1	1.58	800.11			
		20mm Dia Top reinforcement @ 2.469kg/m	12	2	21.1	2.469	1250.30			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	12	2	19.88	2.469	1178.01			
		8mm Dia stirrups reinforcement @ 0.395 kg/m for **Plinth beam, First floor, roof beam**	8	146	1.26	0.395	581.31			
			1	126	1.26	0.395	62.71			

		First Floor Beam								
		20mm Dia main bar reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		16mm Dia main bar reinforcement @ 1.58kg/m	2	2	21.1	1.58	133.35			
		20mm Dia Top reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		20mm Dia main bar reinforcement @ 2.469kg/m	2	2	10.2	2.469	100.74			
		16mm Dia main bar reinforcement @ 1.58kg/m	2	2	10.2	1.58	64.46			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	2	2	16.88	2.469	166.71			
		20mm Dia Top reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	2	2	19.88	2.469	196.33			
						Total	14602.35	***Kg***	**89.38**	**1305158.34**
		Reinforcement Qty. Cal. In shorter length Dir.Pinth beam, first floor and Roof								
		16mm Dia main bar reinforcement @ 1.58kg/m	8	4	10.7	1.58	540.99			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	2	11.25	1.58	284.40			
		20mm Dia main bar reinforcement @ 2.469kg/m	8	2	11.25	2.469	444.42			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	4	11.00	1.58	556.16			
		20mm Dia main bar reinforcement @ 2.469kg/m	8	2	11.38	2.47	449.56			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	2	10	1.58	252.80			
		Stirrups 8mmdia @ 0.395kg/m	8	82	1.04	0.395	269.48			
			10	74	1.04	0.395	303.99			
						Total	3101.80	***Kg***	**89.38**	**277239.27**
27	**RC0083**	Providing & fixing Thermo-Mechanically Treated reinforcement bar (Yield Strength 500 MPa) for R.C.C work including cutting, bending, binding and								

		placing in position complete								
		Slab and Roof slab Reinforcement								
		Bottom reinforcnement								
		10mm Dia main bar reinforcement @ 0.617kg/m	26	18.8	2	0.62	603.18			
		10mm Dia main bar reinforcement @ 0.617kg/m	105	4.75	2	0.62	615.46			
		10mm Dia main bar reinforcement @ 0.617kg/m	52	7.9	2	0.62	506.93			
		10mm Dia main bar reinforcement @ 0.617kg/m	88	4.75	2	0.62	515.81			
		Balcony Reinforcement								
		10mm Dia main bar reinforcement @ 0.617kg/m	4	7	3.9	0.62	67.70			
		10mm Dia main bar reinforcement @ 0.617kg/m	4	22	3.9	0.62	212.78			
		Top reinforcement								
		10mm Dia main bar reinforcement @ 0.617kg/m	26	11.28	2	0.62	361.91			
		10mm Dia main bar reinforcement @ 0.617kg/m	105	2.90	2	0.62	375.75			
		10mm Dia main bar reinforcement @ 0.617kg/m	52	4.68	2	0.62	300.31			
		10mm Dia main bar reinforcement @ 0.617kg/m	88	2.90	2	0.62	314.92			
						Total	3874.75	***Kg***	**89.38**	**346324.93**
		Footing Reinforcement								
		12mm Dia main bar bot. reinforcement @ 0.89kg/m	18	22	2.6	0.89	916.34			
		12mm Dia main bar top reinforcement @ 0.89kg/m	18	18	2.6	0.89	749.74			
						Total	1666.08	***Kg***	**89.38**	**148914.23**
		Windows(Mixed Conifer)								
28	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed, Mixed conifer								
		Window Frame bottom (**Window 1**)	4	2.78	0.20	0.10	0.22			
		Window side frame	4	1.50	0.20	0.10	0.12			
		Kachung	10	1	0.08	0.065	0.05			
		Jugshing	2	2.58	0.065	0.065	0.02			

		Horzhu	2	2.58	0.15	0.065	0.05			
		Window Frame bottom (**Window 2**)	24	2.10	0.2	0.1	1.008			
		Window side frame	24	1.50	0.20	0.10	0.72			
		Kachung	60	1.00	0.08	0.065	0.312			
		Jugshing	12	1.9	0.065	0.065	0.10			
		Horzhu	12	1.9	0.15	0.065	0.22			
		Window Frame bottom (**Window 3**)	2	2.10	0.2	0.1	0.08			
		Window side frame	2	2.00	0.20	0.10	0.08			
		Kachung	1	1.50	0.08	0.065	0.01			
		Jugshing	1	1.9	0.065	0.065	0.01			
		Horzhu	1	1.9	0.15	0.065	0.02			
		Window Frame bottom (**Window 4**)	4	2.78	0.20	0.1	0.22			
		Window side frame	4	1.86	0.20	0.10	0.15			
		Kachung	2	1.36	0.08	0.065	0.01			
		Jugshing	2	2.58	0.065	0.065	0.02			
		Horzhu	2	2.58	0.15	0.065	0.05			
		Window Frame bottom (**Window 5**)	4	2.10	0.20	0.1	0.17			
		Window side frame	4	1.86	0.20	0.10	0.15			
		Kachung	2	1.36	0.08	0.065	0.01			
		Jugshing	2	1.90	0.065	0.065	0.02			
		Horzhu	2	1.90	0.15	0.065	0.04			
		Window Frame bottom (**Window 6**)	8	1.50	0.13	0.1	0.15			
		Window side frame	8	1.10	0.13	0.10	0.11			
		Kachung	4	0.67	0.08	0.065	0.01			
		Horzhu	4	1.12	0.15	0.065	0.04			
		Window Frame bottom (**Window 7**)	16	0.75	0.13	0.1	0.15			
		Window side frame	16	1.10	0.13	0.10	0.22			
		Kachung	16	0.67	0.08	0.065	0.06			
		Horzhu	8	0.55	0.15	0.065	0.04			
						Total	4.65	*cum*	26522.54	**123363.16**
		Door (Oak Tree)								
29	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed, Mixed conifer								

		Door1…....								
		Top frame	4	1.05	0.1	0.125	0.05			
		Side frame	8	2.1	0.1	0.13	0.22			
		Door panel	4	2	0.85	0.035	0.24			
		Door2…....								
		Top frame	16	0.95	0.1	0.125	0.19			
		Side frame	32	2.1	0.1	0.13	0.87			
		Door panel	16	2	0.75	0.035	0.84			
		Door3…....								
		Top frame	8	0.85	0.1	0.125	0.09			
		Side frame	16	2.1	0.1	0.13	0.44			
		Door panel	8	2	0.65	0.035	0.36			
		Door4…....								
		Top frame	8	0.85	0.1	0.125	0.09			
		Side frame	16	2.1	0.1	0.13	0.44			
		Door panel	8	2	0.65	0.035	0.36			
						Total	4.18	*cum*	26522.54	**110972.96**
		Roof Truss								
30	**SW0022**	Steel work welded, in built up sections, trusses, frame-works including cutting, hoisting, fixing and appl. priming coat of red								
		Truss 1(T1)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	8	2.67	6.53		139.48			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	2.60	6.53		135.82			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	0.89	5.1		36.31			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.60	5.1		24.48			
		Truss 2(T2)…....								
		Top Chord or Rafter (76.1ØM ,	8	4.06	6.53		212.09			

		6.53KG/M)….....								
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	3.95	6.53		206.35			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.21	5.1		49.37			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.36	5.1		55.49			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.68	5.1		27.74			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.91	5.1		37.13			
		Truss 3(T3)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)…….	8	5.46	6.53		285.23			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	5.32	6.53		277.92			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.33	5.1		54.26			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.48	5.1		60.38			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.67	5.1		68.14			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.71	5.1		28.97			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.97	5.1		39.58			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	1.23	5.1		50.18			
		Truss 4(T4)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	2	6.88	6.53		89.85			
		Bottom Chord or Tie (76.1ØM ,	2	6.61	6.53		86.33			

		6.53KG/M)….....								
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.07	5.1		10.91			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.38	5.1		14.08			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.54	5.1		15.71			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.73	5.1		17.65			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.96	5.1		19.99			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.23	5.1		2.35			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.45	5.1		4.59			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.72	5.1		7.34			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.995	5.1		10.15			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	1.27	5.1		12.95			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	1.55	5.1		15.81			
		Truss 5(T5)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)…..	14	6.88	6.53		628.97			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	14	6.69	6.53		611.60			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.07	5.1		76.40			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.38	5.1		98.53			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.54	5.1		109.96			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.73	5.1		123.52			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.96	5.1		139.94			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.23	5.1		16.42			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.45	5.1		32.13			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.72	5.1		51.41			
		Strut(Vertical) (60.3Ø M,	14	0.995	5.1		71.04			

		5.1KG/M)….....								
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	1.27	5.1		90.68			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	1.55	5.1		110.67			
		Truss 6(T6)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	4	9.6	6.53		250.75			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	4	9.48	6.53		247.62			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.28	5.1		26.11			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.49	5.1		30.40			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.61	5.1		32.84			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.74	5.1		35.50			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.88	5.1		38.35			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	2.06	5.1		42.02			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.25	5.1		5.10			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.45	5.1		9.18			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.67	5.1		13.67			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.89	5.1		18.16			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.11	5.1		22.64			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.33	5.1		27.13			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.55	5.1		31.62			
						Total	5303.20	Kg	86.59	**459204.16**
		Purlin								
		Purlin (76.1ØM , 6.53KG/M)….....	2	23.05	6.53		301.03			
		Purlin (76.1ØM , 6.53KG/M)….....	2	13.75	6.53		179.58			
		Purlin (76.1ØM , 6.53KG/M)….....	2	19.15	6.53		250.10			
		Purlin (76.1ØM , 6.53KG/M)….....	2	9.85	6.53		128.64			
		Purlin (76.1ØM , 6.53KG/M)….....	2	17.15	6.53		223.98			

		Purlin (76.1ØM , 6.53KG/M)….....	2	7.85	6.53		102.52			
		Purlin (76.1ØM , 6.53KG/M)….....	2	15.15	6.53		197.86			
		Purlin (76.1ØM , 6.53KG/M)….....	2	5.85	6.53		76.40			
						Total	1460.11	Kg	86.59	**126430.75**
31	**RF0003**	Providing & fixing Pre Painted Steel Corrugated Roofing sheets, including bolts, hooks and nuts 8mm dia. with bitumen and G.I limpet washers filled with white lead for connection, excluding the cost of purlins, rafter and trusses.								
		25g (0.50mm)					108.00	*sq.m*	1070.16	**115577.28**
32	**WW0030**	Providing & fixing Eaves board (225x25mm) with moulding fitted and fixed with necessary screws Mixed Conifer		56			56	*m*	180.15	**10088.40**
33	**RF0010**	Providing and fixing of PGI semi-circular gutter including brackets, hooks,sockets bolts, nuts, washers and rain water pipe connections etc complete, excluding the cost of pipe, 110-200mm dia		72				*m*	619.23	**44595.44**
34	**PI0123**	Providing & fixing Kitchen Sinks including all connections and fittings, Stainless steel, 940 x 460 x 160 mm, single bowl & drainboard		4				*each*	2765.41	**11061.64**
35	**PI0050**	Providing & fixing European-type vitreous china w.c pedestal including seat and lid with c.p brass hinges, 15 lit white vitreous china low level cistern, fittings, brackets, repair walls, white, with plastic seat & lid		8				*each*	5889.99	**47119.92**
36	**PI0177**	Providing & fixing C.P. Brass shower fittings Shower arm, standard 15mm		8				*each*	473.96	**3791.68**

APPENDIX B DETAIL ESTIMATE FOR BUILDING ALTERNATIVE 2

SI. No	BSR CODE	Item Description	No	L	B	H	Qty	Unit	Rate	Amount
1	**EW0001**	Surface dressing of ground, including removal of vegetations and inequalities < 150mm deep, disposal of rubbish within 50m in Ordinary Soil	1	21	11		**231**	*sq.m*	12.77	**2949.87**
2	**EW0030**	**Earth work** in excavation over areas, depth >300mm, width >1.5m, area >10 Sq.m on plan, including disposal of excavated earth within 50m lead and 1.5m liff & disposed soil to be neatly dressed. In ordinary Soil								
		Long Walls…...	3	20.40	1.6	1.6	156.67			
		Short Walls…...	6	7.90	1.6	1.6	121.34			
						Total	**278.02**	*cum*	162.02	**45044.1523**
3	**SM0005**	Providing & laying Random Rubble Masonry with hard stone in foundation & plinth In cement mortar 1:4								
		Stone soling for footing…..	18	1.6	1.6	0.15	6.91			
		Stone soling for external and Internal walls…..								
		Long Walls…...	2	19.6	0.8	0.15	4.70			
		Long wall front part…...	1	16.95	0.8	0.15	2.03			
		Short Walls…...	6	8.9	0.6	0.15	4.81			
						Total	**18.46**	*cum*	4970.70	**91739.2392**
4	**CW0006**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 40 mm nominal size)								
		P.C.C for external and Internal walls…..								
		Long Walls…...	2	19.6	0.8	0.10	3.14			
		Long wall front part…...	1	16.95	0.8	0.10	1.36			

		Short Walls…...	6	8.9	0.6	0.10	3.20			
						Total	**7.70**	*cum*	5095.15	**39212.2744**
5	**SM0005**	Providing & laying Random Rubble Masonry with hard stone in foundation & plinth, In cement mortar 1:4								
		Long Walls…...	2	19.25	0.45	0.60	10.40			
		Long wall front part…...	1	16.60	0.45	0.60	4.48			
		Short Walls…...	6	9.10	0.40	0.60	13.10			
						Total	**27.98**	*cum*	4970.70	**139085.157**
6	**SM0015**	Extra for random rubble masonry with hard stone in superstructure above plinth, below & including floor 2 level								
		Long Wall…...	1	19.05	0.40	6.48	49.38			
		Long wall front part…...	1	16.49	0.40	6.48	42.74			
		Long walls at main entry…..	2	5.65	0.40	6.48	29.29			
		Short Walls…...	2	9.25	0.40	6.48	47.95			
		Internal Partition wall…..								
		Partition Walls 1…..	2	9.25	0.30	6.48	35.96			
		Partition Walls 2…..	2	3.68	0.30	6.48	14.29			
		Partition Walls 3…..	2	4.45	0.30	6.48	17.30			
		Partition Walls 4…..	2	3.68	0.30	6.48	14.29			
		Partition Walls 5…..	2	3.50	0.30	6.48	13.61			
		Partition Wall 6..…...	2	3.20	0.30	6.48	12.44			
		External front wall…...	1	3.85	0.30	5.02	5.80			
		Total quantity of bricks without deduction					**283.05**			
		Doors and Windows deduction								
		Doors….....								
		D1….	4	1.05	0.4	2.10	3.53			
		D2….	8	0.95	0.3	2.10	4.79			
		D3….	4	0.85	0.4	2.10	2.86			
		D4….	4	0.85	0.3	2.10	2.14			
		D5….	8	0.85	0.4	2.10	5.71			
		Windows & Cornices….....								
		W1…..	2	2.78	0.4	1.76	3.90			
		W2…..	12	2.10	0.4	1.76	17.74			
		W3…..	1	2.10	0.4	2.78	2.33			

		W4…..	2	2.76	0.4	2.01	4.44			
		W5…..	4	2.10	0.4	2.01	6.75			
		W6…..	4	1.50	0.4	1.36	3.26			
		W7…..	8	0.75	0.4	1.36	3.26			
						Total deduction	**60.71**			
						Total quantity after deduction…	**222.34**	*cum*	402.80	**89557.67**
		Flooring work								
7	**EW0197**	Providing & laying dry earth bedding, including consolidating each deposited layer by watering, ramming and dressing	1	19.15	9.85	0.5	**94.31**	*cum*	213.30	**20117.12**
8	**FL0200**	Providing & fixing Mixed Conifer Flooring including fixing with iron screws etc. complete, excluding the cost of frame. 25mm thick,								
		Master Bed Room	4	3.68	3.73		54.91			
		Bed Room…..	4	3.83	3.48		53.31			
		Kitchen…..	4	3.20	3.48		44.54			
		Dinning room…..	4	3.78	5.90		89.21			
						Total	**241.97**	*sq.m*	673.07	**162863.56**
		Toilet								
9	**SM0072**	Providing and laying Hand packed stone filling or soling with stones								
		Common Toilet…..	2	1.90	2.63	0.15	1.50			
		Toilet…..	2	1.80	2.65	0.15	1.43			
						Total	2.93	*cum*	1697.03	**4972.47**
10	**FL0051**	Pal cement concrete flooring 1:2:4, finished with floating coat of neat cement 20mm aggregates, 40mm thick								
		Common Toilet…..	2	1.90	2.63		9.99			
		Toilet…..	2	1.80	2.65		9.54			
						Total	19.53	*sq.m*	415.75	**8121.26**
11	**WW0021**	Providing & fixing joists, including hoisting, applying wood preservative on unexposed surfaces. Mixed Conifer	68.00	4.75	0.10	0.13	**4.14**	*cu.m*	23245.53	**96309.04**

		Balcony flooring	4	3.90	1.20		**18.72**	*sq.m*	673.07	**12599.87**
		Balcony timber joist	12	1.20	0.10	0.13	**0.18**	*cu.m*	23245.53	**4293.65**
		Roof Flooring								
12	**FL0200**	Providing & fixing Mixed Conifer Flooring including fixing with iron screws etc. complete, excluding the cost of frame. 25mm thick,	1	19.15	9.85		**188.63**	*sq.m*	673.07	**126959.51**
13	**WW0021**	Providing & fixing joists, including hoisting, applying wood preservative on unexposed surfaces. Mixed Conifer	34	4.75	0.10	0.13	**2.07**	*cu.m*	23245.53	**48154.52**
		Traditional Cornices								
		Providing, making & fixing woodwork dressed in traditional cornices complete as per standard design in Mixed Conifer, including applying wood preservative on unexposed surfaces, excluding decorative painting (Measurement to be taken along the cornice and wall junction line)								
14	**WW0036**	At all other floor levels								
		Rabsey 1	2	4.35			8.7	*m*	3678.32	**32001.384**
		Rabsey 2	4	2.10			8.4	m	3678.32	**30897.89**
15	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed								
		Mixed Conifer								
		Timber Bogh	120	0.3	0.125	0.1	0.45			
			20	0.3	0.125	0.1	0.08			
						Total	**0.53**	*cum*	26522.54	**13924.33**

		Traditional Painting								
16	**PT0100**	Providing, preparing and applying Sumdang painting (Not washable)								
		Rab….....	4	2.75	1		11			
			24	2.1	1		50.4			
			4	2.78	0.5		5.56			
			8	2.1	0.5		8.4			
			2	2.1	1		4.2			
			16	0.44	0.5		3.52			
			8	1.5	0.5		6			
			8	1.05	0.50		4.2			
			16	0.95	1.00		15.2			
			8	0.85	0.50		3.4			
			8	0.85	0.50		3.4			
			16	0.85	1.00		13.6			
						Total	**128.88**		1284.53	**165550.226**
		Stair Case								
		Providing & laying in position reinforced cement concrete work in beams, lintels, bands, plain window sills, staircases, spiral staircases upto floor five level excluding the cost of centering, shuttering and reinforcement								
17	**RC0018**	1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Base Slab….	1	3.46	1.33	0.16	0.74			
		Riser and Tread….	16	1.33	0.02		0.48			
		Base Slab….	1	1.54	1.33	0.16	0.33			
						Total	1.54	*cum*	6790.57	**10476.49**
		Stair case landing	1	2.65	1.2	0.15	0.48			
			1	1.33	2.3	0.15	0.46			
						Total	0.94	*cum*	6790.57	**6354.95**
		Plinth Protection Wall/Drain								

18	**SM0072**	Providing and laying Hand packed stone filling or soling with stones								
		Length Wise….....	2	22.65	1.75	0.15	11.89			
		Breath Wise….....	2	9.85	1.75	0.15	5.17			
						Total	17.06	*cum*	1697.03	**28955.5744**
19	**CW0002**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level.								
		1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Length Wise….....	2	22.1	1.475	0.1	6.52			
		Breath Wise….....	2	9.85	1.475	0.1	2.91			
						Total	9.43	*cum*	6661.50	**62786.30**
20	**CW0009**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level.1:4:8 (1 cement : 4 sand : 8 graded crushed stone 50 mm nominal size)								
			2	22.1	1.475	0.05	3.26			
			2	9.85	1.475	0.05	1.45			
						Total	4.71	*cum*	4372.85	**20607.6022**
21	**BW0002**	Providing & laying Second-Class Brick work in Foundation & Plinth. In cement mortar 1:4								
		Length Wise….....	4	22.65	0.125	0.325	3.68			
		Breath Wise….....	4	9.85	0.125	0.325	1.60			
			2	22.65	0.125	0.25	1.42			
			2	9.85	0.125	0.25	0.62			
						Total	7.31	*cum*	9310.91	**68086.0294**

22	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement 20mm plaster in C.M 1:4								
			4	22.65	0.2		18.12			
			4	9.85	0.2		7.88			
			2	22.65	0.25		11.33			
			2	9.85	0.25		4.93			
						Total	42.25	*sq.m*	359.57	**15191.8325**
		Windows(Mixed Conifer)								
23	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed, Mixed conifer								
		Window Frame bottom (**Window 1**)	4	2.78	0.20	0.10	0.22			
		Window side frame	4	1.50	0.20	0.10	0.12			
		Kachung	10	1	0.08	0.065	0.05			
		Jugshing	2	2.58	0.065	0.065	0.02			
		Horzhu	2	2.58	0.15	0.065	0.05			
		Window Frame bottom (**Window 2**)	24	2.10	0.2	0.1	1.008			
		Window side frame	24	1.50	0.20	0.10	0.72			
		Kachung	60	1.00	0.08	0.065	0.312			
		Jugshing	12	1.9	0.065	0.065	0.10			
		Horzhu	12	1.9	0.15	0.065	0.22			
		Window Frame bottom (**Window 3**)	2	2.10	0.2	0.1	0.08			
		Window side frame	2	2.00	0.20	0.10	0.08			
		Kachung	1	1.50	0.08	0.065	0.01			
		Jugshing	1	1.9	0.065	0.065	0.01			
		Horzhu	1	1.9	0.15	0.065	0.02			
		Window Frame bottom (**Window 4**)	4	2.78	0.20	0.1	0.22			
		Window side frame	4	1.86	0.20	0.10	0.15			
		Kachung	2	1.36	0.08	0.065	0.01			
		Jugshing	2	2.58	0.065	0.065	0.02			
		Horzhu	2	2.58	0.15	0.065	0.05			

		Window Frame bottom (**Window 5**)	4	2.10	0.20	0.1	0.17			
		Window side frame	4	1.86	0.20	0.10	0.15			
		Kachung	2	1.36	0.08	0.065	0.01			
		Jugshing	2	1.90	0.065	0.065	0.02			
		Horzhu	2	1.90	0.15	0.065	0.04			
		Window Frame bottom (**Window 6**)	8	1.50	0.13	0.1	0.15			
		Window side frame	8	1.10	0.13	0.10	0.11			
		Kachung	4	0.67	0.08	0.065	0.01			
		Horzhu	4	1.12	0.15	0.065	0.04			
		Window Frame bottom (**Window 7**)	16	0.75	0.13	0.1	0.15			
		Window side frame	16	1.10	0.13	0.10	0.22			
		Kachung	16	0.67	0.08	0.065	0.06			
		Horzhu	8	0.55	0.15	0.065	0.04			
						Total	4.65	*cum*	26522.54	**123363.16**
		Door (Oak Tree)								
24	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed, Mixed conifer								
		Door1……..								
		Top frame	4	1.05	0.1	0.125	0.05			
		Side frame	8	2.1	0.1	0.13	0.22			
		Door panel	4	2	0.85	0.035	0.24			
		Door2……..								
		Top frame	16	0.95	0.1	0.125	0.19			
		Side frame	32	2.1	0.1	0.13	0.87			
		Door panel	16	2	0.75	0.035	0.84			
		Door3……..								
		Top frame	8	0.85	0.1	0.125	0.09			
		Side frame	16	2.1	0.1	0.13	0.44			
		Door panel	8	2	0.65	0.035	0.36			
		Door4……..								
		Top frame	8	0.85	0.1	0.125	0.09			
		Side frame	16	2.1	0.1	0.13	0.44			

		Door panel	8	2	0.65	0.035	0.36			
						Total	4.18	*cum*	26522.54	**110972.96**
		Roof Truss								
25	**SW0022**	Steel work welded, in built up sections, trusses, frame-works including cutting, hoisting, fixing and appl. priming coat of red								
		Truss 1(T1)……..								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	8	2.67	6.53		139.48			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	2.60	6.53		135.82			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	0.89	5.1		36.31			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.60	5.1		24.48			
		Truss 2(T2)……..								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	8	4.06	6.53		212.09			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	3.95	6.53		206.35			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.21	5.1		49.37			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.36	5.1		55.49			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.68	5.1		27.74			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.91	5.1		37.13			

		Truss 3(T3)……..								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)…….	8	5.46	6.53		285.23			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)……..	8	5.32	6.53		277.92			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)……..	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)……..	8	1.33	5.1		54.26			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)……..	8	1.48	5.1		60.38			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)……..	8	1.67	5.1		68.14			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)……..	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)……..	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)……..	8	0.71	5.1		28.97			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)……..	8	0.97	5.1		39.58			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)……..	8	1.23	5.1		50.18			
		Truss 4(T4)……..								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)……..	2	6.88	6.53		89.85			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)……..	2	6.61	6.53		86.33			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)……..	2	1.07	5.1		10.91			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)……..	2	1.38	5.1		14.08			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)……..	2	1.54	5.1		15.71			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)……..	2	1.73	5.1		17.65			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)……..	2	1.96	5.1		19.99			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)……..	2	0.23	5.1		2.35			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)……..	2	0.45	5.1		4.59			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)……..	2	0.72	5.1		7.34			
		Strut(Vertical) (60.3Ø M,	2	0.995	5.1		10.15			

		5.1KG/M)….....								
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	1.27	5.1		12.95			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	1.55	5.1		15.81			
		Truss 5(T5)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)…..	14	6.88	6.53		628.97			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)…..	14	6.69	6.53		611.60			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.07	5.1		76.40			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.38	5.1		98.53			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.54	5.1		109.96			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.73	5.1		123.52			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.96	5.1		139.94			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.23	5.1		16.42			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.45	5.1		32.13			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.72	5.1		51.41			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.995	5.1		71.04			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	1.27	5.1		90.68			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	1.55	5.1		110.67			
		Truss 6(T6)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	4	9.6	6.53		250.75			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)…..	4	9.48	6.53		247.62			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.28	5.1		26.11			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.49	5.1		30.40			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.61	5.1		32.84			
		Strut (Inclined) (60.3Ø M,	4	1.74	5.1		35.50			

		5.1KG/M)….....								
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.88	5.1		38.35			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	2.06	5.1		42.02			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.25	5.1		5.10			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.45	5.1		9.18			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.67	5.1		13.67			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.89	5.1		18.16			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.11	5.1		22.64			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.33	5.1		27.13			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.55	5.1		31.62			
						Total	5303.20	Kg	86.59	**459204.16**
		Purlin								
		Purlin (76.1ØM , 6.53KG/M)….....	2	23.05	6.53		301.03			
		Purlin (76.1ØM , 6.53KG/M)….....	2	13.75	6.53		179.58			
		Purlin (76.1ØM , 6.53KG/M)….....	2	19.15	6.53		250.10			
		Purlin (76.1ØM , 6.53KG/M)….....	2	9.85	6.53		128.64			
		Purlin (76.1ØM , 6.53KG/M)….....	2	17.15	6.53		223.98			
		Purlin (76.1ØM , 6.53KG/M)….....	2	7.85	6.53		102.52			
		Purlin (76.1ØM , 6.53KG/M)….....	2	15.15	6.53		197.86			
		Purlin (76.1ØM , 6.53KG/M)….....	2	5.85	6.53		76.40			
						Total	1460.11	Kg	86.59	**126430.75**
26	**RF0003**	Providing & fixing Pre Painted Steel Corrugated Roofing sheets, including bolts, hooks and nuts 8mm dia. with bitumen and G.I limpet washers filled with white lead for connection, excluding the cost of purlins, rafter and trusses.								
		25g (0.50mm)					108.00	*sq.m*	1070.16	**115577.28**

27	**WW0030**	Providing & fixing Eaves board (225x25mm) with moulding fitted and fixed with necessary screws Mixed Conifer		56			56	*m*	180.15	**10088.40**
28	**RF0010**	Providing and fixing of PGI semi-circular gutter including brackets, hooks,sockets bolts, nuts, washers and rain water pipe connections etc complete, excluding the cost of pipe, 110-200mm dia		72				*m*	619.23	**44584.56**
29	**PI0123**	Providing & fixing Kitchen Sinks including all connections and fittings, Stainless steel, 940 x 460 x 160 mm, single bowl & drainboard		4				*each*	2765.41	**11061.64**
30	**PI0050**	Providing & fixing European-type vitreous china w.c pedestal including seat and lid with c.p brass hinges, 15 lit white vitreous china low level cistern, fittings, brackets, repair walls, white, with plastic seat & lid		8				*each*	5889.99	**47119.92**
31	**PI0177**	Providing & fixing C.P. Brass shower fittings Shower arm, standard 15mm		8				*each*	473.96	**3791.68**

APPENDIX C DETAIL ESTIMATE FOR BUILDING ALTERNATIVE 3

SI. No	BSR CODE	Item Description	No	L	B	H	Qty	Unit	Rate	Amount
1	**EW0001**	Surface dressing of ground, including removal of vegetations and inequalities < 150mm deep, disposal of rubbish within 50m in Ordinary Soil	1	21	11		**231**	*sq.m*	12.77	**2949.87**
2	**EW0030**	**Earth work** in excavation over areas, depth >300mm, width >1.5m, area >10 Sq.m on plan, including disposal of excavated earth within 50m lead and 1.5m liff & disposed soil to be neatly dressed. In ordinary Soil								
		Long Walls…..	3	20.40	1.6	1.6	156.67			
		Short Walls…..	6	7.90	1.6	1.6	121.34			
						Total	**278.02**	*cum*	162.02	**45044.1523**
3	**SM0005**	Providing & laying Random Rubble Masonry with hard stone in foundation & plinth In cement mortar 1:4								
		Stone soling for footing…..	18	1.6	1.6	0.15	6.91			
		Stone soling for external and Internal walls…..								
		Long Walls…..	2	19.6	0.8	0.15	4.70			
		Long wall front part…...	1	16.95	0.8	0.15	2.03			
		Short Walls…..	6	8.9	0.6	0.15	4.81			
						Total	**18.46**	*cum*	4970.70	**91739.2392**
4	**CW0006**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 40 mm nominal size)								
		P.C.C in footing level.	18	1.6	1.6	0.10	4.61			
		P.C.C for external and Internal walls…..								
		Long Walls…..	2	19.6	0.8	0.10	3.14			
		Long wall front part…...	1	16.95	0.8	0.10	1.36			
		Short Walls…..	6	8.9	0.6	0.10	3.20			

						Total	**12.30**	*cum*	5095.15	**62690.7256**
5	**SM0005**	Providing & laying Random Rubble Masonry with hard stone in foundation & plinth, In cement mortar 1:4								
		Long Walls…...	2	19.25	0.45	0.60	10.40			
		Long wall front part…...	1	16.60	0.45	0.60	4.48			
		Short Walls…...	6	9.10	0.40	0.60	13.10			
						Total	**27.98**	*cum*	4970.70	**139085.157**
6	**BW0012**	Extra for brick work in superstructure above plinth level, up to floor two level								
		Long Wall…...	1	19.05	0.25	6.48	30.86			
		Long wall front part…...	1	16.49	0.25	6.48	26.71			
		Long walls at main entry…..	2	5.65	0.25	6.48	18.31			
		Short Walls…...	2	9.25	0.40	6.48	47.95			
		Internal Partition wall…..								
		Partition Walls 1…..	2	9.25	0.125	6.48	14.99			
		Partition Walls 2…..	2	3.68	0.125	6.48	5.95			
		Partition Walls 3…..	2	4.45	0.125	6.48	7.21			
		Partition Walls 4…..	2	3.68	0.125	6.48	5.95			
		Partition Walls 5…..	2	3.50	0.125	6.48	5.67			
		Partition Wall 6..…...	2	3.20	0.125	6.48	5.18			
		External front wall…...	1	3.85	0.25	5.02	4.83			
		Total quantity of bricks without deduction					**173.62**			
		Doors and Windows deduction								
		Doors….....								
		D1….	4	1.05	0.25	2.10	2.21			
		D2….	8	0.95	0.125	2.10	2.00			
		D3….	4	0.85	0.25	2.10	1.79			
		D4….	4	0.85	0.125	2.10	0.89			
		D5….	8	0.85	0.125	2.10	1.79			
		Windows & Cornices….....								
		W1…..	2	2.78	0.25	1.76	2.44			
		W2…..	12	2.10	0.25	1.76	11.09			
		W3…..	1	2.10	0.25	2.78	1.46			
		W4…..	2	2.76	0.25	2.01	2.77			
		W5…..	4	2.10	0.25	2.01	4.22			
		W6…..	4	1.50	0.25	1.36	2.04			

		W7…..	8	0.75	0.25	1.36	2.04			
						Total deduction	**34.72**			
		Total quantity of bricks after deduction…					**138.90**	*cum*	331.47	**46041.9495**
		Flooring work (First Floor)								
7	**EW0197**	Providing & laying dry earth bedding, including consolidating each deposited layer by watering, ramming and dressing	1	19.15	9.85	0.5	**94.31**	*cum*	213.30	**20117.1229**
8	**SM0072**	Providing and laying Hand packed stone filling or soling with stones								
		Master Bed Room…..	2	3.68	3.73	0.15	4.12			
		Bed Room…..	2	3.83	3.48	0.15	4.00			
		Common Toilet…..	2	1.90	2.63	0.15	1.50			
		Toilet…..	2	1.80	2.65	0.15	1.43			
		Kitchen…..	2	3.20	3.48	0.15	3.34			
		Dinning room…..	2	3.78	5.90	0.15	6.69			
						Total	**21.08**	*cum*	1697.03	**35769.8965**
9	**FL0051**	Pal cement concrete flooring 1:2:4, finished with floating coat of neat cement 20mm aggregates, 40mm thick								
		Master Bed Room…..	2	3.68	3.73		27.45			
		Bed Room…..	2	3.83	3.48		26.66			
		Common Toilet…..	2	1.90	2.63		9.99			
		Toilet…..	2	1.80	2.65		9.54			
		Kitchen…..	2	3.20	3.48		22.27			
		Dinning room…..	2	3.78	5.90		44.60			
						Total	**140.52**	*sq.m*	415.75	**58421.0237**
		Flooring work (Second Floor)								
10	**RC0014**	Providing & laying in position reinforced cement concrete work in suspended floor, roofs having slope upto 15o, landings,balconies, shelves and chajjas upto floor five level excluding the cost of centering, shuttering and reinforcement 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Flooring Slab	1	19.15	9.85	0.15	28.29			
		Balcony Slab	2	3.90	1.20	0.15	1.40			

		Roof Slab	1	19.15	9.85	0.14	26.41			
						Total	**56.11**	*cum*	6961.70	**390592.966**
		Concrete Work in Footing, Beams, Columns								
11	**RC0010**	Providing & laying in position reinforced cement concrete work in plinth and skirting courses, fillets, columns , pillars, posts and struts upto floor five level excluding the cost of centering, shuttering and reinforcement.								
		Footing(500mm P.C.C)	18	1.60	1.60	0.50	23.04			
		Column….....	18	8.68	0.40	0.40	25.00			
						Total	**48.04**	*cum*	6795.46	**326443.026**
12	**RC0018**	Providing & laying in position reinforced cement concrete work in beams, lintels, bands, plain window sills, staircases, spiral staircases upto floor five level excluding the cost of centering, shuttering and reinforcement								
		Beams ….	9	18.8	0.40	0.30	20.30			
		Beams ….	18	9.5	0.40	0.30	20.52			
						Total	**40.82**	*cum*	6790.57	**277218.23**
		Plastering work								
13	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement 20mm plaster in C.M 1:4								
		Plastering on External wall	2	19.15	6.48		248.184			
			4	9.85	6.48		255.312			
			4	8	6.48		207.36			
			4	5.9	6.48		152.928			
						Total	**863.784**			
		Doors and Window Deduction								
		Windows & Cornices….....								
		W1…..	4	2.78		1.76	19.48			
		W2…..	24	2.10		1.76	88.70			
		W3…..	2	2.10		2.78	11.66			

		W4…..	4	2.76		2.01	22.19			
		W5…..	8	2.10		2.01	33.77			
		W6…..	8	1.50		1.36	16.32			
		W7…..	16	0.75		1.36	16.32			
		Doors….....								
		D1….	4	1.05		2.10	8.82			
						Total deduction	**217.26**			
					Total after deduction		**646.53**	*sq.m*	359.57	**232471.39**
14	**PL0031**	Providing & laying 15mm cement plaster on rough side of single or half-brick wall C.M 1:4								
		Partition Walls 1…..	4	9.25		6.48	239.76			
		Partition Walls 2…..	4	3.68		6.48	95.26			
		Partition Walls 3…..	4	4.45		6.48	115.34			
		Partition Walls 4…..	4	3.68		6.48	95.26			
		Partition Walls 5…..	4	3.50		6.48	90.72			
		Partition Wall 6……..	4	3.20		6.48	82.94			
						Total	**719.28**			
		Doors Deduction								
		D2….	16	0.95		2.10	31.92			
		D3….	8	0.85		2.10	14.28			
		D4….	8	0.85		2.10	14.28			
		D5….	16	0.85		2.10	28.56			
						Total	**89.04**			
					Total after deduction		**630.24**	*sq.m*	248.37	**156532.709**
		Floor plastering								
15	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement. 20mm plaster in C.M 1:4								
		Master Bedroom	2	3.68	3.73		27.45			
		Bed Room	2	3.83	3.48		26.66			
		Toilet 1	2	2.63	1.9		9.99			
		Toilet 2	2	2.65	1.8		9.54			
		Dinning Room	2	5.9	3.78		44.60			
		Kitchen	2	3.2	3.48		22.27			
							140.52	*sq.m*	359.57	**50526.6326**
16	**PL0011**	Providing & laying 6mm cement plaster (in Ceiling) (C.M 1:4)								
		Master Bedroom	4	3.68	3.73		54.91			

		Bed Room	4	3.83	3.48		53.31			
		Toilet 1	4	2.63	1.9		19.99			
		Toilet 2	4	2.65	1.8		19.08			
		Dinning Room	4	5.9	3.78		89.21			
		Kitchen	4	3.2	3.48		44.54			
						Total	281.04	*sq.m*	160.79	**45188.293**
		Traditional Cornices								
		Bhutan type Traditional Cornices in R.C.C 1:1.5:3, 20 mm aggregate including cost of formwork including finishing with 6mm thick plaster on the exposed surface with cement mortar 1:3, excluding reinforcement & decorative painting cost as per standard design (Measurement to be taken along the cornice and wall junction)								
17	**RC0031**	Multi-Storied building..at floor 2 level including the cost of lhanglag and at other floors where Lhanglag is provided								
		Rabsey 1	2	4.35			8.7	*m*	2843.55	**24738.885**
		Rabsey 2	4	2.10			8.4		2843.55	**23885.82**
18	**RC0003**	Providing & laying in position reinforced cement concrete excluding the cost of centering, shuttering and reinforcement - all work upto plinth level								
		R.C.C Bogh	120	0.3	0.125	0.1	0.45			
			20	0.3	0.125	0.1	0.08			
						Total	**0.53**	*cum*	6059.32	**3181.143**
		Traditional Painting								
19	**PT0100**	Providing, preparing and applying Sumdang painting (Not washable)								
		Rab….....	4	2.75	1		11			

			24	2.1	1		50.4			
			4	2.78	0.5		5.56			
			8	2.1	0.5		8.4			
			2	2.1	1		4.2			
			16	0.44	0.5		3.52			
			8	1.5	0.5		6			
			8	1.05	0.50		4.2			
			16	0.95	1.00		15.2			
			8	0.85	0.50		3.4			
			8	0.85	0.50		3.4			
			16	0.85	1.00		13.6			
						Total	**128.88**		1284.53	**165550.226**
		Stair Case								
		Providing & laying in position reinforced cement concrete work in beams, lintels, bands, plain window sills, staircases, spiral staircases upto floor five level excluding the cost of centering, shuttering and reinforcement								
20	**RC0018**	1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Base Slab….	1	3.46	1.33	0.16	0.74			
		Riser and Tread….	16	1.33	0.02		0.48			
		Base Slab….	1	1.54	1.33	0.16	0.33			
						Total	1.54	*cum*	6790.57	**10476.49**
		Stair case landing	1	2.65	1.2	0.15	0.48			
			1	1.33	2.3	0.15	0.46			
						Total	0.94	*cum*	6790.57	**6354.95493**
		Plinth Protection Wall								
21	**SM0072**	Providing and laying Hand packed stone filling or soling with stones								
		Length Wise….....	2	22.65	1.75	0.15	11.89			
		Breath Wise….....	2	9.85	1.75	0.15	5.17			
						Total	17.06	*cum*	1697.03	**28955.5744**

22	**CW0002**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level.								
		1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Length Wise….....	2	22.1	1.475	0.1	6.52			
		Breath Wise….....	2	9.85	1.475	0.1	2.91			
						Total	9.43	*cum*	6661.50	**62786.3029**
23	**CW0009**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level.1:4:8 (1 cement : 4 sand : 8 graded crushed stone 50 mm nominal size)								
			2	22.1	1.475	0.05	3.26			
			2	9.85	1.475	0.05	1.45			
						Total	4.71	*cum*	4372.85	**20607.6022**
24	**BW0002**	Providing & laying Second-Class Brick work in Foundation & Plinth. In cement mortar 1:4								
		Length Wise….....	4	22.65	0.125	0.325	3.68			
		Breath Wise….....	4	9.85	0.125	0.325	1.60			
			2	22.65	0.125	0.25	1.42			
			2	9.85	0.125	0.25	0.62			
						Total	7.31	*cum*	9310.91	**68086.0294**
25	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement 20mm plaster in C.M 1:4								
			4	22.65	0.2		18.12			
			4	9.85	0.2		7.88			
			2	22.65	0.25		11.33			
			2	9.85	0.25		4.93			
						Total	42.25	*sq.m*	359.57	**15191.8325**

		Column Reinforcement								
26	**RC0083**	Providing & fixing Thermo-Mechanically Treated reinforcement bar (Yield Strength 500 MPa) for R.C.C work including cutting, bending, binding and placing in position complete								
		20mm Dia main bar reinforcement @ 2.469kg/m	18	8	9.86	2.47	3505.58			
		25mm Dia main bar reinforcement @ 3.858kg/m	18	4	9.86	3.858	2738.87			
		8mm Dia stirrups reinforcement @ 0.395 kg/m	18	134	1.264	0.395	1204.26			
		Splicing								
		20mm Dia main bar reinforcement @ 2.469kg/m	18	4	2.35	2.469	417.75			
		25mm Dia main bar reinforcement @ 3.858kg/m	18	2	2.35	3.858	326.39			
		Beam Reinforcement								
		Plinth &Roof Beam reinforcement								
		20mm Dia main bar reinforcement @ 2.469kg/m	12	2	21.1	2.469	1250.30			
		16mm Dia main bar reinforcement @ 1.58kg/m	12	2	21.1	1.58	800.11			
		20mm Dia Top reinforcement @ 2.469kg/m	12	2	21.1	2.469	1250.30			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	12	2	19.88	2.469	1178.01			
		8mm Dia stirrups reinforcement @ 0.395 kg/m for **Plinth beam, First floor, roof beam**	8	146	1.26	0.395	581.31			
			1	126	1.26	0.395	62.71			
		First Floor Beam								
		20mm Dia main bar reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		16mm Dia main bar reinforcement @ 1.58kg/m	2	2	21.1	1.58	133.35			
		20mm Dia Top reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		20mm Dia main bar reinforcement @ 2.469kg/m	2	2	10.2	2.469	100.74			

		16mm Dia main bar reinforcement @ 1.58kg/m	2	2	10.2	1.58	64.46			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	2	2	16.88	2.469	166.71			
		20mm Dia Top reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	2	2	19.88	2.469	196.33			
						Total	14602.35	***Kg***	**89.38**	**1305158.34**
		Reinforcement Qty. Cal. In shorter length Dir.Pinth beam, first floor and Roof								
		16mm Dia main bar reinforcement @ 1.58kg/m	8	4	10.7	1.58	540.99			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	2	11.25	1.58	284.40			
		20mm Dia main bar reinforcement @ 2.469kg/m	8	2	11.25	2.469	444.42			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	4	11.00	1.58	556.16			
		20mm Dia main bar reinforcement @ 2.469kg/m	8	2	11.38	2.47	449.56			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	2	10	1.58	252.80			
		Stirrups 8mmdia @ 0.395kg/m	8	82	1.04	0.395	269.48			
			10	74	1.04	0.395	303.99			
						Total	3101.80	***Kg***	**89.38**	**277239.27**
27	**RC0083**	Providing & fixing Thermo-Mechanically Treated reinforcement bar (Yield Strength 500 MPa) for R.C.C work including cutting, bending, binding and placing in position complete								
		Slab and Roof slab Reinforcement								
		Bottom reinforcnement								
		10mm Dia main bar reinforcement @ 0.617kg/m	26	18.8	2	0.62	603.18			
		10mm Dia main bar reinforcement @ 0.617kg/m	105	4.75	2	0.62	615.46			
		10mm Dia main bar reinforcement @ 0.617kg/m	52	7.9	2	0.62	506.93			

		10mm Dia main bar reinforcement @ 0.617kg/m	88	4.75	2	0.62	515.81			
		Balcony Reinforcement								
		10mm Dia main bar reinforcement @ 0.617kg/m	4	7	3.9	0.62	67.70			
		10mm Dia main bar reinforcement @ 0.617kg/m	4	22	3.9	0.62	212.78			
		Top reinforcement								
		10mm Dia main bar reinforcement @ 0.617kg/m	26	11.28	2	0.62	361.91			
		10mm Dia main bar reinforcement @ 0.617kg/m	105	2.90	2	0.62	375.75			
		10mm Dia main bar reinforcement @ 0.617kg/m	52	4.68	2	0.62	300.31			
		10mm Dia main bar reinforcement @ 0.617kg/m	88	2.90	2	0.62	314.92			
						Total	3874.75	***Kg***	**89.38**	**346324.93**
		Footing Reinforcement								
		12mm Dia main bar bot. reinforcement @ 0.89kg/m	18	22	2.6	0.89	916.34			
		12mm Dia main bar top reinforcement @ 0.89kg/m	18	18	2.6	0.89	749.74			
						Total	1666.08	***Kg***	**89.38**	**148914.23**
		Windows(Mixed Conifer)								
28	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed, Mixed conifer								
		Window Frame bottom (**Window 1**)	4	2.78	0.20	0.10	0.22			
		Window side frame	4	1.50	0.20	0.10	0.12			
		Kachung	10	1	0.08	0.065	0.05			
		Jugshing	2	2.58	0.065	0.065	0.02			
		Horzhu	2	2.58	0.15	0.065	0.05			
		Window Frame bottom (**Window 2**)	24	2.10	0.2	0.1	1.008			
		Window side frame	24	1.50	0.20	0.10	0.72			
		Kachung	60	1.00	0.08	0.065	0.312			
		Jugshing	12	1.9	0.065	0.065	0.10			
		Horzhu	12	1.9	0.15	0.065	0.22			
		Window Frame bottom (**Window 3**)	2	2.10	0.2	0.1	0.08			
		Window side frame	2	2.00	0.20	0.10	0.08			

		Kachung	1	1.50	0.08	0.065	0.01			
		Jugshing	1	1.9	0.065	0.065	0.01			
		Horzhu	1	1.9	0.15	0.065	0.02			
		Window Frame bottom (**Window 4**)	4	2.78	0.20	0.1	0.22			
		Window side frame	4	1.86	0.20	0.10	0.15			
		Kachung	2	1.36	0.08	0.065	0.01			
		Jugshing	2	2.58	0.065	0.065	0.02			
		Horzhu	2	2.58	0.15	0.065	0.05			
		Window Frame bottom (**Window 5**)	4	2.10	0.20	0.1	0.17			
		Window side frame	4	1.86	0.20	0.10	0.15			
		Kachung	2	1.36	0.08	0.065	0.01			
		Jugshing	2	1.90	0.065	0.065	0.02			
		Horzhu	2	1.90	0.15	0.065	0.04			
		Window Frame bottom (**Window 6**)	8	1.50	0.13	0.1	0.15			
		Window side frame	8	1.10	0.13	0.10	0.11			
		Kachung	4	0.67	0.08	0.065	0.01			
		Horzhu	4	1.12	0.15	0.065	0.04			
		Window Frame bottom (**Window 7**)	16	0.75	0.13	0.1	0.15			
		Window side frame	16	1.10	0.13	0.10	0.22			
		Kachung	16	0.67	0.08	0.065	0.06			
		Horzhu	8	0.55	0.15	0.065	0.04			
						Total	4.65	*cum*	26522.54	**123363.16**
		Door (Oak Tree)								
29	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed, Mixed conifer								
		Door1……..								
		Top frame	4	1.05	0.1	0.125	0.05			
		Side frame	8	2.1	0.1	0.13	0.22			
		Door panel	4	2	0.85	0.035	0.24			
		Door2……..								
		Top frame	16	0.95	0.1	0.125	0.19			
		Side frame	32	2.1	0.1	0.13	0.87			
		Door panel	16	2	0.75	0.035	0.84			

		Door3……..								
		Top frame	8	0.85	0.1	0.125	0.09			
		Side frame	16	2.1	0.1	0.13	0.44			
		Door panel	8	2	0.65	0.035	0.36			
		Door4……..								
		Top frame	8	0.85	0.1	0.125	0.09			
		Side frame	16	2.1	0.1	0.13	0.44			
		Door panel	8	2	0.65	0.035	0.36			
						Total	4.18	*cum*	26522.54	**110972.96**
		Roof Truss								
30	**SW0022**	Steel work welded, in built up sections, trusses, frame-works including cutting, hoisting, fixing and appl. priming coat of red								
		Truss 1(T1)……..								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	8	2.67	6.53		139.48			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	2.60	6.53		135.82			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	0.89	5.1		36.31			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.60	5.1		24.48			
		Truss 2(T2)……..								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	8	4.06	6.53		212.09			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	3.95	6.53		206.35			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.21	5.1		49.37			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.36	5.1		55.49			
		Strut(Vertical) (60.3Ø M,	8	0.23	5.1		9.38			

		5.1KG/M)….....								
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.68	5.1		27.74			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.91	5.1		37.13			
		Truss 3(T3)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)…….	8	5.46	6.53		285.23			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	5.32	6.53		277.92			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.33	5.1		54.26			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.48	5.1		60.38			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.67	5.1		68.14			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.71	5.1		28.97			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.97	5.1		39.58			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	1.23	5.1		50.18			
		Truss 4(T4)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	2	6.88	6.53		89.85			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	2	6.61	6.53		86.33			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.07	5.1		10.91			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.38	5.1		14.08			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.54	5.1		15.71			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.73	5.1		17.65			
		Strut (Inclined) (60.3Ø M,	2	1.96	5.1		19.99			

		5.1KG/M)….....								
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.23	5.1		2.35			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.45	5.1		4.59			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.72	5.1		7.34			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.995	5.1		10.15			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	1.27	5.1		12.95			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	1.55	5.1		15.81			
		Truss 5(T5)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)…..	14	6.88	6.53		628.97			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)…..	14	6.69	6.53		611.60			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.07	5.1		76.40			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.38	5.1		98.53			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.54	5.1		109.96			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.73	5.1		123.52			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.96	5.1		139.94			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.23	5.1		16.42			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.45	5.1		32.13			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.72	5.1		51.41			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.995	5.1		71.04			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	1.27	5.1		90.68			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	1.55	5.1		110.67			
		Truss 6(T6)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	4	9.6	6.53		250.75			
		Bottom Chord or Tie (76.1ØM ,	4	9.48	6.53		247.62			

		6.53KG/M)….....								
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.28	5.1		26.11			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.49	5.1		30.40			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.61	5.1		32.84			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.74	5.1		35.50			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.88	5.1		38.35			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	2.06	5.1		42.02			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.25	5.1		5.10			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.45	5.1		9.18			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.67	5.1		13.67			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.89	5.1		18.16			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.11	5.1		22.64			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.33	5.1		27.13			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.55	5.1		31.62			
						Total	5303.20	Kg	86.59	**459204.16**
		Purlin								
		Purlin (76.1ØM , 6.53KG/M)….....	2	23.05	6.53		301.03			
		Purlin (76.1ØM , 6.53KG/M)….....	2	13.75	6.53		179.58			
		Purlin (76.1ØM , 6.53KG/M)….....	2	19.15	6.53		250.10			
		Purlin (76.1ØM , 6.53KG/M)….....	2	9.85	6.53		128.64			
		Purlin (76.1ØM , 6.53KG/M)….....	2	17.15	6.53		223.98			
		Purlin (76.1ØM , 6.53KG/M)….....	2	7.85	6.53		102.52			
		Purlin (76.1ØM , 6.53KG/M)….....	2	15.15	6.53		197.86			
		Purlin (76.1ØM , 6.53KG/M)….....	2	5.85	6.53		76.40			
						Total	1460.11	Kg	86.59	**126430.75**

31	**RF0003**	Providing & fixing Pre Painted Steel Corrugated Roofing sheets, including bolts, hooks and nuts 8mm dia. with bitumen and G.I limpet washers filled with white lead for connection, excluding the cost of purlins, rafter and trusses.								
		25g (0.50mm)					108.00	*sq.m*	1070.16	**115588.16**
32	**WW0030**	Providing & fixing Eaves board (225x25mm) with moulding fitted and fixed with necessary screws Mixed Conifer		56			56	*m*	180.15	**10088.40**
33	**RF0010**	Providing and fixing of PGI semi-circular gutter including brackets, hooks,sockets bolts, nuts, washers and rain water pipe connections etc complete, excluding the cost of pipe, 110-200mm dia		72				*m*	619.23	**44584.56**
34	**PI0123**	Providing & fixing Kitchen Sinks including all connections and fittings, Stainless steel, 940 x 460 x 160 mm, single bowl & drainboard		4				*each*	2765.41	**11061.64**
35	**PI0050**	Providing & fixing European-type vitreous china w.c pedestal including seat and lid with c.p brass hinges, 15 lit white vitreous china low level cistern, fittings, brackets, repair walls, white, with plastic seat & lid		8				*each*	5889.99	**47119.92**
36	**PI0177**	Providing & fixing C.P. Brass shower fittings Shower arm, standard 15mm		8				*each*	473.96	**3791.68**

APPENDIX D DETAIL ESTIMATE FOR BUILDING ALTERNATIVE 4

Sl. No	BSR CODE	Item Description	No	L	B	H	Qty	Unit	Rate	Amount
1	**EW0001**	Surface dressing of ground, including removal of vegetations and inequalities < 150mm deep, disposal of rubbish within 50m in Ordinary Soil	1	21	11		**231**	*sq.m*	12.77	**2949.87**
2	**EW0030**	**Earth work** in excavation over areas, depth >300mm, width >1.5m, area >10 Sq.m on plan, including disposal of excavated earth within 50m lead and 1.5m liff & disposed soil to be neatly dressed. In ordinary Soil								
		Long Walls…..	3	20.40	1.6	1.6	156.67			
		Short Walls…..	6	7.90	1.6	1.6	121.34			
						Total	**278.02**	*cum*	162.02	**45044.1523**
3	**SM0005**	Providing & laying Random Rubble Masonry with hard stone in foundation & plinth In cement mortar 1:4								
		Stone soling for footing…..	18	1.6	1.6	0.15	6.91			
		Stone soling for external and Internal walls…..								
		Long Walls…..	2	19.6	0.8	0.15	4.70			
		Long wall front part…..	1	16.95	0.8	0.15	2.03			
		Short Walls…..	6	8.9	0.6	0.15	4.81			
						Total	**18.46**	*cum*	4970.70	**91739.2392**
4	**CW0006**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 40 mm nominal size)								

		P.C.C in footing level.	18	1.6	1.6	0.10	4.61			
		P.C.C for external and Internal walls…..								
		Long Walls…...	2	19.6	0.8	0.10	3.14			
		Long wall front part…...	1	16.95	0.8	0.10	1.36			
		Short Walls…...	6	8.9	0.6	0.10	3.20			
						Total	**12.30**	*cum*	5095.15	**62690.7256**
5	**SM0005**	Providing & laying Random Rubble Masonry with hard stone in foundation & plinth, In cement mortar 1:4								
		Long Walls…...	2	19.25	0.45	0.60	10.40			
		Long wall front part…...	1	16.60	0.45	0.60	4.48			
		Short Walls…...	6	9.10	0.40	0.60	13.10			
						Total	**27.98**	*cum*	4970.70	**139085.157**
6	**BW0012**	Extra for brick work in superstructure above plinth level, up to floor two level								
		Long Wall…...	1	19.05	0.105	6.48	12.96			
		Long wall front part…...	1	16.49	0.105	6.48	11.22			
		Short Walls…...	2	9.25	0.105	6.48	12.59			
		Long walls at main entry…..	2	5.65	0.105	6.48	7.69			
		Internal Partition wall…..								
		Partition Walls 1…..	2	9.25	0.125	6.48	14.99			
		Partition Walls 2…..	2	3.68	0.125	6.48	5.95			
		Partition Walls 3…..	2	4.45	0.125	6.48	7.21			
		Partition Walls 4…..	2	3.68	0.125	6.48	5.95			
		Partition Walls 5…..	2	3.50	0.125	6.48	5.67			
		Partition Wall 6..…...	2	3.20	0.125	6.48	5.18			
		External front wall…...	1	3.85	0.105	5.02	2.03			
		Total quantity of bricks without deduction					**91.44**			
		Doors and Windows deduction								
		Doors….....								
		D1….	4	1.05	0.25	2.10	2.21			
		D2….	8	0.95	0.125	2.10	2.00			

		D3….	4	0.85	0.25	2.10	1.79			
		D4….	4	0.85	0.125	2.10	0.89			
		D5….	8	0.85	0.125	2.10	1.79			
		Windows & Cornices….....								
		W1…..	2	2.78	0.25	1.76	2.44			
		W2…..	12	2.10	0.25	1.76	11.09			
		W3…..	1	2.10	0.25	2.78	1.46			
		W4…..	2	2.76	0.25	2.01	2.77			
		W5…..	4	2.10	0.25	2.01	4.22			
		W6…..	4	1.50	0.25	1.36	2.04			
		W7…..	8	0.75	0.25	1.36	2.04			
						Total deduction	**34.72**			
		Total quantity of bricks after deduction…					**56.72**	*cum*	331.47	**18802.448**
		EPS insulation...								
		Long Wall…...	1	19.05		6.48	123.44			
		Long wall front part…...	1	16.49		6.48	106.86			
		Short Walls…...	2	9.25		6.48	119.88			
		Long walls at main entry…..	2	5.65		6.48	73.22			
		External front wall…...	1	3.85		5.02	19.33			
					Total		**442.73**			
		Doors and Window Deduction								
		Windows & Cornices….....								
		W1…..	2	2.78		1.76	9.74			
		W2…..	12	2.10		1.76	44.35			
		W3…..	1	2.10		2.78	5.83			
		W4…..	2	2.76		2.01	11.10			
		W5…..	4	2.10		2.01	16.88			
		W6…..	4	1.50		1.36	8.16			
		W7…..	8	0.75		1.36	8.16			
		Doors….....								
		D1….	4	1.05		2.10	8.82			
						Total deduction	**113.04**			
					Total after deduction		**329.69**	*sq.m*	250.00	**82422.81**
7	**MT0140**	Autoclaved aerated cement (AAC) blocks								
		Long Wall…...	1	19.05	0.15	6.48	18.52			
		Long wall front part…...	1	16.49	0.15	6.48	16.03			

		Short Walls…..	2	9.25	0.15	6.48	17.98			
		Long walls at main entry…..	2	5.65	0.15	6.48	10.98			
		External front wall…..	1	3.85	0.15	5.02	2.90			
			Total				**66.41**			
		Doors and Window Deduction								
		Windows & Cornices….....								
		W1…..	2	2.78	0.25	1.76	2.44			
		W2…..	12	2.10	0.25	1.76	11.09			
		W3…..	1	2.10	0.25	2.78	1.46			
		W4…..	2	2.76	0.25	2.01	2.77			
		W5…..	4	2.10	0.25	2.01	4.22			
		W6…..	4	1.50	0.25	1.36	2.04			
		W7…..	8	0.75	0.25	1.36	2.04			
		Doors….....								
		D1….	4	1.05	0.25	2.10	2.21			
						Total deduction	**28.26**			
			Total after deduction				**38.15**	*cu.m*	6500.00	**247973.65**
8	**PL0021**	Providing & laying 13mm cement plaster C.M 1:4								
		Long Wall…..	1	19.05		6.48	**123.44**			
		Long wall front part…...	1	16.49		6.48	**106.86**			
		Short Walls…...	2	9.25		6.48	**119.88**			
		Long walls at main entry…..	2	5.65		6.48	**73.22**			
		External front wall…..	1	3.85		5.02	**19.33**			
			Total				**442.73**			
		Doors and Window Deduction								
		Windows & Cornices….....								
		W1…..	2	2.78	0.25	1.76	2.44			
		W2…..	12	2.10	0.25	1.76	11.09			
		W3…..	1	2.10	0.25	2.78	1.46			
		W4…..	2	2.76	0.25	2.01	2.77			
		W5…..	4	2.10	0.25	2.01	4.22			
		W6…..	4	1.50	0.25	1.36	2.04			
		W7…..	8	0.75	0.25	1.36	2.04			
		Doors….....								

		D1….	4	1.05	0.25	2.10	2.21			
						Total deduction	**28.26**			
				Total after deduction			**414.47**	*sq.m*	210.85	**87391.10**
		Flooring work (First Floor)								
9	**EW0197**	Providing & laying dry earth bedding, including consolidating each deposited layer by watering, ramming and dressing	1	19.15	9.85	0.5	**94.31**	*cum*	213.30	**20117.12**
10	**SM0072**	Providing and laying Hand packed stone filling or soling with stones								
		Master Bed Room…..	2	3.68	3.73	0.15	4.12			
		Bed Room…..	2	3.83	3.48	0.15	4.00			
		Common Toilet…..	2	1.90	2.63	0.15	1.50			
		Toilet…..	2	1.80	2.65	0.15	1.43			
		Kitchen…..	2	3.20	3.48	0.15	3.34			
		Dinning room…..	2	3.78	5.90	0.15	6.69			
						Total	**21.08**	*cum*	1697.03	**35769.90**
11	**FL0051**	Pal cement concrete flooring 1:2:4, finished with floating coat of neat cement 20mm aggregates, 40mm thick								
		Master Bed Room…..	2	3.68	3.73		27.45			
		Bed Room…..	2	3.83	3.48		26.66			
		Common Toilet…..	2	1.90	2.63		9.99			
		Toilet…..	2	1.80	2.65		9.54			
		Kitchen…..	2	3.20	3.48		22.27			
		Dinning room…..	2	3.78	5.90		44.60			
						Total	**140.52**	*sq.m*	415.75	**58421.0237**
		Flooring work (Second Floor)								

12	**RC0014**	Providing & laying in position reinforced cement concrete work in suspended floor, roofs having slope upto 15o, landings,balconies, shelves and chajjas upto floor five level excluding the cost of centering, shuttering and reinforcement 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Flooring Slab	1	19.15	9.85	0.15	28.29			
		Balcony Slab	2	3.90	1.20	0.15	1.40			
		Roof Slab	1	19.15	9.85	0.14	26.41			
						Total	**56.11**	*cum*	6961.70	**390592.966**
		Concrete Work in Footing, Beams, Columns								
13	**RC0010**	Providing & laying in position reinforced cement concrete work in plinth and skirting courses, fillets, columns , pillars, posts and struts upto floor five level excluding the cost of centering, shuttering and reinforcement.								
		Footing(500mm P.C.C)	18	1.60	1.60	0.50	23.04			
		Column….....	18	8.68	0.40	0.40	25.00			
						Total	**48.04**	*cum*	6795.46	**326443.026**
14	**RC0018**	Providing & laying in position reinforced cement concrete work in beams, lintels, bands, plain window sills, staircases, spiral staircases upto floor five level excluding								

		the cost of centering, shuttering and reinforcement								
		Beams ….	9	18.8	0.40	0.30	20.30			
		Beams ….	18	9.5	0.40	0.30	20.52			
						Total	**40.82**	*cum*	6790.57	**277218.23**
		Plastering work								
15	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement 20mm plaster in C.M 1:4								
		Plastering on External wall	2	19.15	6.48		248.184			
			4	9.85	6.48		255.312			
			4	8	6.48		207.36			
			4	5.9	6.48		152.928			
						Total	**863.784**			
		Doors and Window Deduction								
		Windows & Cornices….....								
		W1…..	4	2.78		1.76	19.48			
		W2…..	24	2.10		1.76	88.70			
		W3…..	2	2.10		2.78	11.66			
		W4…..	4	2.76		2.01	22.19			
		W5…..	8	2.10		2.01	33.77			
		W6…..	8	1.50		1.36	16.32			
		W7…..	16	0.75		1.36	16.32			
		Doors….....								
		D1….	4	1.05		2.10	8.82			
						Total deduction	**217.26**			
					Total after deduction		**646.53**	*sq.m*	359.57	**232471.39**
16	**PL0031**	Providing & laying 15mm cement plaster on rough side of single or half-brick wall C.M 1:4								
		Partition Walls 1…..	4	9.25		6.48	239.76			
		Partition Walls 2…..	4	3.68		6.48	95.26			

		Partition Walls 3…..	4	4.45		6.48	115.34			
		Partition Walls 4…..	4	3.68		6.48	95.26			
		Partition Walls 5…..	4	3.50		6.48	90.72			
		Partition Wall 6..….	4	3.20		6.48	82.94			
						Total	**719.28**			
		Doors Deduction								
		D2….	16	0.95		2.10	31.92			
		D3….	8	0.85		2.10	14.28			
		D4….	8	0.85		2.10	14.28			
		D5….	16	0.85		2.10	28.56			
						Total	**89.04**			
			Total after deduction				**630.24**	*sq.m*	248.37	**156532.71**
		Floor plastering								
17	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement. 20mm plaster in C.M 1:4								
		Master Bedroom	2	3.68	3.73		27.45			
		Bed Room	2	3.83	3.48		26.66			
		Toilet 1	2	2.63	1.9		9.99			
		Toilet 2	2	2.65	1.8		9.54			
		Dinning Room	2	5.9	3.78		44.60			
		Kitchen	2	3.2	3.48		22.27			
							140.52	*sq.m*	359.57	**50526.6326**
18	**PL0011**	Providing & laying 6mm cement plaster (in Ceiling) (C.M 1:4)								
		Master Bedroom	4	3.68	3.73		54.91			
		Bed Room	4	3.83	3.48		53.31			
		Toilet 1	4	2.63	1.9		19.99			
		Toilet 2	4	2.65	1.8		19.08			
		Dinning Room	4	5.9	3.78		89.21			
		Kitchen	4	3.2	3.48		44.54			
						Total	281.04	*sq.m*	160.79	**45188.29**
		Traditional Cornices								

		Bhutan type Traditional Cornices in R.C.C 1:1.5:3, 20 mm aggregate including cost of formwork including finishing with 6mm thick plaster on the exposed surface with cement mortar 1:3, excluding reinforcement & decorative painting cost as per standard design (Measurement to be taken along the cornice and wall junction)								
19	**RC0031**	Multi-Storied building..at floor 2 level including the cost of lhanglag and at other floors where Lhanglag is provided								
		Rabsey 1	2	4.35			8.7	*m*	2843.55	**24738.89**
		Rabsey 2	4	2.10			8.4		2843.55	**23885.82**
20	**RC0003**	Providing & laying in position reinforced cement concrete excluding the cost of centering, shuttering and reinforcement - all work upto plinth level								
		R.C.C Bogh	120	0.3	0.125	0.1	0.45			
			20	0.3	0.125	0.1	0.08			
						Total	**0.53**	*cum*	6059.32	**3181.143**
		Traditional Painting								
21	**PT0100**	Providing, preparing and applying Sumdang painting (Not washable)								

		Rab….....	4	2.75	1		11			
			24	2.1	1		50.4			
			4	2.78	0.5		5.56			
			8	2.1	0.5		8.4			
			2	2.1	1		4.2			
			16	0.44	0.5		3.52			
			8	1.5	0.5		6			
			8	1.05	0.50		4.2			
			16	0.95	1.00		15.2			
			8	0.85	0.50		3.4			
			8	0.85	0.50		3.4			
			16	0.85	1.00		13.6			
						Total	**128.88**		1284.53	**165550.23**
		Stair Case								
		Providing & laying in position reinforced cement concrete work in beams, lintels, bands, plain window sills, staircases, spiral staircases upto floor five level excluding the cost of centering, shuttering and reinforcement								
22	**RC0018**	1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Base Slab….	1	3.46	1.33	0.16	0.74			
		Riser and Tread….	16	1.33	0.02		0.48			
		Base Slab….	1	1.54	1.33	0.16	0.33			
						Total	1.54	*cum*	6790.57	**10476.49**
		Stair case landing	1	2.65	1.2	0.15	0.48			
			1	1.33	2.3	0.15	0.46			
						Total	0.94	*cum*	6790.57	**6354.95493**
		Plinth Protection Wall								
23	**SM0072**	Providing and laying Hand packed stone filling or soling with stones								

		Length Wise….....	2	22.65	1.75	0.15	11.89			
		Breath Wise….....	2	9.85	1.75	0.15	5.17			
						Total	17.06	*cum*	1697.03	**28955.57**
24	**CW0002**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level.								
		1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Length Wise….....	2	22.1	1.475	0.1	6.52			
		Breath Wise….....	2	9.85	1.475	0.1	2.91			
						Total	9.43	*cum*	6661.50	**62786.30**
25	**CW0009**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level.1:4:8 (1 cement : 4 sand : 8 graded crushed stone 50 mm nominal size)								
			2	22.1	1.475	0.05	3.26			
			2	9.85	1.475	0.05	1.45			
						Total	4.71	*cum*	4372.85	**20607.60**
26	**BW0002**	Providing & laying Second-Class Brick work in Foundation & Plinth. In cement mortar 1:4								
		Length Wise….....	4	22.65	0.125	0.325	3.68			
		Breath Wise….....	4	9.85	0.125	0.325	1.60			
			2	22.65	0.125	0.25	1.42			
			2	9.85	0.125	0.25	0.62			
						Total	7.31	*cum*	9310.91	**68086.0294**

27	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement 20mm plaster in C.M 1:4								
			4	22.65	0.2		18.12			
			4	9.85	0.2		7.88			
			2	22.65	0.25		11.33			
			2	9.85	0.25		4.93			
						Total	42.25	*sq.m*	359.57	**15191.83**
		Column Reinforcement								
28	**RC0083**	Providing & fixing Thermo-Mechanically Treated reinforcement bar (Yield Strength 500 MPa) for R.C.C work including cutting, bending, binding and placing in position complete								
		20mm Dia main bar reinforcement @ 2.469kg/m	18	8	9.86	2.47	3505.58			
		25mm Dia main bar reinforcement @ 3.858kg/m	18	4	9.86	3.858	2738.87			
		8mm Dia stirrups reinforcement @ 0.395 kg/m	18	134	1.264	0.395	1204.26			
		Splicing								
		20mm Dia main bar reinforcement @ 2.469kg/m	18	4	2.35	2.469	417.75			
		25mm Dia main bar reinforcement @ 3.858kg/m	18	2	2.35	3.858	326.39			
		Beam Reinforcement								
		Plinth &Roof Beam reinforcement								
		20mm Dia main bar reinforcement @ 2.469kg/m	12	2	21.1	2.469	1250.30			
		16mm Dia main	12	2	21.1	1.58	800.11			

		bar reinforcement @ 1.58kg/m								
		20mm Dia Top reinforcement @ 2.469kg/m	12	2	21.1	2.469	1250.30			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	12	2	19.88	2.469	1178.01			
		8mm Dia stirrups reinforcement @ 0.395 kg/m for **Plinth beam, First floor, roof beam**	8	146	1.26	0.395	581.31			
			1	126	1.26	0.395	62.71			
		First Floor Beam								
		20mm Dia main bar reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		16mm Dia main bar reinforcement @ 1.58kg/m	2	2	21.1	1.58	133.35			
		20mm Dia Top reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		20mm Dia main bar reinforcement @ 2.469kg/m	2	2	10.2	2.469	100.74			
		16mm Dia main bar reinforcement @ 1.58kg/m	2	2	10.2	1.58	64.46			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	2	2	16.88	2.469	166.71			
		20mm Dia Top reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	2	2	19.88	2.469	196.33			
						Total	14602.35	***Kg***	**89.38**	**1305158.34**
		Reinforcement Qty. Cal. In shorter length Dir.Pinth beam, first floor and Roof								
		16mm Dia main bar reinforcement @ 1.58kg/m	8	4	10.7	1.58	540.99			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	2	11.25	1.58	284.40			
		20mm Dia main bar reinforcement @ 2.469kg/m	8	2	11.25	2.469	444.42			

		16mm Dia main bar reinforcement @ 1.58kg/m	8	4	11.00	1.58	556.16			
		20mm Dia main bar reinforcement @ 2.469kg/m	8	2	11.38	2.47	449.56			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	2	10	1.58	252.80			
		Stirrups 8mmdia @ 0.395kg/m	8	82	1.04	0.395	269.48			
			10	74	1.04	0.395	303.99			
						Total	3101.80	***Kg***	**89.38**	**277239.27**
29	**RC0083**	Providing & fixing Thermo-Mechanically Treated reinforcement bar (Yield Strength 500 MPa) for R.C.C work including cutting, bending, binding and placing in position complete								
		Slab and Roof slab Reinforcement								
		Bottom reinforcnement								
		10mm Dia main bar reinforcement @ 0.617kg/m	26	18.8	2	0.62	603.18			
		10mm Dia main bar reinforcement @ 0.617kg/m	105	4.75	2	0.62	615.46			
		10mm Dia main bar reinforcement @ 0.617kg/m	52	7.9	2	0.62	506.93			
		10mm Dia main bar reinforcement @ 0.617kg/m	88	4.75	2	0.62	515.81			
		Balcony Reinforcement								
		10mm Dia main bar reinforcement @ 0.617kg/m	4	7	3.9	0.62	67.70			
		10mm Dia main bar reinforcement @ 0.617kg/m	4	22	3.9	0.62	212.78			
		Top reinforcement								
		10mm Dia main bar	26	11.28	2	0.62	361.91			

		reinforcement @ 0.617kg/m								
		10mm Dia main bar reinforcement @ 0.617kg/m	105	2.90	2	0.62	375.75			
		10mm Dia main bar reinforcement @ 0.617kg/m	52	4.68	2	0.62	300.31			
		10mm Dia main bar reinforcement @ 0.617kg/m	88	2.90	2	0.62	314.92			
						Total	3874.75	***Kg***	**89.38**	**346324.93**
		Footing Reinforcement								
		12mm Dia main bar bot. reinforcement @ 0.89kg/m	18	22	2.6	0.89	916.34			
		12mm Dia main bar top reinforcement @ 0.89kg/m	18	18	2.6	0.89	749.74			
						Total	1666.08	***Kg***	**89.38**	**148914.23**
		Windows(Mixed Conifer)								
30	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed, Mixed conifer								
		Window Frame bottom (**Window 1**)	4	2.78	0.20	0.10	0.22			
		Window side frame	4	1.50	0.20	0.10	0.12			
		Kachung	10	1	0.08	0.065	0.05			
		Jugshing	2	2.58	0.065	0.065	0.02			
		Horzhu	2	2.58	0.15	0.065	0.05			
		Window Frame bottom (**Window 2**)	24	2.10	0.2	0.1	1.008			
		Window side frame	24	1.50	0.20	0.10	0.72			
		Kachung	60	1.00	0.08	0.065	0.312			
		Jugshing	12	1.9	0.065	0.065	0.10			
		Horzhu	12	1.9	0.15	0.065	0.22			
		Window Frame bottom (**Window 3**)	2	2.10	0.2	0.1	0.08			
		Window side frame	2	2.00	0.20	0.10	0.08			

		Kachung	1	1.50	0.08	0.065	0.01			
		Jugshing	1	1.9	0.065	0.065	0.01			
		Horzhu	1	1.9	0.15	0.065	0.02			
		Window Frame bottom (**Window 4**)	4	2.78	0.20	0.1	0.22			
		Window side frame	4	1.86	0.20	0.10	0.15			
		Kachung	2	1.36	0.08	0.065	0.01			
		Jugshing	2	2.58	0.065	0.065	0.02			
		Horzhu	2	2.58	0.15	0.065	0.05			
		Window Frame bottom (**Window 5**)	4	2.10	0.20	0.1	0.17			
		Window side frame	4	1.86	0.20	0.10	0.15			
		Kachung	2	1.36	0.08	0.065	0.01			
		Jugshing	2	1.90	0.065	0.065	0.02			
		Horzhu	2	1.90	0.15	0.065	0.04			
		Window Frame bottom (**Window 6**)	8	1.50	0.13	0.1	0.15			
		Window side frame	8	1.10	0.13	0.10	0.11			
		Kachung	4	0.67	0.08	0.065	0.01			
		Horzhu	4	1.12	0.15	0.065	0.04			
		Window Frame bottom (**Window 7**)	16	0.75	0.13	0.1	0.15			
		Window side frame	16	1.10	0.13	0.10	0.22			
		Kachung	16	0.67	0.08	0.065	0.06			
		Horzhu	8	0.55	0.15	0.065	0.04			
						Total	4.65	*cum*	26522.54	**123363.16**
		Door (Oak Tree)								
31	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed, Mixed conifer								
		Door1…....								
		Top frame	4	1.05	0.1	0.125	0.05			
		Side frame	8	2.1	0.1	0.13	0.22			
		Door panel	4	2	0.85	0.03	0.24			

						5				
		Door2…....								
		Top frame	16	0.95	0.1	0.125	0.19			
		Side frame	32	2.1	0.1	0.13	0.87			
		Door panel	16	2	0.75	0.035	0.84			
		Door3…....								
		Top frame	8	0.85	0.1	0.125	0.09			
		Side frame	16	2.1	0.1	0.13	0.44			
		Door panel	8	2	0.65	0.035	0.36			
		Door4…....								
		Top frame	8	0.85	0.1	0.125	0.09			
		Side frame	16	2.1	0.1	0.13	0.44			
		Door panel	8	2	0.65	0.035	0.36			
						Total	4.18	*cum*	26522.54	**110972.96**
		Roof Truss								
32	**SW0022**	Steel work welded, in built up sections, trusses, frame-works including cutting, hoisting, fixing and appl. priming coat of red								
		Truss 1(T1)…....								
		Top Chord or Rafter (76.1ØM, 6.53KG/M)….....	8	2.67	6.53		139.48			
		Bottom Chord or Tie (76.1ØM, 6.53KG/M)….....	8	2.60	6.53		135.82			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	0.89	5.1		36.31			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.60	5.1		24.48			
		Truss 2(T2)…....								
		Top Chord or Rafter (76.1ØM, 6.53KG/M)….....	8	4.06	6.53		212.09			

		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	3.95	6.53		206.35			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.21	5.1		49.37			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.36	5.1		55.49			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.68	5.1		27.74			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.91	5.1		37.13			
		Truss 3(T3)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)…… .	8	5.46	6.53		285.23			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	5.32	6.53		277.92			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.33	5.1		54.26			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.48	5.1		60.38			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.67	5.1		68.14			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.71	5.1		28.97			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.97	5.1		39.58			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	1.23	5.1		50.18			
		Truss 4(T4)…....								
		Top Chord or Rafter (76.1ØM	2	6.88	6.53		89.85			

		, 6.53KG/M)….....								
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	2	6.61	6.53		86.33			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.07	5.1		10.91			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.38	5.1		14.08			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.54	5.1		15.71			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.73	5.1		17.65			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.96	5.1		19.99			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.23	5.1		2.35			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.45	5.1		4.59			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.72	5.1		7.34			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.995	5.1		10.15			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	1.27	5.1		12.95			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	1.55	5.1		15.81			
		Truss 5(T5)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)…..	14	6.88	6.53		628.97			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	14	6.69	6.53		611.60			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.07	5.1		76.40			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.38	5.1		98.53			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.54	5.1		109.96			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.73	5.1		123.52			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.96	5.1		139.94			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.23	5.1		16.42			

		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.45	5.1		32.13			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.72	5.1		51.41			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.995	5.1		71.04			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	1.27	5.1		90.68			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	1.55	5.1		110.67			
		Truss 6(T6)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	4	9.6	6.53		250.75			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	4	9.48	6.53		247.62			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.28	5.1		26.11			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.49	5.1		30.40			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.61	5.1		32.84			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.74	5.1		35.50			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.88	5.1		38.35			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	2.06	5.1		42.02			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.25	5.1		5.10			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.45	5.1		9.18			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.67	5.1		13.67			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.89	5.1		18.16			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.11	5.1		22.64			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.33	5.1		27.13			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.55	5.1		31.62			
						Total	5303.20	Kg	86.59	**459204.16**
		Purlin								

		Purlin (76.1ØM, 6.53KG/M)….....	2	23.05	6.53		301.03			
		Purlin (76.1ØM, 6.53KG/M)….....	2	13.75	6.53		179.58			
		Purlin (76.1ØM, 6.53KG/M)….....	2	19.15	6.53		250.10			
		Purlin (76.1ØM, 6.53KG/M)….....	2	9.85	6.53		128.64			
		Purlin (76.1ØM, 6.53KG/M)….....	2	17.15	6.53		223.98			
		Purlin (76.1ØM, 6.53KG/M)….....	2	7.85	6.53		102.52			
		Purlin (76.1ØM, 6.53KG/M)….....	2	15.15	6.53		197.86			
		Purlin (76.1ØM, 6.53KG/M)….....	2	5.85	6.53		76.40			
						Total	1460.11	Kg	86.59	**126430.75**
33	**RF0003**	Providing & fixing Pre Painted Steel Corrugated Roofing sheets, including bolts, hooks and nuts 8mm dia. with bitumen and G.I limpet washers filled with white lead for connection, excluding the cost of purlins, rafter and trusses.								
		25g (0.50mm)					108.00	*sq.m*	1070.16	**115577.28**
34	**WW0030**	Providing & fixing Eaves board (225x25mm) with moulding fitted and fixed with necessary screws Mixed Conifer		56			56	*m*	180.15	**10088.40**

35	**RF0010**	Providing and fixing of PGI semi-circular gutter including brackets, hooks,sockets bolts, nuts, washers and rain water pipe connections etc complete, excluding the cost of pipe, 110-200mm dia		72				*m*	619.23	**44584.56**
36	**PI0123**	Providing & fixing Kitchen Sinks including all connections and fittings, Stainless steel, 940 x 460 x 160 mm, single bowl & drainboard		4				*each*	2765.41	**11061.64**
37	**PI0050**	Providing & fixing European-type vitreous china w.c pedestal including seat and lid with c.p brass hinges, 15 lit white vitreous china low level cistern, fittings, brackets, repair walls, white, with plastic seat & lid		8				*each*	5889.99	**47119.92**
38	**PI0177**	Providing & fixing C.P. Brass shower fittings Shower arm, standard 15mm		8				*each*	473.96	**3791.68**

APPENDIX E DETAIL ESTIMATE FOR BUILDING ALTERNATIVE 5

SI. No	BSR CODE	Item Description	No	L	B	H	Qty	Unit	Rate	Amount
1	**EW0001**	Surface dressing of ground, including removal of vegetations and inequalities < 150mm deep, disposal of rubbish within 50m in Ordinary Soil	1	21	11		**231**	*sq.m*	12.77	**2949.87**
2	**EW0030**	**Earth work** in excavation over areas, depth >300mm, width >1.5m, area >10 Sq.m on plan, including disposal of excavated earth within 50m lead and 1.5m liff & disposed soil to be neatly dressed. In ordinary Soil								
		Long Walls…..	3	20.40	1.6	1.6	156.67			
		Short Walls…..	6	7.90	1.6	1.6	121.34			
						Total	**278.02**	*cum*	162.02	**45044.1523**
3	**SM0005**	Providing & laying Random Rubble Masonry with hard stone in foundation & plinth In cement mortar 1:4								
		Stone soling for footing…..	18	1.6	1.6	0.15	6.91			
		Stone soling for external and Internal walls…..								
		Long Walls…..	2	19.6	0.8	0.15	4.70			
		Long wall front part…...	1	16.95	0.8	0.15	2.03			
		Short Walls…..	6	8.9	0.6	0.15	4.81			
						Total	**18.46**	*cum*	4970.70	**91739.2392**
4	**CW0006**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth 1:3:6 (1 cement : 3 sand : 6 graded								

		crushed rock 40 mm nominal size)								
		P.C.C in footing level.	18	1.6	1.6	0.10	4.61			
		P.C.C for external and Internal walls…..								
		Long Walls…...	2	19.6	0.8	0.10	3.14			
		Long wall front part…...	1	16.95	0.8	0.10	1.36			
		Short Walls…...	6	8.9	0.6	0.10	3.20			
						Total	**12.30**	*cum*	5095.15	**62690.7256**
5	**SM0005**	Providing & laying Random Rubble Masonry with hard stone in foundation & plinth, In cement mortar 1:4								
		Long Walls…...	2	19.25	0.45	0.60	10.40			
		Long wall front part…...	1	16.60	0.45	0.60	4.48			
		Short Walls…...	6	9.10	0.40	0.60	13.10			
						Total	**27.98**	*cum*	4970.70	**139085.157**
6	**BW0012**	Extra for brick work in superstructure above plinth level, up to floor two level								
		Long Wall…...	1	19.05	0.105	6.48	12.96			
		Long wall front part…...	1	16.49	0.105	6.48	11.22			
		Short Walls…...	2	9.25	0.105	6.48	12.59			
		Long walls at main entry…..	2	5.65	0.105	6.48	7.69			
		Internal Partition wall…..								
		Partition Walls 1…..	2	9.25	0.125	6.48	14.99			
		Partition Walls 2…..	2	3.68	0.125	6.48	5.95			
		Partition Walls 3…..	2	4.45	0.125	6.48	7.21			
		Partition Walls 4…..	2	3.68	0.125	6.48	5.95			
		Partition Walls 5…..	2	3.50	0.125	6.48	5.67			
		Partition Wall 6..….	2	3.20	0.125	6.48	5.18			
		External front wall…...	1	3.85	0.105	5.02	2.03			
		Total quantity of bricks without deduction					**91.44**			

		Doors and Windows deduction								
		Doors….....								
		D1….	4	1.05	0.25	2.10	2.21			
		D2….	8	0.95	0.125	2.10	2.00			
		D3….	4	0.85	0.25	2.10	1.79			
		D4….	4	0.85	0.125	2.10	0.89			
		D5….	8	0.85	0.125	2.10	1.79			
		Windows & Cornices….....								
		W1…..	2	2.78	0.25	1.76	2.44			
		W2…..	12	2.10	0.25	1.76	11.09			
		W3…..	1	2.10	0.25	2.78	1.46			
		W4…..	2	2.76	0.25	2.01	2.77			
		W5…..	4	2.10	0.25	2.01	4.22			
		W6…..	4	1.50	0.25	1.36	2.04			
		W7…..	8	0.75	0.25	1.36	2.04			
						Total deduction	**34.72**			
						Total quantity of bricks after deduction…	**56.72**	*cum*	331.47	**18802.448**
7	**MT0140**	Autoclaved aerated cement (AAC) blocks								
		Long Wall…...	1	19.05	0.15	6.48	18.52			
		Long wall front part…...	1	16.49	0.15	6.48	16.03			
		Short Walls…...	2	9.25	0.15	6.48	17.98			
		Long walls at main entry…..	2	5.65	0.15	6.48	10.98			
		External front wall…...	1	3.85	0.15	5.02	2.90			
						Total	**66.41**			
		Doors and Window Deduction								
		Windows & Cornices….....								
		W1…..	2	2.78	0.25	1.76	2.44			
		W2…..	12	2.10	0.25	1.76	11.09			
		W3…..	1	2.10	0.25	2.78	1.46			
		W4…..	2	2.76	0.25	2.01	2.77			
		W5…..	4	2.10	0.25	2.01	4.22			
		W6…..	4	1.50	0.25	1.36	2.04			
		W7…..	8	0.75	0.25	1.36	2.04			
		Doors….....								
		D1….	4	1.05	0.25	2.10	2.21			

						Total deduction	**28.26**			
				Total after deduction			**38.15**	*cu.m*	6500.00	**247973.65**
8	**PL0021**	Providing & laying 13mm cement plaster C.M 1:4								
		Long Wall…...	1	19.05		6.48	**123.44**			
		Long wall front part…...	1	16.49		6.48	**106.86**			
		Short Walls…...	2	9.25		6.48	**119.88**			
		Long walls at main entry…..	2	5.65		6.48	**73.22**			
		External front wall…...	1	3.85		5.02	**19.33**			
					Total		**442.73**			
		Doors and Window Deduction								
		Windows & Cornices….....								
		W1…..	2	2.78	0.25	1.76	2.44			
		W2…..	12	2.10	0.25	1.76	11.09			
		W3…..	1	2.10	0.25	2.78	1.46			
		W4…..	2	2.76	0.25	2.01	2.77			
		W5…..	4	2.10	0.25	2.01	4.22			
		W6…..	4	1.50	0.25	1.36	2.04			
		W7…..	8	0.75	0.25	1.36	2.04			
		Doors….....								
		D1….	4	1.05	0.25	2.10	2.21			
						Total deduction	**28.26**			
				Total after deduction			**414.47**	*sq.m*	210.85	**87391.10**
		Flooring work (First Floor)								
9	**EW0197**	Providing & laying dry earth bedding, including consolidating each deposited layer by watering, ramming and dressing	1	19.15	9.85	0.5	**94.31**	*cum*	213.30	**20117.1229**
10	**SM0072**	Providing and laying Hand packed stone filling or soling with stones								
		Master Bed Room…..	2	3.68	3.73	0.15	4.12			
		Bed Room…..	2	3.83	3.48	0.15	4.00			

		Common Toilet…..	2	1.90	2.63	0.15	1.50			
		Toilet…..	2	1.80	2.65	0.15	1.43			
		Kitchen…..	2	3.20	3.48	0.15	3.34			
		Dinning room…..	2	3.78	5.90	0.15	6.69			
						Total	**21.08**	*cum*	1697.03	**35769.8965**
11	**FL0051**	Pal cement concrete flooring 1:2:4, finished with floating coat of neat cement 20mm aggregates, 40mm thick								
		Master Bed Room…..	2	3.68	3.73		27.45			
		Bed Room…..	2	3.83	3.48		26.66			
		Common Toilet…..	2	1.90	2.63		9.99			
		Toilet…..	2	1.80	2.65		9.54			
		Kitchen…..	2	3.20	3.48		22.27			
		Dinning room…..	2	3.78	5.90		44.60			
						Total	**140.52**	*sq.m*	415.75	**58421.0237**
		Flooring work (Second Floor)								
12	**RC0014**	Providing & laying in position reinforced cement concrete work in suspended floor, roofs having slope upto 15o, landings,balconies, shelves and chajjas upto floor five level excluding the cost of centering, shuttering and reinforcement 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Flooring Slab	1	19.15	9.85	0.15	28.29			
		Balcony Slab	2	3.90	1.20	0.15	1.40			
		Roof Slab	1	19.15	9.85	0.14	26.41			
						Total	**56.11**	*cum*	6961.70	**390592.966**
		Concrete Work in Footing, Beams, Columns								

13	**RC0010**	Providing & laying in position reinforced cement concrete work in plinth and skirting courses, fillets, columns , pillars, posts and struts upto floor five level excluding the cost of centering, shuttering and reinforcement.								
		Footing(500mm P.C.C)	18	1.60	1.60	0.50	23.04			
		Column….....	18	8.68	0.40	0.40	25.00			
						Total	**48.04**	*cum*	6795.46	**326443.026**
14	**RC0018**	Providing & laying in position reinforced cement concrete work in beams, lintels, bands, plain window sills, staircases, spiral staircases upto floor five level excluding the cost of centering, shuttering and reinforcement								
		Beams ….	9	18.8	0.40	0.30	20.30			
		Beams ….	18	9.5	0.40	0.30	20.52			
						Total	**40.82**	*cum*	6790.57	**277218.23**
		Plastering work								
15	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement 20mm plaster in C.M 1:4								
		Plastering on External wall	2	19.15	6.48		248.184			
			4	9.85	6.48		255.312			
			4	8	6.48		207.36			
			4	5.9	6.48		152.928			
						Total	**863.784**			
		Doors and Window Deduction								
		Windows & Cornices….....								
		W1…..	4	2.78		1.76	19.48			
		W2…..	24	2.10		1.76	88.70			

		W3…..	2	2.10		2.78	11.66			
		W4…..	4	2.76		2.01	22.19			
		W5…..	8	2.10		2.01	33.77			
		W6…..	8	1.50		1.36	16.32			
		W7…..	16	0.75		1.36	16.32			
		Doors….....								
		D1….	4	1.05		2.10	8.82			
						Total deduction	**217.26**			
					Total after deduction		**646.53**	*sq.m*	359.57	**232471.39**
16	**PL0031**	Providing & laying 15mm cement plaster on rough side of single or half-brick wall C.M 1:4								
		Partition Walls 1…..	4	9.25		6.48	239.76			
		Partition Walls 2…..	4	3.68		6.48	95.26			
		Partition Walls 3…..	4	4.45		6.48	115.34			
		Partition Walls 4…..	4	3.68		6.48	95.26			
		Partition Walls 5…..	4	3.50		6.48	90.72			
		Partition Wall 6…….	4	3.20		6.48	82.94			
						Total	**719.28**			
		Doors Deduction								
		D2….	16	0.95		2.10	31.92			
		D3….	8	0.85		2.10	14.28			
		D4….	8	0.85		2.10	14.28			
		D5….	16	0.85		2.10	28.56			
						Total	**89.04**			
					Total after deduction		**630.24**	*sq.m*	248.37	**156532.709**
		Floor plastering								
17	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement. 20mm plaster in C.M 1:4								
		Master Bedroom	2	3.68	3.73		27.45			
		Bed Room	2	3.83	3.48		26.66			
		Toilet 1	2	2.63	1.9		9.99			
		Toilet 2	2	2.65	1.8		9.54			

		Dinning Room	2	5.9	3.78		44.60			
		Kitchen	2	3.2	3.48		22.27			
							140.52	*sq.m*	359.57	**50526.6326**
18	**PL0011**	Providing & laying 6mm cement plaster (in Ceiling) (C.M 1:4)								
		Master Bedroom	4	3.68	3.73		54.91			
		Bed Room	4	3.83	3.48		53.31			
		Toilet 1	4	2.63	1.9		19.99			
		Toilet 2	4	2.65	1.8		19.08			
		Dinning Room	4	5.9	3.78		89.21			
		Kitchen	4	3.2	3.48		44.54			
						Total	281.04	*sq.m*	160.79	**45188.293**
		Traditional Cornices								
		Bhutan type Traditional Cornices in R.C.C 1:1.5:3, 20 mm aggregate including cost of formwork including finishing with 6mm thick plaster on the exposed surface with cement mortar 1:3, excluding reinforcement & decorative painting cost as per standard design (Measurement to be taken along the cornice and wall junction)								
19	**RC0031**	Multi-Storied building..at floor 2 level including the cost of lhanglag and at other floors where Lhanglag is provided								
		Rabsey 1	2	4.35			8.7	*m*	2843.55	**24738.885**
		Rabsey 2	4	2.10			8.4		2843.55	**23885.82**

20	**RC0003**	Providing & laying in position reinforced cement concrete excluding the cost of centering, shuttering and reinforcement - all work upto plinth level								
		R.C.C Bogh	120	0.3	0.125	0.1	0.45			
			20	0.3	0.125	0.1	0.08			
						Total	**0.53**	*cum*	6059.32	**3181.143**
		Traditional Painting								
21	**PT0100**	Providing, preparing and applying Sumdang painting (Not washable)								
		Rab….....	4	2.75	1		11			
			24	2.1	1		50.4			
			4	2.78	0.5		5.56			
			8	2.1	0.5		8.4			
			2	2.1	1		4.2			
			16	0.44	0.5		3.52			
			8	1.5	0.5		6			
			8	1.05	0.50		4.2			
			16	0.95	1.00		15.2			
			8	0.85	0.50		3.4			
			8	0.85	0.50		3.4			
			16	0.85	1.00		13.6			
						Total	**128.88**		1284.53	**165550.226**
		Stair Case								
		Providing & laying in position reinforced cement concrete work in beams, lintels, bands, plain window sills, staircases, spiral staircases upto floor five level excluding the cost of centering, shuttering and								

		reinforcement								
22	**RC0018**	1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Base Slab….	1	3.46	1.33	0.16	0.74			
		Riser and Tread….	16	1.33	0.02		0.48			
		Base Slab….	1	1.54	1.33	0.16	0.33			
						Total	1.54	*cum*	6790.57	**10476.49**
		Stair case landing	1	2.65	1.2	0.15	0.48			
			1	1.33	2.3	0.15	0.46			
						Total	0.94	*cum*	6790.57	**6354.95493**
		Plinth Protection Wall								
23	**SM0072**	Providing and laying Hand packed stone filling or soling with stones								
		Length Wise….....	2	22.65	1.75	0.15	11.89			
		Breath Wise….....	2	9.85	1.75	0.15	5.17			
						Total	17.06	*cum*	1697.03	**28955.5744**
24	**CW0002**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level.								
		1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Length Wise….....	2	22.1	1.475	0.1	6.52			
		Breath Wise….....	2	9.85	1.475	0.1	2.91			
						Total	9.43	*cum*	6661.50	**62786.3029**

25	**CW0009**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level.1:4:8 (1 cement : 4 sand : 8 graded crushed stone 50 mm nominal size)								
			2	22.1	1.475	0.05	3.26			
			2	9.85	1.475	0.05	1.45			
						Total	4.71	*cum*	4372.85	**20607.6022**
26	**BW0002**	Providing & laying Second-Class Brick work in Foundation & Plinth. In cement mortar 1:4								
		Length Wise….....	4	22.65	0.125	0.325	3.68			
		Breath Wise….....	4	9.85	0.125	0.325	1.60			
			2	22.65	0.125	0.25	1.42			
			2	9.85	0.125	0.25	0.62			
						Total	7.31	*cum*	9310.91	**68086.0294**
27	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement 20mm plaster in C.M 1:4								
			4	22.65	0.2		18.12			
			4	9.85	0.2		7.88			
			2	22.65	0.25		11.33			
			2	9.85	0.25		4.93			
						Total	42.25	*sq.m*	359.57	**15191.8325**
		Column Reinforcement								
28	**RC0083**	Providing & fixing Thermo-Mechanically Treated reinforcement bar (Yield Strength 500 MPa) for R.C.C work including								

		cutting, bending, binding and placing in position complete								
		20mm Dia main bar reinforcement @ 2.469kg/m	18	8	9.86	2.47	3505.58			
		25mm Dia main bar reinforcement @ 3.858kg/m	18	4	9.86	3.858	2738.87			
		8mm Dia stirrups reinforcement @ 0.395 kg/m	18	134	1.264	0.395	1204.26			
		Splicing								
		20mm Dia main bar reinforcement @ 2.469kg/m	18	4	2.35	2.469	417.75			
		25mm Dia main bar reinforcement @ 3.858kg/m	18	2	2.35	3.858	326.39			
		Beam Reinforcement								
		Plinth &Roof Beam reinforcement								
		20mm Dia main bar reinforcement @ 2.469kg/m	12	2	21.1	2.469	1250.30			
		16mm Dia main bar reinforcement @ 1.58kg/m	12	2	21.1	1.58	800.11			
		20mm Dia Top reinforcement @ 2.469kg/m	12	2	21.1	2.469	1250.30			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	12	2	19.88	2.469	1178.01			
		8mm Dia stirrups reinforcement @ 0.395 kg/m for **Plinth beam, First floor, roof beam**	8	146	1.26	0.395	581.31			
			1	126	1.26	0.395	62.71			
		First Floor Beam								
		20mm Dia main bar reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		16mm Dia main bar reinforcement	2	2	21.1	1.58	133.35			

		@ 1.58kg/m								
		20mm Dia Top reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		20mm Dia main bar reinforcement @ 2.469kg/m	2	2	10.2	2.469	100.74			
		16mm Dia main bar reinforcement @ 1.58kg/m	2	2	10.2	1.58	64.46			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	2	2	16.88	2.469	166.71			
		20mm Dia Top reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	2	2	19.88	2.469	196.33			
						Total	14602.35	***Kg***	**89.38**	**1305158.34**
		Reinforcement Qty. Cal. In shorter length Dir.Pinth beam, first floor and Roof								
		16mm Dia main bar reinforcement @ 1.58kg/m	8	4	10.7	1.58	540.99			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	2	11.25	1.58	284.40			
		20mm Dia main bar reinforcement @ 2.469kg/m	8	2	11.25	2.469	444.42			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	4	11.00	1.58	556.16			
		20mm Dia main bar reinforcement @ 2.469kg/m	8	2	11.38	2.47	449.56			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	2	10	1.58	252.80			
		Stirrups 8mmdia @ 0.395kg/m	8	82	1.04	0.395	269.48			
			10	74	1.04	0.395	303.99			
						Total	3101.80	***Kg***	**89.38**	**277239.27**

29	**RC0083**	Providing & fixing Thermo-Mechanically Treated reinforcement bar (Yield Strength 500 MPa) for R.C.C work including cutting, bending, binding and placing in position complete								
		Slab and Roof slab Reinforcement								
		Bottom reinforcnement								
		10mm Dia main bar reinforcement @ 0.617kg/m	26	18.8	2	0.62	603.18			
		10mm Dia main bar reinforcement @ 0.617kg/m	105	4.75	2	0.62	615.46			
		10mm Dia main bar reinforcement @ 0.617kg/m	52	7.9	2	0.62	506.93			
		10mm Dia main bar reinforcement @ 0.617kg/m	88	4.75	2	0.62	515.81			
		Balcony Reinforcement								
		10mm Dia main bar reinforcement @ 0.617kg/m	4	7	3.9	0.62	67.70			
		10mm Dia main bar reinforcement @ 0.617kg/m	4	22	3.9	0.62	212.78			
		Top reinforcement								
		10mm Dia main bar reinforcement @ 0.617kg/m	26	11.28	2	0.62	361.91			
		10mm Dia main bar reinforcement @ 0.617kg/m	105	2.90	2	0.62	375.75			
		10mm Dia main bar reinforcement @ 0.617kg/m	52	4.68	2	0.62	300.31			
		10mm Dia main bar reinforcement @ 0.617kg/m	88	2.90	2	0.62	314.92			
						Total	3874.75	***Kg***	**89.38**	**346324.93**
		Footing Reinforcement								
		12mm Dia main bar bot. reinforcement	18	22	2.6	0.89	916.34			

		@ 0.89kg/m								
		12mm Dia main bar top reinforcement @ 0.89kg/m	18	18	2.6	0.89	749.74			
						Total	1666.08	***Kg***	**89.38**	**148914.23**
		Windows(Mixed Conifer)								
30	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed, Mixed conifer								
		Window Frame bottom (**Window 1**)	4	2.78	0.20	0.10	0.22			
		Window side frame	4	1.50	0.20	0.10	0.12			
		Kachung	10	1	0.08	0.065	0.05			
		Jugshing	2	2.58	0.065	0.065	0.02			
		Horzhu	2	2.58	0.15	0.065	0.05			
		Window Frame bottom (**Window 2**)	24	2.10	0.2	0.1	1.008			
		Window side frame	24	1.50	0.20	0.10	0.72			
		Kachung	60	1.00	0.08	0.065	0.312			
		Jugshing	12	1.9	0.065	0.065	0.10			
		Horzhu	12	1.9	0.15	0.065	0.22			
		Window Frame bottom (**Window 3**)	2	2.10	0.2	0.1	0.08			
		Window side frame	2	2.00	0.20	0.10	0.08			
		Kachung	1	1.50	0.08	0.065	0.01			
		Jugshing	1	1.9	0.065	0.065	0.01			
		Horzhu	1	1.9	0.15	0.065	0.02			
		Window Frame bottom (**Window 4**)	4	2.78	0.20	0.1	0.22			
		Window side frame	4	1.86	0.20	0.10	0.15			
		Kachung	2	1.36	0.08	0.065	0.01			
		Jugshing	2	2.58	0.065	0.065	0.02			
		Horzhu	2	2.58	0.15	0.065	0.05			
		Window Frame bottom (**Window 5**)	4	2.10	0.20	0.1	0.17			
		Window side frame	4	1.86	0.20	0.10	0.15			
		Kachung	2	1.36	0.08	0.065	0.01			
		Jugshing	2	1.90	0.065	0.065	0.02			

		Horzhu	2	1.90	0.15	0.065	0.04			
		Window Frame bottom (**Window 6**)	8	1.50	0.13	0.1	0.15			
		Window side frame	8	1.10	0.13	0.10	0.11			
		Kachung	4	0.67	0.08	0.065	0.01			
		Horzhu	4	1.12	0.15	0.065	0.04			
		Window Frame bottom (**Window 7**)	16	0.75	0.13	0.1	0.15			
		Window side frame	16	1.10	0.13	0.10	0.22			
		Kachung	16	0.67	0.08	0.065	0.06			
		Horzhu	8	0.55	0.15	0.065	0.04			
						Total	4.65	*cum*	26522.54	**123363.16**
		Door (Oak Tree)								
31	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed, Mixed conifer								
		Door1……..								
		Top frame	4	1.05	0.1	0.125	0.05			
		Side frame	8	2.1	0.1	0.13	0.22			
		Door panel	4	2	0.85	0.035	0.24			
		Door2……..								
		Top frame	16	0.95	0.1	0.125	0.19			
		Side frame	32	2.1	0.1	0.13	0.87			
		Door panel	16	2	0.75	0.035	0.84			
		Door3……..								
		Top frame	8	0.85	0.1	0.125	0.09			
		Side frame	16	2.1	0.1	0.13	0.44			
		Door panel	8	2	0.65	0.035	0.36			
		Door4……..								
		Top frame	8	0.85	0.1	0.125	0.09			
		Side frame	16	2.1	0.1	0.13	0.44			
		Door panel	8	2	0.65	0.035	0.36			
						Total	4.18	*cum*	26522.54	**110972.96**
		Roof Truss								

32	**SW0022**	Steel work welded, in built up sections, trusses, frame-works including cutting, hoisting, fixing and appl. priming coat of red								
		Truss 1(T1)…....								
		Top Chord or Rafter (76.1ØM, 6.53KG/M)…......	8	2.67	6.53		139.48			
		Bottom Chord or Tie (76.1ØM, 6.53KG/M)…......	8	2.60	6.53		135.82			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	0.89	5.1		36.31			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.60	5.1		24.48			
		Truss 2(T2)…....								
		Top Chord or Rafter (76.1ØM, 6.53KG/M)…......	8	4.06	6.53		212.09			
		Bottom Chord or Tie (76.1ØM, 6.53KG/M)…......	8	3.95	6.53		206.35			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.21	5.1		49.37			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.36	5.1		55.49			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.68	5.1		27.74			
		Strut(Vertical) (60.3Ø M,	8	0.91	5.1		37.13			

		5.1KG/M)….....								
		Truss 3(T3)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)……	8	5.46	6.53		285.23			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)…...	8	5.32	6.53		277.92			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.33	5.1		54.26			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.48	5.1		60.38			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.67	5.1		68.14			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.71	5.1		28.97			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.97	5.1		39.58			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	1.23	5.1		50.18			
		Truss 4(T4)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)…...	2	6.88	6.53		89.85			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)…...	2	6.61	6.53		86.33			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.07	5.1		10.91			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.38	5.1		14.08			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.54	5.1		15.71			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.73	5.1		17.65			
		Strut (Inclined) (60.3Ø M,	2	1.96	5.1		19.99			

		5.1KG/M)….....								
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.23	5.1		2.35			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.45	5.1		4.59			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.72	5.1		7.34			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.995	5.1		10.15			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	1.27	5.1		12.95			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	1.55	5.1		15.81			
		Truss 5(T5)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)…...	14	6.88	6.53		628.97			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)…...	14	6.69	6.53		611.60			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.07	5.1		76.40			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.38	5.1		98.53			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.54	5.1		109.96			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.73	5.1		123.52			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.96	5.1		139.94			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.23	5.1		16.42			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.45	5.1		32.13			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.72	5.1		51.41			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.995	5.1		71.04			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	1.27	5.1		90.68			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	1.55	5.1		110.67			
		Truss 6(T6)…....								
		Top Chord or	4	9.6	6.53		250.75			

		Rafter (76.1ØM, 6.53KG/M)……..								
		Bottom Chord or Tie (76.1ØM, 6.53KG/M)…….	4	9.48	6.53		247.62			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.28	5.1		26.11			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.49	5.1		30.40			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.61	5.1		32.84			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.74	5.1		35.50			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.88	5.1		38.35			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	2.06	5.1		42.02			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.25	5.1		5.10			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.45	5.1		9.18			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.67	5.1		13.67			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.89	5.1		18.16			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.11	5.1		22.64			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.33	5.1		27.13			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.55	5.1		31.62			
						Total	5303.20	Kg	86.59	**459204.16**
		Purlin								
		Purlin (76.1ØM, 6.53KG/M)……..	2	23.05	6.53		301.03			
		Purlin (76.1ØM, 6.53KG/M)……..	2	13.75	6.53		179.58			
		Purlin (76.1ØM, 6.53KG/M)……..	2	19.15	6.53		250.10			
		Purlin (76.1ØM, 6.53KG/M)……..	2	9.85	6.53		128.64			
		Purlin (76.1ØM, 6.53KG/M)…….	2	17.15	6.53		223.98			

		..								
		Purlin (76.1ØM, 6.53KG/M)……..	2	7.85	6.53		102.52			
		Purlin (76.1ØM, 6.53KG/M)……..	2	15.15	6.53		197.86			
		Purlin (76.1ØM, 6.53KG/M)……..	2	5.85	6.53		76.40			
						Total	1460.11	Kg	86.59	**126430.75**
33	**RF0003**	Providing & fixing Pre Painted Steel Corrugated Roofing sheets, including bolts, hooks and nuts 8mm dia. with bitumen and G.I limpet washers filled with white lead for connection, excluding the cost of purlins, rafter and trusses.								
		25g (0.50mm)					108.00	*sq.m*	1070.16	**115577.28**
34	**WW0030**	Providing & fixing Eaves board (225x25mm) with moulding fitted and fixed with necessary screws Mixed Conifer		56			56	*m*	180.15	**10088.40**
35	**RF0010**	Providing and fixing of PGI semi-circular gutter including brackets, hooks,sockets bolts, nuts, washers and rain water pipe connections etc complete, excluding the cost of pipe, 110-200mm dia		72				*m*	619.23	**44584.56**
36	**PI0123**	Providing & fixing Kitchen Sinks including all connections and fittings, Stainless steel, 940 x 460 x 160		4				*each*	2765.41	**11061.64**

		mm, single bowl & drainboard								
37	**PI0050**	Providing & fixing European-type vitreous china w.c pedestal including seat and lid with c.p brass hinges, 15 lit white vitreous china low level cistern, fittings, brackets, repair walls, white, with plastic seat & lid		8				*each*	5889.99	**47119.92**
38	**PI0177**	Providing & fixing C.P. Brass shower fittings Shower arm, standard 15mm		8				*each*	473.96	**3791.68**

APPENDIX F DETAIL ESTIMATE FOR BUILDING ALTERNATIVE 6

SI. No	BSR CODE	Item Description	No	L	B	H	Qty	Unit	Rate	Amount
1	**EW0001**	Surface dressing of ground, including removal of vegetations and inequalities < 150mm deep, disposal of rubbish within 50m in Ordinary Soil	1	21	11		**231**	*sq.m*	12.77	**2949.87**
2	**EW0030**	**Earth work** in excavation over areas, depth >300mm, width >1.5m, area >10 Sq.m on plan, including disposal of excavated earth within 50m lead and 1.5m liff & disposed soil to be neatly dressed. In ordinary Soil								
		Long Walls…..	3	20.40	1.6	1.6	156.67			
		Short Walls…..	6	7.90	1.6	1.6	121.34			
						Total	**278.02**	*cum*	162.02	**45044.1523**
3	**SM0005**	Providing & laying Random Rubble Masonry with hard stone in foundation & plinth In cement mortar 1:4								
		Stone soling for footing…..	18	1.6	1.6	0.15	6.91			
		Stone soling for external and Internal walls…..								
		Long Walls…..	2	19.6	0.8	0.15	4.70			
		Long wall front part…..	1	16.95	0.8	0.15	2.03			
		Short Walls…..	6	8.9	0.6	0.15	4.81			
						Total	**18.46**	*cum*	4970.70	**91739.2392**
4	**CW0006**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth 1:3:6 (1 cement : 3 sand : 6 graded crushed rock 40 mm nominal size)								
		P.C.C in footing level.	18	1.6	1.6	0.10	4.61			
		P.C.C for external and Internal walls…..								
		Long Walls…..	2	19.6	0.8	0.10	3.14			
		Long wall front part…..	1	16.95	0.8	0.10	1.36			
		Short Walls…..	6	8.9	0.6	0.10	3.20			

						Total	**12.30**	*cum*	5095.15	**62690.7256**
5	**SM0005**	Providing & laying Random Rubble Masonry with hard stone in foundation & plinth, In cement mortar 1:4								
		Long Walls…...	2	19.25	0.45	0.60	10.40			
		Long wall front part…...	1	16.60	0.45	0.60	4.48			
		Short Walls…...	6	9.10	0.40	0.60	13.10			
						Total	**27.98**	*cum*	4970.70	**139085.157**
6	**BW0012**	Extra for brick work in superstructure above plinth level, up to floor two level								
		Long Wall…...	1	19.05	0.105	6.48	12.96			
		Long wall front part…...	1	16.49	0.105	6.48	11.22			
		Short Walls…...	2	9.25	0.105	6.48	12.59			
		Long walls at main entry…..	2	5.65	0.105	6.48	7.69			
		Internal Partition wall…..								
		Partition Walls 1…..	2	9.25	0.125	6.48	14.99			
		Partition Walls 2…..	2	3.68	0.125	6.48	5.95			
		Partition Walls 3…..	2	4.45	0.125	6.48	7.21			
		Partition Walls 4…..	2	3.68	0.125	6.48	5.95			
		Partition Walls 5…..	2	3.50	0.125	6.48	5.67			
		Partition Wall 6..…...	2	3.20	0.125	6.48	5.18			
		External front wall…...	1	3.85	0.105	5.02	2.03			
		Total quantity of bricks without deduction					**91.44**			
		Doors and Windows deduction								
		Doors….....								
		D1….	4	1.05	0.25	2.10	2.21			
		D2….	8	0.95	0.125	2.10	2.00			
		D3….	4	0.85	0.25	2.10	1.79			
		D4….	4	0.85	0.125	2.10	0.89			
		D5….	8	0.85	0.125	2.10	1.79			
		Windows & Cornices….....								
		W1…..	2	2.78	0.25	1.76	2.44			
		W2…..	12	2.10	0.25	1.76	11.09			
		W3…..	1	2.10	0.25	2.78	1.46			
		W4…..	2	2.76	0.25	2.01	2.77			
		W5…..	4	2.10	0.25	2.01	4.22			

		W6…..	4	1.50	0.25	1.36	2.04			
		W7…..	8	0.75	0.25	1.36	2.04			
						Total deduction	**34.72**			
		Total quantity of bricks after deduction…					**56.72**	*cum*	331.47	**18802.448**
7	**MT0140**	Autoclaved aerated cement (AAC) blocks								
		Long Wall…...	1	19.05	0.10	6.48	12.34			
		Long wall front part…...	1	16.49	0.10	6.48	10.69			
		Short Walls…...	2	9.25	0.10	6.48	11.99			
		Long walls at main entry…..	2	5.65	0.10	6.48	7.32			
		External front wall…...	1	3.85	0.10	5.02	1.93			
					Total		**44.27**			
		Doors and Window Deduction								
		Windows & Cornices….....								
		W1…..	2	2.78	0.25	1.76	2.44			
		W2…..	12	2.10	0.25	1.76	11.09			
		W3…..	1	2.10	0.25	2.78	1.46			
		W4…..	2	2.76	0.25	2.01	2.77			
		W5…..	4	2.10	0.25	2.01	4.22			
		W6…..	4	1.50	0.25	1.36	2.04			
		W7…..	8	0.75	0.25	1.36	2.04			
		Doors….....								
		D1….	4	1.05	0.25	2.10	2.21			
						Total deduction	**28.26**			
					Total after deduction		**16.01**	*cu.m*	6500.00	**104086.34**
8	**PL0021**	Providing & laying 13mm cement plaster C.M 1:4								
		Long Wall…...	1	19.05		6.48	**123.44**			
		Long wall front part…...	1	16.49		6.48	**106.86**			
		Short Walls…...	2	9.25		6.48	**119.88**			
		Long walls at main entry…..	2	5.65		6.48	**73.22**			
		External front wall…...	1	3.85		5.02	**19.33**			
					Total		**442.73**			
		Doors and Window Deduction								
		Windows & Cornices….....								

		W1…..	2	2.78	0.25	1.76	2.44			
		W2…..	12	2.10	0.25	1.76	11.09			
		W3…..	1	2.10	0.25	2.78	1.46			
		W4…..	2	2.76	0.25	2.01	2.77			
		W5…..	4	2.10	0.25	2.01	4.22			
		W6…..	4	1.50	0.25	1.36	2.04			
		W7…..	8	0.75	0.25	1.36	2.04			
		Doors….....								
		D1….	4	1.05	0.25	2.10	2.21			
						Total deduction	**28.26**			
					Total after deduction		**414.47**	*sq.m*	210.85	**87391.10**
		Flooring work (First Floor)								
9	**EW0197**	Providing & laying dry earth bedding, including consolidating each deposited layer by watering, ramming and dressing	1	19.15	9.85	0.5	**94.31**	*cum*	213.30	**20117.1229**
10	**SM0072**	Providing and laying Hand packed stone filling or soling with stones								
		Master Bed Room…..	2	3.68	3.73	0.15	4.12			
		Bed Room…..	2	3.83	3.48	0.15	4.00			
		Common Toilet…..	2	1.90	2.63	0.15	1.50			
		Toilet…..	2	1.80	2.65	0.15	1.43			
		Kitchen…..	2	3.20	3.48	0.15	3.34			
		Dinning room…..	2	3.78	5.90	0.15	6.69			
						Total	**21.08**	*cum*	1697.03	**35769.8965**
11	**FL0051**	Pal cement concrete flooring 1:2:4, finished with floating coat of neat cement 20mm aggregates, 40mm thick								
		Master Bed Room…..	2	3.68	3.73		27.45			
		Bed Room…..	2	3.83	3.48		26.66			
		Common Toilet…..	2	1.90	2.63		9.99			
		Toilet…..	2	1.80	2.65		9.54			
		Kitchen…..	2	3.20	3.48		22.27			
		Dinning room…..	2	3.78	5.90		44.60			
						Total	**140.52**	*sq.m*	415.75	**58421.0237**
		Flooring work (Second Floor)								

12	**RC0014**	Providing & laying in position reinforced cement concrete work in suspended floor, roofs having slope upto 15o, landings,balconies, shelves and chajjas upto floor five level excluding the cost of centering, shuttering and reinforcement 1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Flooring Slab	1	19.15	9.85	0.15	28.29			
		Balcony Slab	2	3.90	1.20	0.15	1.40			
		Roof Slab	1	19.15	9.85	0.14	26.41			
						Total	**56.11**	*cum*	6961.70	**390592.966**
		Concrete Work in Footing, Beams, Columns								
13	**RC0010**	Providing & laying in position reinforced cement concrete work in plinth and skirting courses, fillets, columns , pillars, posts and struts upto floor five level excluding the cost of centering, shuttering and reinforcement.								
		Footing(500mm P.C.C)	18	1.60	1.60	0.50	23.04			
		Column….....	18	8.68	0.40	0.40	25.00			
						Total	**48.04**	*cum*	6795.46	**326443.026**
14	**RC0018**	Providing & laying in position reinforced cement concrete work in beams, lintels, bands, plain window sills, staircases, spiral staircases upto floor five level excluding the cost of centering, shuttering and reinforcement								
		Beams ….	9	18.8	0.40	0.30	20.30			
		Beams ….	18	9.5	0.40	0.30	20.52			
						Total	**40.82**	*cum*	6790.57	**277218.23**
		Plastering work								
15	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement 20mm plaster in C.M 1:4								

		Plastering on External wall	2	19.15	6.48		248.184			
			4	9.85	6.48		255.312			
			4	8	6.48		207.36			
			4	5.9	6.48		152.928			
						Total	**863.784**			
		Doors and Window Deduction								
		Windows & Cornices….....								
		W1…..	4	2.78		1.76	19.48			
		W2…..	24	2.10		1.76	88.70			
		W3…..	2	2.10		2.78	11.66			
		W4…..	4	2.76		2.01	22.19			
		W5…..	8	2.10		2.01	33.77			
		W6…..	8	1.50		1.36	16.32			
		W7…..	16	0.75		1.36	16.32			
		Doors….....								
		D1….	4	1.05		2.10	8.82			
						Total deduction	**217.26**			
					Total after deduction		**646.53**	*sq.m*	359.57	**232471.39**
16	**PL0031**	Providing & laying 15mm cement plaster on rough side of single or half-brick wall C.M 1:4								
		Partition Walls 1…..	4	9.25		6.48	239.76			
		Partition Walls 2…..	4	3.68		6.48	95.26			
		Partition Walls 3…..	4	4.45		6.48	115.34			
		Partition Walls 4…..	4	3.68		6.48	95.26			
		Partition Walls 5…..	4	3.50		6.48	90.72			
		Partition Wall 6…….	4	3.20		6.48	82.94			
						Total	**719.28**			
		Doors Deduction								
		D2….	16	0.95		2.10	31.92			
		D3….	8	0.85		2.10	14.28			
		D4….	8	0.85		2.10	14.28			
		D5….	16	0.85		2.10	28.56			
						Total	**89.04**			
					Total after deduction		**630.24**	*sq.m*	248.37	**156532.709**
		Floor plastering								

17	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement. 20mm plaster in C.M 1:4								
		Master Bedroom	2	3.68	3.73		27.45			
		Bed Room	2	3.83	3.48		26.66			
		Toilet 1	2	2.63	1.9		9.99			
		Toilet 2	2	2.65	1.8		9.54			
		Dinning Room	2	5.9	3.78		44.60			
		Kitchen	2	3.2	3.48		22.27			
							140.52	*sq.m*	359.57	**50526.6326**
18	**PL0011**	Providing & laying 6mm cement plaster (in Ceiling) (C.M 1:4)								
		Master Bedroom	4	3.68	3.73		54.91			
		Bed Room	4	3.83	3.48		53.31			
		Toilet 1	4	2.63	1.9		19.99			
		Toilet 2	4	2.65	1.8		19.08			
		Dinning Room	4	5.9	3.78		89.21			
		Kitchen	4	3.2	3.48		44.54			
						Total	281.04	*sq.m*	160.79	**45188.293**
		Traditional Cornices								
		Bhutan type Traditional Cornices in R.C.C 1:1.5:3, 20 mm aggregate including cost of formwork including finishing with 6mm thick plaster on the exposed surface with cement mortar 1:3, excluding reinforcement & decorative painting cost as per standard design (Measurement to be taken along the cornice and wall junction)								
19	**RC0031**	Multi-Storied building..at floor 2 level including the cost of lhanglag and at other floors where Lhanglag is provided								
		Rabsey 1	2	4.35			8.7	*m*	2843.55	**24738.885**
		Rabsey 2	4	2.10			8.4		2843.55	**23885.82**

20	**RC0003**	Providing & laying in position reinforced cement concrete excluding the cost of centering, shuttering and reinforcement - all work upto plinth level								
		R.C.C Bogh	120	0.3	0.125	0.1	0.45			
			20	0.3	0.125	0.1	0.08			
						Total	**0.53**	*cum*	6059.32	**3181.143**
		Traditional Painting								
21	**PT0100**	Providing, preparing and applying Sumdang painting (Not washable)								
		Rab….....	4	2.75	1		11			
			24	2.1	1		50.4			
			4	2.78	0.5		5.56			
			8	2.1	0.5		8.4			
			2	2.1	1		4.2			
			16	0.44	0.5		3.52			
			8	1.5	0.5		6			
			8	1.05	0.50		4.2			
			16	0.95	1.00		15.2			
			8	0.85	0.50		3.4			
			8	0.85	0.50		3.4			
			16	0.85	1.00		13.6			
						Total	**128.88**		1284.53	**165550.226**
		Stair Case								
		Providing & laying in position reinforced cement concrete work in beams, lintels, bands, plain window sills, staircases, spiral staircases upto floor five level excluding the cost of centering, shuttering and reinforcement								
22	**RC0018**	1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Base Slab….	1	3.46	1.33	0.16	0.74			
		Riser and Tread….	16	1.33	0.02		0.48			

		Base Slab….	1	1.54	1.33	0.16	0.33			
						Total	1.54	*cum*	6790.57	**10476.49**
		Stair case landing	1	2.65	1.2	0.15	0.48			
			1	1.33	2.3	0.15	0.46			
						Total	0.94	*cum*	6790.57	**6354.95493**
		Plinth Protection Wall								
23	**SM0072**	Providing and laying Hand packed stone filling or soling with stones								
		Length Wise….....	2	22.65	1.75	0.15	11.89			
		Breath Wise….....	2	9.85	1.75	0.15	5.17			
						Total	17.06	*cum*	1697.03	**28955.5744**
24	**CW0002**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level.								
		1:1.5:3 (1 cement : 1.5 sand : 3 graded crushed rock 20 mm nominal size)								
		Length Wise….....	2	22.1	1.475	0.1	6.52			
		Breath Wise….....	2	9.85	1.475	0.1	2.91			
						Total	9.43	*cum*	6661.50	**62786.3029**
25	**CW0009**	Providing and laying in position plain cement concrete excluding the cost of centering and shuttering - All work upto plinth level.1:4:8 (1 cement : 4 sand : 8 graded crushed stone 50 mm nominal size)								
			2	22.1	1.475	0.05	3.26			
			2	9.85	1.475	0.05	1.45			
						Total	4.71	*cum*	4372.85	**20607.6022**
26	**BW0002**	Providing & laying Second-Class Brick work in Foundation & Plinth. In cement mortar 1:4								
		Length Wise….....	4	22.65	0.125	0.325	3.68			

		Breath Wise….....	4	9.85	0.125	0.325	1.60			
			2	22.65	0.125	0.25	1.42			
			2	9.85	0.125	0.25	0.62			
						Total	7.31	*cum*	9310.91	**68086.0294**
27	**PL0075**	Providing & laying cement plaster, finished with floating coat of neat cement 20mm plaster in C.M 1:4								
			4	22.65	0.2		18.12			
			4	9.85	0.2		7.88			
			2	22.65	0.25		11.33			
			2	9.85	0.25		4.93			
						Total	42.25	*sq.m*	359.57	**15191.8325**
		Column Reinforcement								
28	**RC0083**	Providing & fixing Thermo-Mechanically Treated reinforcement bar (Yield Strength 500 MPa) for R.C.C work including cutting, bending, binding and placing in position complete								
		20mm Dia main bar reinforcement @ 2.469kg/m	18	8	9.86	2.47	3505.58			
		25mm Dia main bar reinforcement @ 3.858kg/m	18	4	9.86	3.858	2738.87			
		8mm Dia stirrups reinforcement @ 0.395 kg/m	18	134	1.264	0.395	1204.26			
		Splicing								
		20mm Dia main bar reinforcement @ 2.469kg/m	18	4	2.35	2.469	417.75			
		25mm Dia main bar reinforcement @ 3.858kg/m	18	2	2.35	3.858	326.39			
		Beam Reinforcement								
		Plinth &Roof Beam reinforcement								
		20mm Dia main bar reinforcement @ 2.469kg/m	12	2	21.1	2.469	1250.30			
		16mm Dia main bar reinforcement @ 1.58kg/m	12	2	21.1	1.58	800.11			

		20mm Dia Top reinforcement @ 2.469kg/m	12	2	21.1	2.469	1250.30			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	12	2	19.88	2.469	1178.01			
		8mm Dia stirrups reinforcement @ 0.395 kg/m for **Plinth beam, First floor, roof beam**	8	146	1.26	0.395	581.31			
			1	126	1.26	0.395	62.71			
		First Floor Beam								
		20mm Dia main bar reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		16mm Dia main bar reinforcement @ 1.58kg/m	2	2	21.1	1.58	133.35			
		20mm Dia Top reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		20mm Dia main bar reinforcement @ 2.469kg/m	2	2	10.2	2.469	100.74			
		16mm Dia main bar reinforcement @ 1.58kg/m	2	2	10.2	1.58	64.46			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	2	2	16.88	2.469	166.71			
		20mm Dia Top reinforcement @ 2.469kg/m	2	2	21.1	2.469	208.38			
		20mm Dia Top reinforcement bentup bar @ 2.469kg/m	2	2	19.88	2.469	196.33			
						Total	14602.35	***Kg***	**89.38**	**1305158.34**
		Reinforcement Qty. Cal. In shorter length Dir.Pinth beam, first floor and Roof								
		16mm Dia main bar reinforcement @ 1.58kg/m	8	4	10.7	1.58	540.99			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	2	11.25	1.58	284.40			
		20mm Dia main bar reinforcement @ 2.469kg/m	8	2	11.25	2.469	444.42			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	4	11.00	1.58	556.16			
		20mm Dia main bar reinforcement @ 2.469kg/m	8	2	11.38	2.47	449.56			
		16mm Dia main bar reinforcement @ 1.58kg/m	8	2	10	1.58	252.80			
		Stirrups 8mmdia @ 0.395kg/m	8	82	1.04	0.395	269.48			
			10	74	1.04	0.395	303.99			

						Total	3101.80	***Kg***	**89.38**	**277239.27**
29	**RC0083**	Providing & fixing Thermo-Mechanically Treated reinforcement bar (Yield Strength 500 MPa) for R.C.C work including cutting, bending, binding and placing in position complete								
		Slab and Roof slab Reinforcement								
		Bottom reinforcnement								
		10mm Dia main bar reinforcement @ 0.617kg/m	26	18.8	2	0.62	603.18			
		10mm Dia main bar reinforcement @ 0.617kg/m	105	4.75	2	0.62	615.46			
		10mm Dia main bar reinforcement @ 0.617kg/m	52	7.9	2	0.62	506.93			
		10mm Dia main bar reinforcement @ 0.617kg/m	88	4.75	2	0.62	515.81			
		Balcony Reinforcement								
		10mm Dia main bar reinforcement @ 0.617kg/m	4	7	3.9	0.62	67.70			
		10mm Dia main bar reinforcement @ 0.617kg/m	4	22	3.9	0.62	212.78			
		Top reinforcement								
		10mm Dia main bar reinforcement @ 0.617kg/m	26	11.28	2	0.62	361.91			
		10mm Dia main bar reinforcement @ 0.617kg/m	105	2.90	2	0.62	375.75			
		10mm Dia main bar reinforcement @ 0.617kg/m	52	4.68	2	0.62	300.31			
		10mm Dia main bar reinforcement @ 0.617kg/m	88	2.90	2	0.62	314.92			
						Total	3874.75	***Kg***	**89.38**	**346324.93**
		Footing Reinforcement								
		12mm Dia main bar bot. reinforcement @ 0.89kg/m	18	22	2.6	0.89	916.34			
		12mm Dia main bar top reinforcement @ 0.89kg/m	18	18	2.6	0.89	749.74			
						Total	1666.08	***Kg***	**89.38**	**148914.23**
		Windows(Mixed Conifer)								

30	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed, Mixed conifer								
		Window Frame bottom (**Window 1**)	4	2.78	0.20	0.10	0.22			
		Window side frame	4	1.50	0.20	0.10	0.12			
		Kachung	10	1	0.08	0.065	0.05			
		Jugshing	2	2.58	0.065	0.065	0.02			
		Horzhu	2	2.58	0.15	0.065	0.05			
		Window Frame bottom (**Window 2**)	24	2.10	0.2	0.1	1.008			
		Window side frame	24	1.50	0.20	0.10	0.72			
		Kachung	60	1.00	0.08	0.065	0.312			
		Jugshing	12	1.9	0.065	0.065	0.10			
		Horzhu	12	1.9	0.15	0.065	0.22			
		Window Frame bottom (**Window 3**)	2	2.10	0.2	0.1	0.08			
		Window side frame	2	2.00	0.20	0.10	0.08			
		Kachung	1	1.50	0.08	0.065	0.01			
		Jugshing	1	1.9	0.065	0.065	0.01			
		Horzhu	1	1.9	0.15	0.065	0.02			
		Window Frame bottom (**Window 4**)	4	2.78	0.20	0.1	0.22			
		Window side frame	4	1.86	0.20	0.10	0.15			
		Kachung	2	1.36	0.08	0.065	0.01			
		Jugshing	2	2.58	0.065	0.065	0.02			
		Horzhu	2	2.58	0.15	0.065	0.05			
		Window Frame bottom (**Window 5**)	4	2.10	0.20	0.1	0.17			
		Window side frame	4	1.86	0.20	0.10	0.15			
		Kachung	2	1.36	0.08	0.065	0.01			
		Jugshing	2	1.90	0.065	0.065	0.02			
		Horzhu	2	1.90	0.15	0.065	0.04			
		Window Frame bottom (**Window 6**)	8	1.50	0.13	0.1	0.15			
		Window side frame	8	1.10	0.13	0.10	0.11			
		Kachung	4	0.67	0.08	0.065	0.01			
		Horzhu	4	1.12	0.15	0.065	0.04			
		Window Frame bottom (**Window 7**)	16	0.75	0.13	0.1	0.15			
		Window side frame	16	1.10	0.13	0.10	0.22			
		Kachung	16	0.67	0.08	0.065	0.06			

		Horzhu	8	0.55	0.15	0.065	0.04			
						Total	4.65	*cum*	26522.54	**123363.16**
		Door (Oak Tree)								
31	**WW0003**	Providing & fixing in position dressed wood work in frames of doors, windows, clerestory windows and other frames, wrought and framed, Mixed conifer								
		Door1…....								
		Top frame	4	1.05	0.1	0.125	0.05			
		Side frame	8	2.1	0.1	0.13	0.22			
		Door panel	4	2	0.85	0.035	0.24			
		Door2…....								
		Top frame	16	0.95	0.1	0.125	0.19			
		Side frame	32	2.1	0.1	0.13	0.87			
		Door panel	16	2	0.75	0.035	0.84			
		Door3…....								
		Top frame	8	0.85	0.1	0.125	0.09			
		Side frame	16	2.1	0.1	0.13	0.44			
		Door panel	8	2	0.65	0.035	0.36			
		Door4…....								
		Top frame	8	0.85	0.1	0.125	0.09			
		Side frame	16	2.1	0.1	0.13	0.44			
		Door panel	8	2	0.65	0.035	0.36			
						Total	4.18	*cum*	26522.54	**110972.96**
		Roof Truss								
32	**SW0022**	Steel work welded, in built up sections, trusses, frame-works including cutting, hoisting, fixing and appl. priming coat of red								
		Truss 1(T1)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	8	2.67	6.53		139.48			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	2.60	6.53		135.82			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	0.89	5.1		36.31			

		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.60	5.1		24.48			
		Truss 2(T2)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	8	4.06	6.53		212.09			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	3.95	6.53		206.35			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.21	5.1		49.37			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.36	5.1		55.49			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.68	5.1		27.74			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.91	5.1		37.13			
		Truss 3(T3)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)…….	8	5.46	6.53		285.23			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	8	5.32	6.53		277.92			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.07	5.1		43.66			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.33	5.1		54.26			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.48	5.1		60.38			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	8	1.67	5.1		68.14			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.23	5.1		9.38			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.45	5.1		18.36			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.71	5.1		28.97			

		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	0.97	5.1		39.58			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	8	1.23	5.1		50.18			
		Truss 4(T4)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	2	6.88	6.53		89.85			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	2	6.61	6.53		86.33			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.07	5.1		10.91			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.38	5.1		14.08			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.54	5.1		15.71			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.73	5.1		17.65			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	2	1.96	5.1		19.99			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.23	5.1		2.35			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.45	5.1		4.59			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.72	5.1		7.34			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	0.995	5.1		10.15			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	1.27	5.1		12.95			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	2	1.55	5.1		15.81			
		Truss 5(T5)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)…...	14	6.88	6.53		628.97			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	14	6.69	6.53		611.60			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.07	5.1		76.40			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.38	5.1		98.53			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.54	5.1		109.96			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.73	5.1		123.52			

		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	14	1.96	5.1		139.94			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.23	5.1		16.42			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.45	5.1		32.13			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.72	5.1		51.41			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	0.995	5.1		71.04			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	1.27	5.1		90.68			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	14	1.55	5.1		110.67			
		Truss 6(T6)…....								
		Top Chord or Rafter (76.1ØM , 6.53KG/M)….....	4	9.6	6.53		250.75			
		Bottom Chord or Tie (76.1ØM , 6.53KG/M)….....	4	9.48	6.53		247.62			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.28	5.1		26.11			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.49	5.1		30.40			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.61	5.1		32.84			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.74	5.1		35.50			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	1.88	5.1		38.35			
		Strut (Inclined) (60.3Ø M, 5.1KG/M)….....	4	2.06	5.1		42.02			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.25	5.1		5.10			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.45	5.1		9.18			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.67	5.1		13.67			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	0.89	5.1		18.16			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.11	5.1		22.64			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.33	5.1		27.13			
		Strut(Vertical) (60.3Ø M, 5.1KG/M)….....	4	1.55	5.1		31.62			
						Total	5303.20	Kg	86.59	**459204.16**

		Purlin								
		Purlin (76.1ØM , 6.53KG/M)….....	2	23.05	6.53		301.03			
		Purlin (76.1ØM , 6.53KG/M)….....	2	13.75	6.53		179.58			
		Purlin (76.1ØM , 6.53KG/M)….....	2	19.15	6.53		250.10			
		Purlin (76.1ØM , 6.53KG/M)….....	2	9.85	6.53		128.64			
		Purlin (76.1ØM , 6.53KG/M)….....	2	17.15	6.53		223.98			
		Purlin (76.1ØM , 6.53KG/M)….....	2	7.85	6.53		102.52			
		Purlin (76.1ØM , 6.53KG/M)….....	2	15.15	6.53		197.86			
		Purlin (76.1ØM , 6.53KG/M)….....	2	5.85	6.53		76.40			
						Total	1460.11	Kg	86.59	**126430.75**
33	**RF0003**	Providing & fixing Pre Painted Steel Corrugated Roofing sheets, including bolts, hooks and nuts 8mm dia. with bitumen and G.I limpet washers filled with white lead for connection, excluding the cost of purlins, rafter and trusses.								
		25g (0.50mm)					108.00	*sq.m*	1070.16	**115577.28**
34	**WW0030**	Providing & fixing Eaves board (225x25mm) with moulding fitted and fixed with necessary screws Mixed Conifer		56			56	*m*	180.15	**10088.40**
35	**RF0010**	Providing and fixing of PGI semi-circular gutter including brackets, hooks,sockets bolts, nuts, washers and rain water pipe connections etc complete, excluding the cost of pipe, 110-200mm dia		72				*m*	619.23	**44584.56**
36	**PI0123**	Providing & fixing Kitchen Sinks including all connections and fittings, Stainless steel, 940 x 460 x 160 mm, single bowl & drainboard		4				*each*	2765.41	**11061.64**

37	**PI0050**	Providing & fixing European-type vitreous china w.c pedestal including seat and lid with c.p brass hinges, 15 lit white vitreous china low level cistern, fittings, brackets, repair walls, white, with plastic seat & lid		8				*each*	5889.99	**47119.92**
38	**PI0177**	Providing & fixing C.P. Brass shower fittings Shower arm, standard 15mm		8				*each*	473.96	**3791.68**

APPENDIX G REPAIR AND REPLACEMENT COSTS

Sl. no	Work Description	Units	Quantity	Date	2012 - 2021
1	Fixing of bib-cock	Nos	5	15/05/2018	**6**
2	Fixing of kitchen sinks	Nos	3	17/05/2018	**4**
3	Fixing of toilet pot	Nos	2	3/8/2018	**2**
4	Fixing of cistern	Nos	1	25/11/2018	**2**
7	Fixing and maintenance of 16A power socket	Nos	10	18/06/2019	**10**
8	Installation of new ceiling fan	Nos	2	25/10/2018	**2**
9	Fixing of power socket	Nos	3	25/1/2019	**4**
10	Fixing of holder	Nos	4	1/10/2019	**8**
11	Fixing of tube light	Nos	8	4/3/2020	**8**
12	Fixing of switch box	Nos	2	12/2/2021	**2**

APPENDIX H DEMOLITION COST ESTIMATE FOR BUILDING ALTERNATIVE1, BUILDING ALTERNATIVE 4, BUILDING ALTERNATIVE 5 AND BUILDING ALTERNATIVE 6

S/NO	BSR CODE	Item Description	Quantity	Unit	Rate	Amount
1	DD0045	Dismantling G.I sheets including ridges, hips, valleys, gutters & stacking materials within 50m lead	108	sq.m	82.46	8905.68
2	DD0017	Demolishing brick work including stacking useful materials & disposal of rubbish within 50m lead. In cement mortar	139	cu.m	715.73	99486.47
4	DD0003	Demolishing reinforced concrete, including stacking steel bars and disposal of rubbish within 50m lead, Slab	56.11	cu.m	1587.05	89049.38
5	DD0030	Dismantling doors, windows and clerestory windows >3sq.m (steel\wood) including architrave, hold fasts, and stacking within 50m lead	61	each	251.38	15334.18
6	DD0023	Dismantling steelwork in built up sections in channels, angles, tees and flats in all gusset plates, bolts, nuts, cutting rivets, welding etc. including dismembering and stacking within 50 m lead	6763.3	Kg	2.64	17855.11
7	DD0003	Demolishing reinforced concrete, including stacking steel bars and disposal of rubbish within 50m lead. Beam and Column	88.86	cu.m	1587.05	141025.26
			Total (Nu)			**371656.08**

APPENDIX I DEMOLITION COST ESTIMATE FOR BUILDING ALTERNATIVE 2

S/NO	BSR CODE	Item Description	Quantity	Unit	Rate	Amount
1	DD0045	Dismantling G.I sheets including ridges, hips, valleys, gutters & stacking materials within 50m lead	108	sq.m	82.46	8905.68
2	DD0006	Demolishing stone rubble masonry including stacking useful materials & disposal of rubbish within 50m lead	222.34	cu.m	847.58	188450.9372
4	DD0040	Dismantling wooden flooring including stacking useful materials & disposal of rubbish within 50m lead	53.18	cu.m	73.88	3928.94
5	DD0030	Dismantling doors, windows and clerestory windows >3sq.m (steel\wood) including architrave, hold fasts, and stacking within 50m lead	61	each	251.38	15334.18
6	DD0023	Dismantling steelwork in built up sections in channels, angles, tees and flats in all gusset plates, bolts, nuts, cutting rivets, welding etc. including dismembering and stacking within 50 m lead	6763.3	Kg	2.64	17855.11
			Total (Nu)			**234474.85**

APPENDIX J DEMOLITION COST ESTIMATE FOR BUILDING ALTERNATIVE 3

S/NO	BSR CODE	Item Description	Quantity	Unit	Rate	Amount
1	DD0045	Dismantling G.I sheets including ridges, hips, valleys, gutters & stacking materials within 50m lead	108	sq.m	82.46	8905.68
2	DD0017	Demolishing brick work including stacking useful materials & disposal of rubbish within 50m lead. In cement mortar	139	cu.m	715.73	99486.47
4	DD0003	Demolishing reinforced concrete, including stacking steel bars and disposal of rubbish within 50m lead, Slab	56.11	cu.m	1587.05	89049.38
5	DD0030	Dismantling doors, windows and clerestory windows >3sq.m (steel\wood) including architrave, hold fasts, and stacking within 50m lead	61	each	251.38	15334.18
6	DD0023	Dismantling steelwork in built up sections in channels, angles, tees and flats in all gusset plates, bolts, nuts, cutting rivets, welding etc. including dismembering and stacking within 50 m lead	6763.3	Kg	2.64	17855.11
7	DD0003	Demolishing reinforced concrete, including stacking steel bars and disposal of rubbish within 50m lead. Beam and Column	88.86	cu.m	1587.05	141025.26
			Total (Nu)			**371656.08**

APPENDIX K DISCRETE COMPOUNDING; I = 5%

Single payment			Uniform Series			
	Compound Amount Factor	Present Worth Factor	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor
N	To Find F Given P F/P	To Find p Given F P/F	To Find F Given A F/A	To Find P Given A P/A	To Find A Given F A/F	To Find A Given P A/P
1	1.0500	0.9524	1.0000	0.9524	1.000	1.0500
2	1.1025	0.9070	2.0500	1.8594	0.4878	0.5378
3	1.1576	0.8638	3.1525	2.7232	0.3172	0.3672
4	1.2155	0.8227	4.3101	3.5460	0.2320	0.2820
5	1.2763	0.7835	5.5256	4.3295	0.1810	0.2310
6	1.3401	0.7462	6.8019	5.0757	0.1470	0.1970
7	1.4071	0.7107	8.1420	5.7864	0.1228	0.1728
8	1.4775	0.6768	9.5491	6.4632	0.1047	0.1547
9	1.5513	0.6446	11.0266	7.1078	0.0907	0.1407
10	1.6289	0.6139	12.5779	7.7217	0.0795	0.1295
11	1.7103	0.5847	14.2068	8.3064	0.0704	0.1204
12	1.7959	0.5568	15.9171	8.8633	0.0628	0.1128
13	1.8856	0.5303	17.7130	9.3936	0.0565	0.1065
14	1.9799	0.5051	19.5986	9.8986	0.0510	0.1010
15	2.0789	0.4810	21.5786	10.3797	0.0463	0.0963
16	2.1829	0.4581	23.6575	10.8378	0.0423	0.0923
17	2.2920	0.4363	25.8404	11.2741	0.0387	0.0887
18	2.4066	0.4155	28.1324	11.6896	0.0355	0.0855
19	2.5270	0.3957	30.5390	12.0853	0.0327	0.0827
20	2.6533	0.3769	33.0660	12.4622	0.0302	0.0802
21	2.7860	0.3589	35.7193	12.8212	0.0280	0.0780
22	2.9253	0.3418	38.5052	13.1630	0.0260	0.0760
23	3.0715	0.3256	41.4305	13.4886	0.0241	0.0741
24	3.2251	0.3101	44.5020	13.7986	0.0225	0.0725
25	3.3864	0.2953	47.7271	14.0939	0.0210	0.0710
30	4.3219	0.2314	66.4388	15.3725	0.0151	0.0651
35	5.5160	0.1813	90.3203	16.3742	0.0111	0.0611
40	7.0400	0.1420	120.7998	17.1591	0.0083	0.0583
45	8.9850	0.1113	159.7002	17.7741	0.0063	0.0563
50	11.4674	0.0872	209.3480	18.2559	0.0048	0.0548
60	18.6792	0.0535	353.5837	18.9293	0.0028	0.0528
80	49.5614	0.0202	971.2288	19.5965	0.0010	0.0510
100	131.5013	0.0076	2610.0252	19.8479	0.0004	0.0504
∞				20.0000		0.0500

APPENDIX L DISCRETE COMPOUNDING; I = 10%

Single payment			Uniform Series			
	Compound Amount Factor	Present Worth Factor	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor
N	To Find F Given P F/P	To Find p Given F P/F	To Find F Given A F/A	To Find P Given A P/A	To Find A Given F A/F	To Find A Given P A/P
1	1.1000	0.9091	1.0000	0.9091	1.000	1.1000
2	1.2100	0.8264	2.1000	1.7355	0.4762	0.5762
3	1.3310	0.7531	3.3100	2.4869	0.3021	0.4021
4	1.4641	0.6830	4.6410	3.1699	0.2155	0.3155
5	1.6105	0.6209	6.1051	3.7908	0.1638	0.2638
6	1.7716	0.5645	7.7156	4.3553	0.1296	0.2296
7	1.9487	0.5132	9.4872	4.8684	0.1054	0.2054
8	2.1436	0.4665	11.4359	5.3349	0.0874	0.1874
9	2.3579	0.4241	13.5795	5.7590	0.0736	0.1736
10	2.5937	0.3855	15.9374	6.1446	0.0627	0.1627
11	2.8531	0.3505	18.5312	6.4951	0.0540	0.1540
12	3.1384	0.3186	21.3843	6.8137	0.0468	0.1468
13	3.4523	0.2897	24.5227	7.1034	0.0408	0.1408
14	3.7975	0.2633	27.9750	7.3667	0.0357	0.1357
15	4.1772	0.2394	31.7725	7.6061	0.0315	0.1315
16	4.5950	0.2176	35.9497	7.8237	0.0278	0.1278
17	5.0545	0.1978	40.5447	8.0216	0.0247	0.1247
18	5.5599	0.1799	45.5992	8.2014	0.0219	0.1219
19	6.1159	0.1635	51.1591	8.3649	0.0195	0.1195
20	6.7275	0.1486	57.2750	8.5136	0.0175	0.1175
21	7.4002	0.1351	64.0025	8.6487	0.0156	0.1156
22	8.1403	0.1228	71.4027	8.7715	0.0140	0.1140
23	8.9543	0.1117	79.5430	8.8832	0.0126	0.1126
24	9.8497	0.1015	88.4973	8.9847	0.0113	0.1113
25	10.8347	0.0923	98.3471	9.0770	0.0102	0.1102
30	17.4494	0.0573	164.4940	9.4269	0.0061	0.1061
35	28.1024	0.0356	271.0244	9.6442	0.0037	0.1037
40	45.2593	0.0221	442.5926	9.7791	0.0023	0.1023
45	72.8905	0.0137	718.9048	9.8628	0.0014	0.1014
50	117.3909	0.0085	1163.9085	9.9148	0.0009	0.1009
60	304.4816	0.0033	3034.8164	9.9672	0.0003	0.1003
80	2048.4002	0.0005	20474.0021	9.9951	a	0.1000
100	13780.6123	0.0001	137796.1234	9.9993	a	0.1000
∞				10.000		0.1000

BIOGRAPHY

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