COMPARISON OF 9(NINE) STORIED CONVENTIONAL AND SUSTAINABLE GREEN BUILDING IN BANGLADESH

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering



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Section: 13C
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DECLARATION

It is hereby declared that this thesis/project or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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Dedicated

to

"Our Beloved Parents"

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.

ABSTRACT

With the increase in the application of modern technologies in Civil Engineering, construction of residential building is increasing very hastily. But besides this technology they are doing hampered of environment and also human body. So to safe this valuable environment and give a healthier life to human we have been considered “A Nine (9) storied conventional and sustainable green building and its cost and also difference between conventional and sustainable green building. The Bangladesh National Building Code (BNBC), 2020 has been considered in the analysis.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

A ‘green’ building is a building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts, on our climate and natural environment. Green buildings preserve precious natural resources and improve our quality of life. Any building can be a green building, whether it’s a home, an office, a school, a hospital, a community centre, or any other type of structure, provided it some features (1) .

However, it is worth noting that not all green buildings are needed to be the same. Different countries and regions have a variety of characteristics such as distinctive climatic conditions, unique cultures and traditions, diverse building types and ages, or wide-ranging environmental, economic and social priorities – all of which shape their approach to green building.

This requires close cooperation of the contractor, the architects, the engineers, and the client at all project stages. The Green Building practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. In doing so, the three dimensions of sustainability, i.e., planet, people and profit across the entire supply chain need to be considered (2)**.**

1.2 Back ground of the study

Buildings and infrastructure have inevitable adverse effects on the natural environment. Effects range in scale from local, such as displacement of ecological habitats, to global, such as greenhouse gas emission ultimately leading to global warming and climate change. Various effects arise throughout the life cycle of a building, from construction to operation and up to its eventual closure and decommissioning. Construction and maintenance impacts are mainly brought about by the consumption of natural resources.

Green building practices and technologies seek to address these foreseeable adverse environmental effects The United States Environmental Protection Agency (2012) defines green buildings as the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from sitting to design, construction, operation, maintenance, renovation and demolition. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high performance building.

A sustainable green building can save our natural resources by reducing environmental impacts, lowering transportation costs, and decreasing water consumption. Not only do green buildings have environmental benefits, but they also have economic and social benefits. Green buildings create jobs, inspire growth and innovation in the local community, enhance occupant health and comfort, maintain a healthier indoor environment and air quality minimize strain on public infrastructure and improve overall quality of life. Green buildings also have economic benefits. They reduce operating costs, improve occupant productivity, and enhance profits. Therefore, green buildings have the power to change our way of life and transform the future by being sustainable today.

1.3 Green Building Rating Systems

Leadership in Energy and Environmental Design (LEED), the most popular of the green building rating systems, was developed in the United States of America but is used internationally. Different building types in various places, however, have unique design and efficiency needs depending on their function and exposure to climate. The Philippine Green Building Council (PHILGBC) saw the need to find a viable and locally applicable solution that will help promote environmental conservation and protection in the Philippines. Hence, Building for Ecologically Responsive Design Excellence (BERDE), was developed. BERDE was designed to measure the environmental performance of buildings. According to PHILGBC, BERDE is a tool to measure, verify and monitor the environmental performance of buildings. It is consensus driven and was developed through a multi-stakeholder consultation and collaboration process. The certification is credible, unbiased and impartial because it is achieved through a third party process in line with international standards. (3).

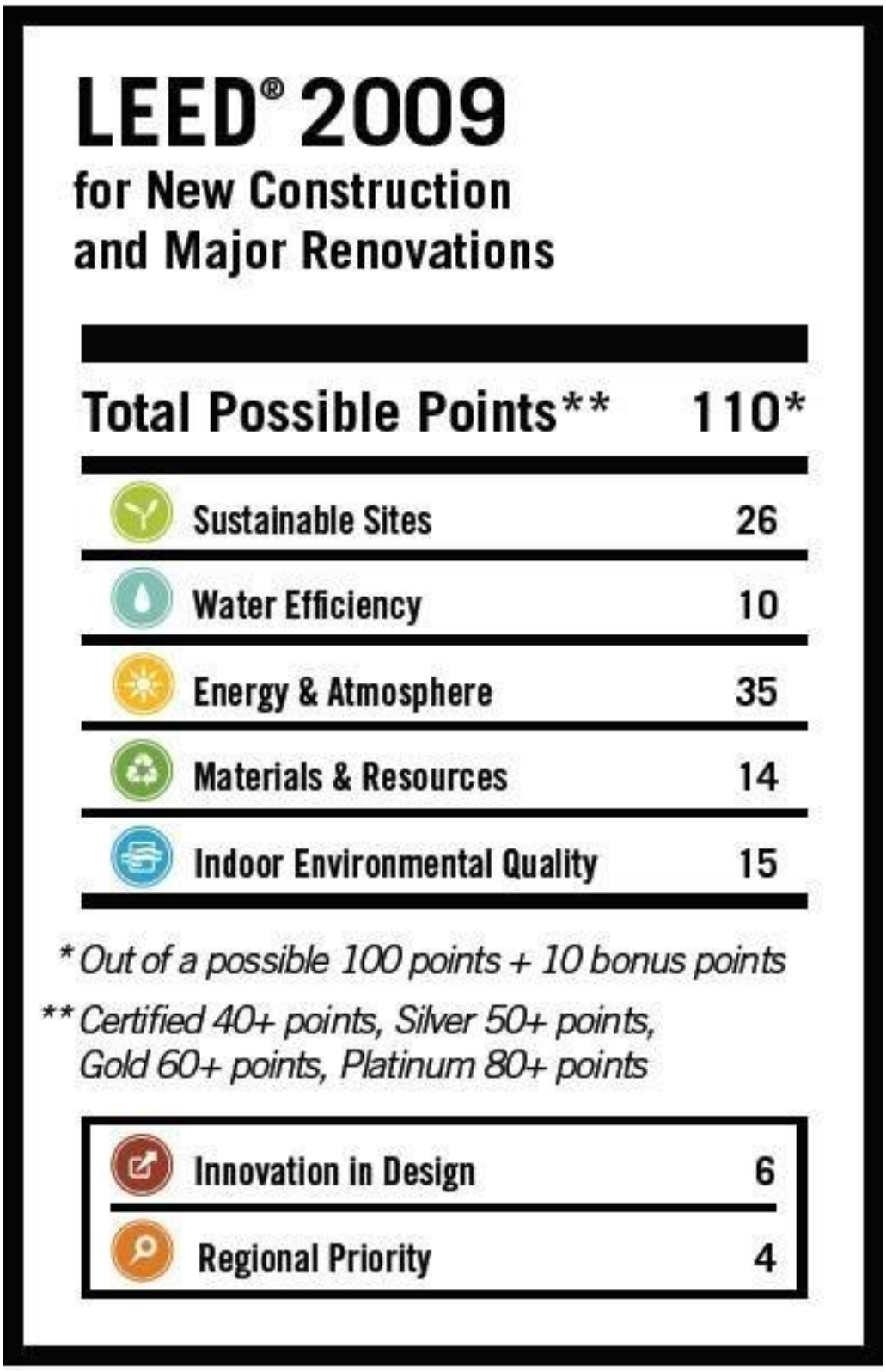


Fig 1.1: LEED Distribution of Point. (4)

1.4 Objective:-

Our main objectives are to develop a sustainable green building in Bangladesh and achieve LEED number also. The specific objectives are:

1) Compare the project cost of conventional building with sustainable green building.

2) Compare the characteristics between conventional building and sustainable green building.

3) Achieve LEED number of both conventional and sustainable green building

1.5 Activity: Our activities of these projects are given below:

1) To gain knowledge on sustainable Building

2) Project design or working drawing sheet.

3) Working on ETABS software.

4) Gain knowledge on different building materials.

5) Calculate Working cost.

6) Compare total cost between normal building and sustainable building.

1.6 Scope of the study: -

The following of the scope of the study:

- Passive and Active Hybrid Approach to build design
- Sustainable Integration of the natural and build environment
- Innovative Technology and Integrated system for high performance buildings
- Technologies in sustainable building.
- Building integrated renewable such as solar and wind energy
- Building and district sustainable energy system
- Thermal and electrical energy storage in building.
- Advanced Daylight system and lighting performance.
- Smart monitor and intelligent building controls
- Indoor environment quality, health and thermal comfort and human perception
- Green building codes and standards green retrofit.
- Building Information Modeling (BIM)
- Life Cycle Analysis or Life Cycle Costing

- Social and Economic Sustainability
- Modeling and Optimization of Building Performance (results based on simulations with clear links to experimental measurements**)** (5)

1.7 Organization of the Report:

The thesis was presented in six (6) chapters as follows:

1) **Chapter 1:** Gives the introduction which also includes background of the research, Green building rating system It also states the benefits, scope and method of the research briefly.

2) **Chapter 2**: Gives on overview of literature related with this work.

3) **Chapter 3**: Green building in sustainable building. It briefs about green building in Bangladesh.

4) **Chapter 4**: Methodology. This chapter describes the methodology adopted to carry out the research.

5) **Chapter 5**: Gives the general overview of the principle of regression analysis. This chapter also shows the research data analysis process, discussion and finding.

6) **Chapter 6**: Contains the conclusions drawn from the research, the researcher's contribution to knowledge and recommendations for further research.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature review in whole world

In whole world there are so many structures which are related with green building system. Some literature review is given below:

1. **Suzlon- A powering a greener tomorrow:** Suzlon believes in creating and maintaining a positive environment, both outside its office walls as well as on the inside. Suzlon One Earth is the embodiment of this belief. Situated in Pune, India, it is the eco-friendly, self-sufficient headquarters of the company. The campus is spread across 10 acres and is completely powered by renewable energy, including hybrid wind turbines, solar panels and photovoltaic cells.

Suzlon One Earth is a LEED Platinum and GRIHA 5 - star certified building and is one of the greenest corporate campuses in the world. It is divided into five interconnected, individual buildings that are aptly named after the elements of nature – Sun, Aqua, Sky, Tree and SEA. (6)



Fig 2.1: Suzlon (6)



Fig 2.2: Suzlon (6)

2. Centre for Environmental Sciences & Engineering Building, IIT, Kanpur, India:

The CESE is a 5 star green rating building by GRIHA(India) and research facility at the IIT (Indian Institute of Technology), Kanpur on a plot area of 175, 000 square meter . It has been designed in an environment friendly manner and conceptualized and constructed as a "building in the garden" that is sustainable.

Key Sustainable Features:

- •The building is fully compliant with the ECBC (Energy Conservation Building Code).
- •Sustainable site planning has been integrated to maintain favorable microclimate.
- •The architectural design has been optimized as per climate and sun path analysis.
- •The building has energy-efficient artificial lighting design and daylight integration.
- •Water body to cool the micro climate.
- •Orientation of building: North – South.
- •It also has energy-efficient air conditioning design with controls integrated to reduce annual energy consumption. (7)



Fig 2.3: Centre for Environmental Sciences & Engineering Building, IIT, Kanpur, India (7)

2.2 Basic Principles of Green Building

Green buildings are designed, constructed, and operated to enhance the well-being of their occupants and support a healthy community and natural environment. The five principles of green building:

- Livable communities
- Energy efficiency
- Indoor air quality
- Resource conservation
- Water conservation

2.3 Characteristics of Green Building

In practical terms, green building is a whole-systems-approach to building that includes:

- Designing for livable communities
- Using sun and site to the building's advantage for natural heating, cooling, and day lighting
- Landscaping with native, drought-resistant plants and water-efficient practices
- Building quality, durable structures
- Reducing and recycling construction and demolition waste
- Insulating well and ventilating appropriately
- Incorporating durable, salvaged, recycled, and sustainably harvested materials
- Using healthy products and building practices
- Using energy-efficient and water-saving appliances, fixtures and technologies

2.4 Top 10 Sustainable Building Methods

Many organizations are recognizing the value of sustainable and green building methods. New advances in materials, technology and practices enable companies to use environmentally friendly processes that also lead to better overall efficiency. Here are the top 10 sustainable building methods currently in use or under development.

1. IoT Integrated Automated Building Systems

The Internet of Things (IoT) gives facility managers access to data that they did not previously have access to. These small connected sensors can integrate with automated building systems to improve the sustainability of operations. For example, IoT sensors can dynamically adjust the required ventilation and lighting levels inside the building based on temperature, weather and CO2 readings. The facility manager doesn't need to manually stay on top of these adjustments or input data from multiple pieces of equipment.



Fig 2.4: IoT Integrated Automated Building Systems (8)

2. Synthetic Roof Underlayment

The underlayment on roofs is typically asphalt-based, which breaks down relatively quickly. Replacing this layer is necessary to keep moisture out of the building's interior. Synthetic roof underlayment offers an alternative that weighs less and holds up to the wear and tear of an exterior environment. This material uses polymer that comes from recycled scrap materials. It also eliminates VOCs from the underlayment.

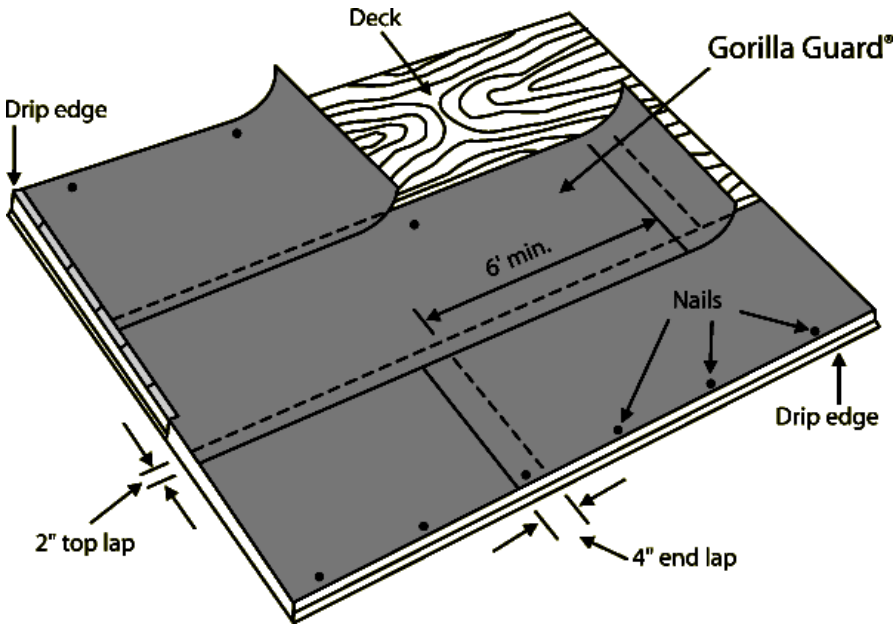


Fig2.5: Synthetic Roof Underlayment (8)

3. Green Roofs

Another innovation for the top of commercial properties comes from green roofs. Grass, plants, flowers, bushes and other greenery grows on the roofing material. Storm water is absorbed into the soil and managed more easily than with a bare roof. Heating and cooling costs are reduced, and the air quality is improved.



Fig2.6: Green Roof (8)

4. **Passive Solar**

Another way to leverage a sustainable solar energy source is to construct the building based on the passive solar concept. The facility's location and design maximize solar energy for heating during winter, while reducing its impact during warmer months.

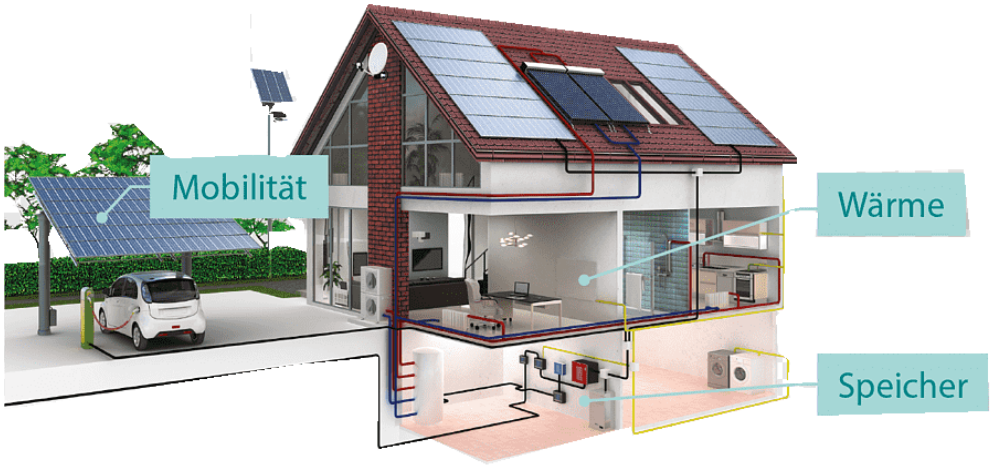


Fig2.7: Use of solar Panel (8)

5. **Grid Hybrid System**

Renewable energy sources provide a sustainable way for organizations to power their commercial properties, but many grid systems lack storage to power facilities during times of low solar availability. A hybrid system stores excess energy and allows the renewable source to function at night, during overcast days and in other conditions that aren't ideal.

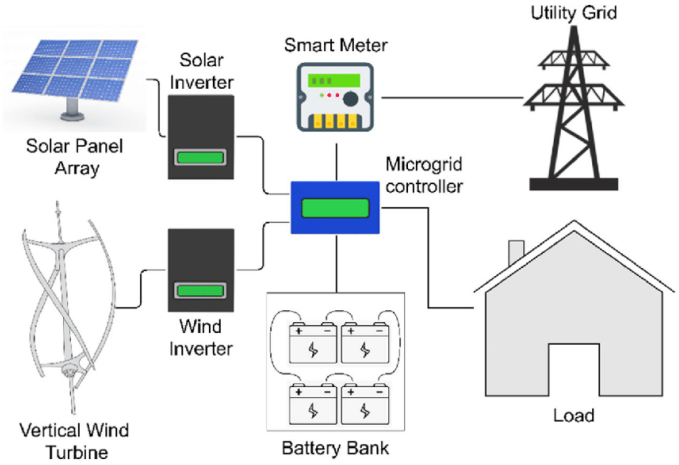


Fig 2.8: Grid Hybrid System (8)

6. Grey water Plumbing System

Grey water systems reduce the facility's need for fresh water, as everything except for toilet streams can be processed for reuse. The most common uses for this water include irrigation and supplying toilets with water.

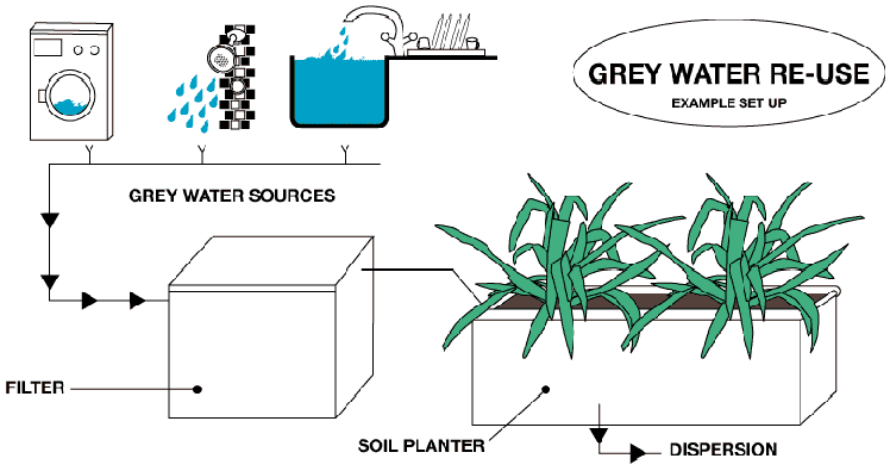


Fig 2.9 Grey water Plumbing System (8)

7. Electro Chromic Glass

Electro chromic glass can shift from clear to opaque based on external stimuli such as an electrical current or UV rays. It eliminates the need for shades and other window treatments, while adapting to current conditions passively. Additional benefits include blocking the vast majority of UV rays.

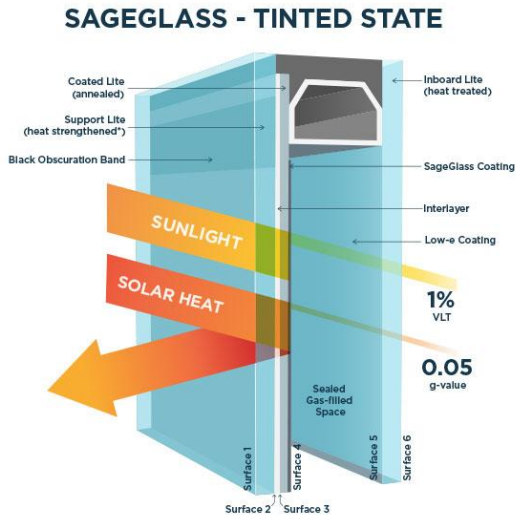


Fig 2.10: Electro Chromic Glass (8)

8. Solar Thermal Cladding

Solar thermal cladding is a passive solar building method designed specifically to hold heat during the winter. The sun's energy is stored within this material and passed through to the building for heat retention purposes.

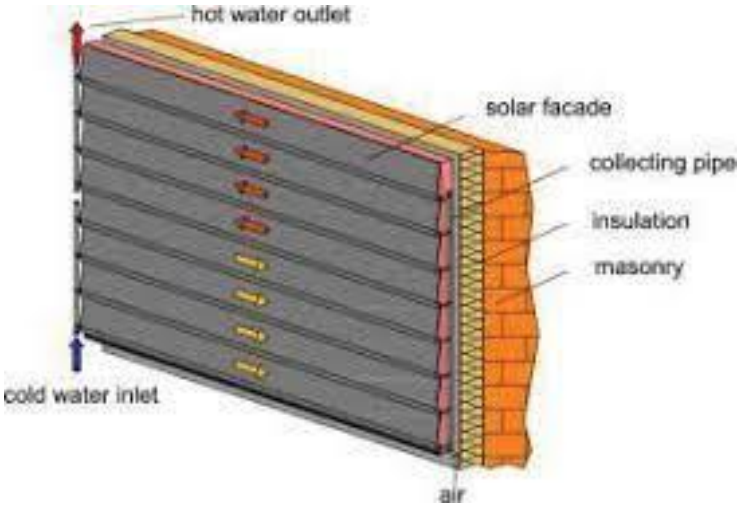


Fig 2.11: Solar Thermal Cladding (8)

9. Structural 3D Printing

Creating and moving building materials to the job site can have heavy environmental costs. As structure 3D printing begins moving forward, it becomes easier to cut down on shipping costs or reduce the weight of components



Fig2.12: 3D Painting in Constriction (8)

10. Self-healing Concrete

This material is in its early stages, but once it's commercially viable it opens up many sustainable possibilities. Everything from roads to walkways can benefit from concrete that heals itself. Road crews would no longer need to shut down busy streets and highway lanes to address potholes and cracks (8).

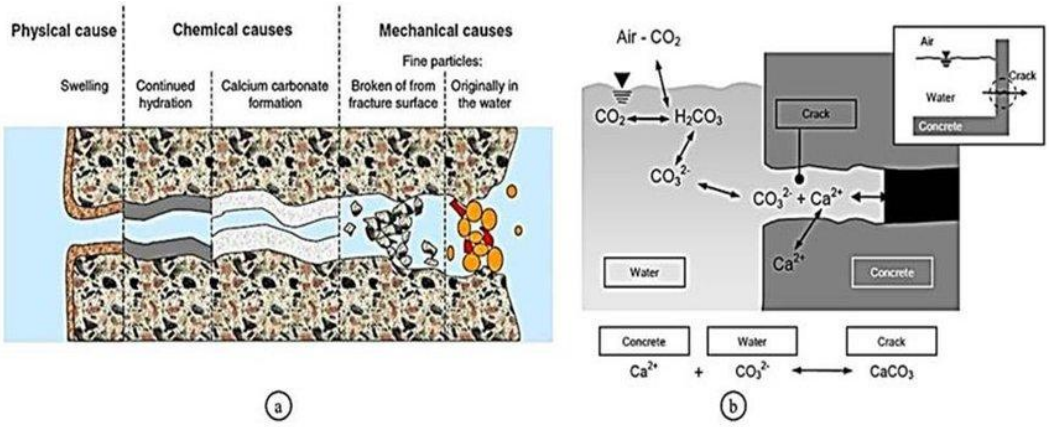


Fig2.13:Self-healing Concrete (8)

2.5 Difference between Conventional Building and Green Building

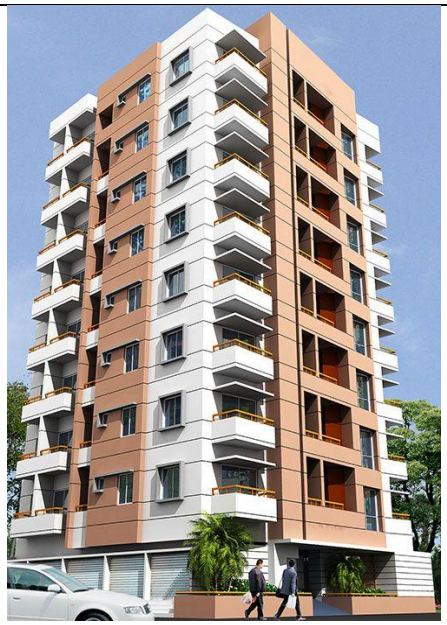
Conventional Building	Green Building
1. Conventional construction is a method of ordinary or standard construction. It commonly involves the utility of traditional materials, and remains within a particular set of parameters.	"A green building is one which uses less water, optimizes energy efficacy, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to conventional building."
2. Use Normal tube and CFL lights	2. Use Led lights for energy saving.
3. Use of normal materials	3. Use of economical and eco materials
4. No water saving process	4. Water saving methods and also rain water harvest
5. Green roof top	5. Green roof top and solar panel for energy saving.
6. Typical waste treatment	6. Onsite sewerage treatment process.
7. No energy saving method.	7. Energy saving though using sunlight.
 **Conventional Building**	 **LEED Certified Green Building in Dhaka**

Table no. 2.1: Difference between Conventional Building and Green Building

CHAPTER 3

Green Building in Bangladesh

3.1 Green Building in Bangladesh

Bangladesh is one of the most vulnerable nations in the world due to climate change. As the ninth most populous country and twelfth most densely populated countries in the world, its rising population and limited land space have put tremendous strains on the urban ecosystem. The capital of Dhaka itself underwent severe transformations in recent years to catch up the increased rate of urbanization. This change was paralleled by a boom in the real estate, construction and housing industry. According to United Nations Population Fund (UNFPA), Dhaka is one of the most polluted cities in the world. There are six main sectors most likely to be affected by climate change in Bangladesh – water resources and coastal zones, infrastructure and human settlements, agriculture and food security, forestry and biodiversity, fisheries, and human health. Deforestation has resulted in several man made disasters in the country's history. Green buildings assure efficient usage of water and energy and the nation is struggling in the production of electricity and suffering from water. The First Government Green Building Initiative was taken by the Housing and Building Research Institute in 2007.The Eco-Housing Project designed by Ar. Md Nafizur Rahman. With the support of IFC-world bank the HBRI Drafted the Guideline for Green building Code in 2012, in the same year a new chapter on Energy Efficiency and Sustainability was included in BNBC. The Building Energy and Environment Rating System for Bangladesh has been Drafted by Ar. Md. Nafizur Rahman in 2018 for the Sustainable and Renewable Energy Authority (SREDA) The Bangladesh Bank with the support of SREDA also created a point-based rating system for their Refinancing scheme in 2017. In the private sector, the first green building in Bangladesh was by EPIC group in May 2011. Since 2008, Sustainable Built Environment Initiative – Bangladesh (later Bangladesh Green Building Council) founder, Sanwar Azam had worked to unify the stake holders towards a greener country, saying that with growing population in a diminishing land and rapid urbanization to major cities, 'Going green' had become a marketing ploy for various organizations as there were no quantifiable way to judge a structures sustainability. He offered a centralized board to offer Leadership in Energy and Environmental Design (LEED) certifications to interested projects and firms. In addition, he proposed a similar voluntary building rating tool that is much cheaper to attain and one that is much suited to the socio-economic conditions of the country and relevant to its building environment and construction culture (9)

3.2 Example of Green Building in Bangladesh

CITYSCAPE TOWER (LEED PLATINUM CERTIFICATION)



Fig3.1: Cityscape Tower (10)

Cityscape Tower is the first Platinum certified commercial LEED certified building in Dhaka. The building scored 81/110 in the LEED Certification scorecard. The developers of the building, Cityscape International Ltd, have gone leaps and bounds to ensure a LEED Platinum Certification. The building scored highly in each of the seven factors, including 10/10 in Water efficiency. Special features of the building include energy efficient air conditioning, $CO_2$and CO sensors for air quality. On-site water treatment, and rain water harvesting is also present. The roof also contains 18 KVA solar panels. Cityscape Tower is also the first building with full wooden cladding in Bangladesh, making it unique from the glass towers seen in Gulshan Avenue nowadays. Its renewable energy solar system results in the building consuming 44% less energy and 60% water savings compared to buildings situated nearby.

SAIHAM TOWER (LEED PLATINUM CERTIFICATION)



Fig3.2: SAIHAM TOWER (10)

Attaining LEED Platinum certification in 2018, Saiham Tower scored 80/110 in the LEED certification scorecard, with Saiham Properties striving for the best in class when it comes to sustainable building. The facility makes use of various optimization methods, resulting in a very high score in each criterion, including 23/37 in Energy & Atmosphere. Saiham Tower's environmentally friendly features include efficient HVAC design for energy efficiency, water use reduction and rain water harvesting facilities. Natural lighting and air, recycled construction materials, and LEED compliant faucets and fixtures are also present. The Curtain Wall glass used in the building's exterior helps with maintaining proper daylight reaching the insides of the building, temperature control, as well as its aesthetics, making the building both functional and aesthetically pleasing.

SIMPLETREE ANARKALI (LEED GOLD CERTIFICATION)



Fig 3.3: SIMPLETREE ANARKALI (10)

The LEED Gold Certified building is the first core and shell constructed LEED certified building in Bangladesh, scoring 71/110 in the LEED certification scorecard. Simpletree Anarkali embodies water conservation, energy efficiency, and sustainable building. It scored well in each of the certification criteria, including 25/28 for Sustainable Sites. The forecourt in the roof consists of 65.3% vegetation. Rain water and recovered water helps with irrigation of the vegetation.

The water recovery facilities of Simpletree Anarkali help it achieve 25% reduction in rainwater runoff and 41% decrease in the use of portable water. Furthermore, all the wastewater created on site is subject to Tertiary Treatment. The building also is 12.5% more energy efficient. The western side of the building has double low-e, ceramic fritted glazing panels fitted, helping it keep up with the mandatory SHGC (solar heat gain coefficient) value, while adding to the aesthetics with the display of urban artwork on the west faced.

SHAHJALAL ISLAMI BANK CORPORATE HEADQUARTERS (LEED GOLD CERTIFICATION)



Fig 3.4: SHAHJALAL ISLAMI BANK (10)

Shahjalal Islami Bank Ltd has set the tone for other banks to follow by making the first-ever LEED Gold Certified bank headquarter in Dhaka. The building scoring 68/110 on the LEED certification score board. Volumezero architects designed the building with the LEED certification in mind. The building had good scores in every criterion, including a score of 9/15 in Indoor Air Quality.

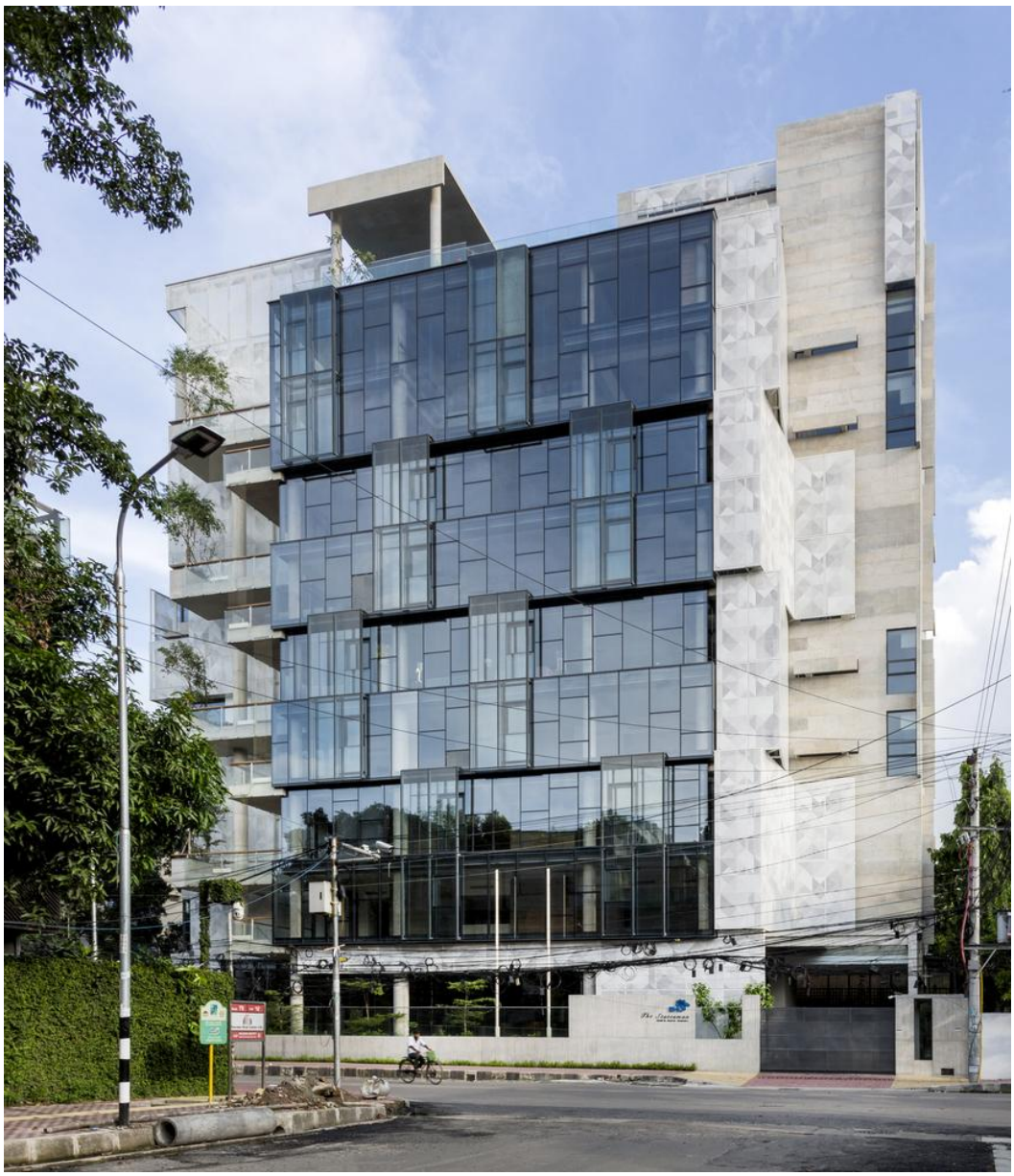
The front of the building faces east, with layers of glasses serving different functions. The first layer consists of horizontal bands containing ceramic fretting, which provides heat resistance. The second layer consists of glass fins with low thermal emissions. These fins run through the length of the building. Horizontal shading covers the southern side of the building, helping further with indoor temperature control. The core of the building acts as a buffer from the heat coming in from the west. This intricate layering of the glass shell also results in an aesthetically pleasing form factor for the building.

All in all, the LEED Certified buildings in Dhaka mentioned above are torch bearers in sustainable buildings. In the midst of the concrete giants that we can see in the skylines of Dhaka, the newly built LEED certified buildings in Dhaka are a fresh breath of air. The LEED certified buildings in Dhaka are also helping towards making a greener, cleaner, and more sustainable Dhaka (10)**.**

3.3 Some picture about The Sustainable Building

'The Statesman'.

Located in the capital's Gulshan area, the 3775 m² residential building manages to capture your attention with its unorthodox structure. The large, rectangular building stretches from east to west. It has a large glass facade all over the north side and a patterned, perforated metal shell on the south side (11). Some Picture of this building are giving below:



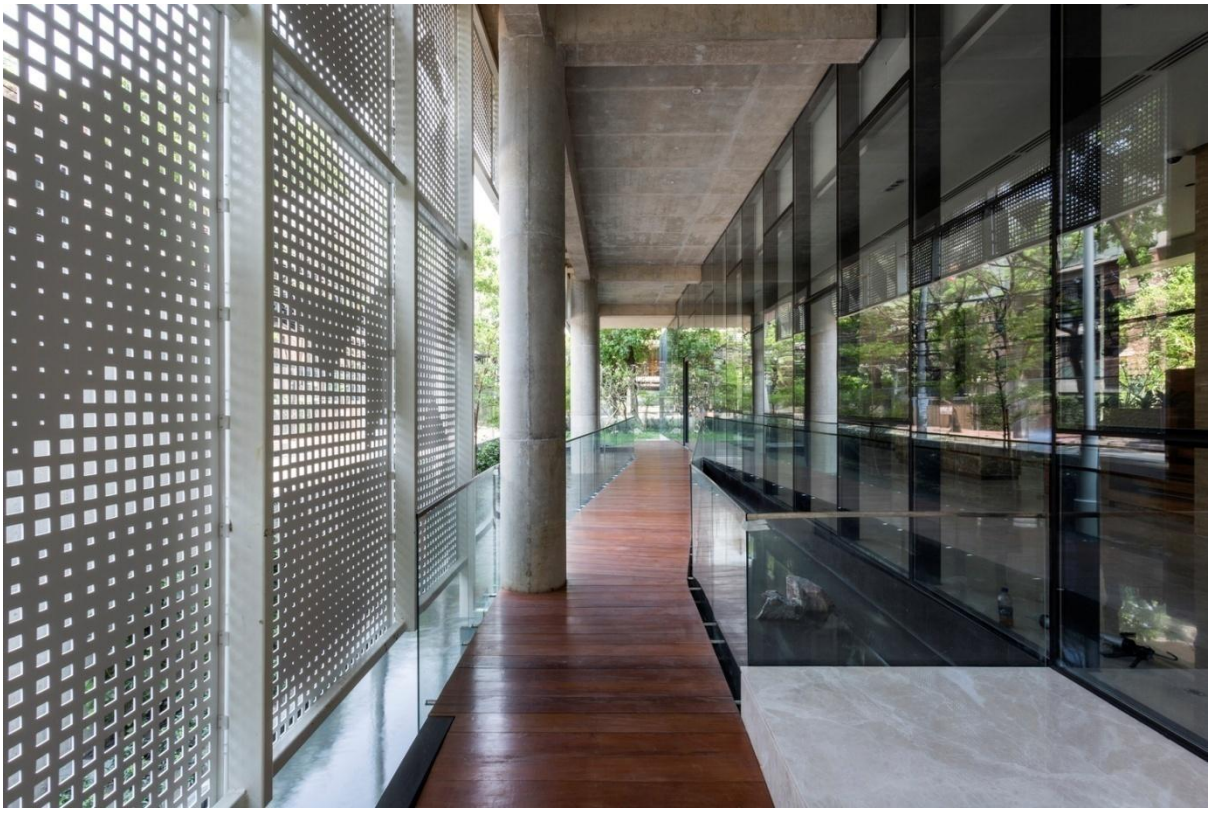














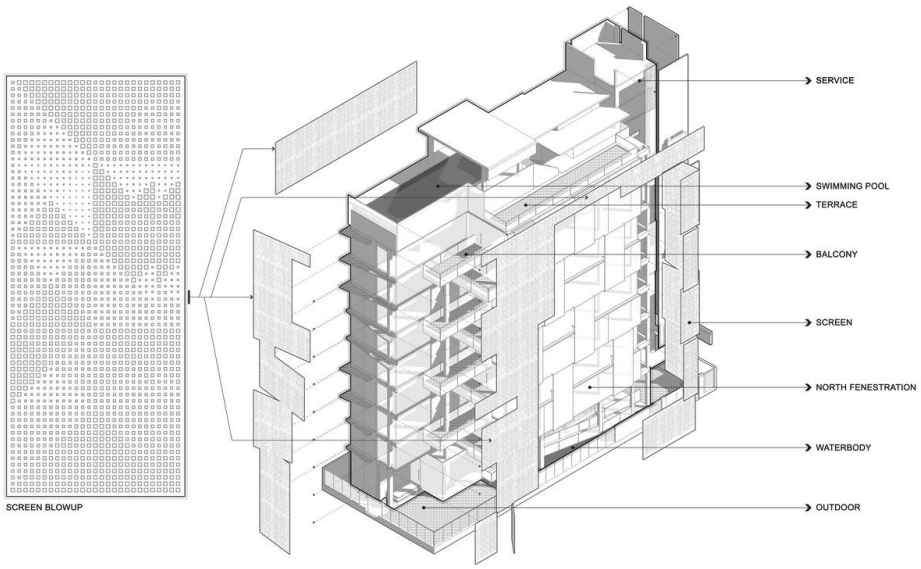


Fig3.5: Some Picture of "The Statesman" Building in Gulshan, Bangladesh (11)

CHAPTER 04

METHODOLOGY

One of the key factors in construction industry is estimating and costing. Accurate estimation is very important as the success and quality of a construction or project depend on it. And cost analysis of a construction is generally developed at all of the stages of the investment process. The loss and profit of a construction or project is strictly dependent on proper estimating and costing. Slight variation of the construction cost can hamper the overall success of a real estate enterprise and it can also hamper the financial stability of the developer. In this paper, a complete guideline for estimating of projects is provided with respect to architectural, structural, electrical and plumbing design. The item wise estimation and costing of a 9 storied residential building in Dhaka city is performed in the spread sheet analysis and the discussion of result and recommendations are provided.

The study has been accomplished based on:
1. General survey: At first we selected a site to make our projects. Then we make a survey and also did the soil test report.
2. Design and drawing collection: We make our projects design though different software like AutoCAD, ETABS etc and made stable our projects.
3. Spread sheet analysis: After doing all process about survey and design and drawing we made a spread sheet about estimation and costing.
4. Cost benefit analysis: Doing all steps 1, 2, 3 we compared the cost benefit between conventional and sustainable green building.

SPECIFICATION OF MATERIALS

The full specifications of the materials for the construction of the building are given below:

Cement

Cement is Ordinary Portland Cement conforming to the requirements of the Standard Specifications for Portland cement Type-I. ASTM C-150 r BDS 232: 1993. BNBC 2.4, 5.2.1 unless otherwise specified. Cement was delivered in bags by the manufacturer with the brand name, type of cement and weight of each bag marked on the bag. Sample test of cement was done from the laboratory designated by the Engineer for every consignment of cement. Bulk cement which partially set or which contains lumps of caked cement was rejected. The use of cement reclaimed from discarded or used bags was not permitted.

Water

The water used in mixing and curing concrete was tested by methods described in AASHTO test Method T-26. Water was clean and free from salt, oil, acid, vegetable or other substance injurious to the finished product. Water used in construction work was potable.

Fine Aggregate: Sand

Fine Aggregate was conformed to BDS 243:1963, ASTM C40-92.C87-83 (1990). Fine Aggregate was natural sand, composed of clean, hard, durable uncoated particles resulting from the disintegration of siliceous. Fine Aggregate was free of injurious amounts of organic impurities.

Deleterious substances were not exceeding the following percentages by weight:
1. Clay lumps and friable particles: 3%
2. Coal and Lignite: 0.25%
3. Material passing the 0.075 mm (No 200) sieve: 2%
4. Shale, coal, soft or flaky fragments: 11%
5. Sulfur compounds: 0.3%
6. Organic material content: 5%

Coarse Aggregate: Stone Chips

For all types of concrete with the exception of blinding concrete was consists of hard durable crushed stone boulder and conform to BDS 243:1963 (Coarse and Fine Aggregate for Natural Sources for concrete 1: ASTM C 33: Concrete Aggregates). Coarse aggregate was clean, free from dust and other deleterious materials.

The amount of deleterious substances was not exceeding the following limits:
1. Soft fragments; by 2% by mass
2. Clay lumps; 0.25% by mass
3. Material passing the 0.075 mm sieve: 0.5% by mass if clay. 1.5% by mass if fracture dust.

Coarse Aggregate: Brick Chips

It was made from brick and conformed to the following requirements:
1. It was made of first class and picked jhama bricks.
2. Nominal size: same as stone aggregate.
3. Appearance was completely non-plastic and free from all organic and other deleterious materials.
4. Unit weight was less than 1100 kg/cum.
5. Water absorption as a percentage of the dry weight did not exceed 14%.
6. Percent wear did not exceed 40% tested by Los Angeles Abrasion Test.

SEQUENCE OF STRUCTURAL WORK

A construction sequence schedule is a specified work schedule that coordinates the timing of land disturbing activities and the installation if erosion-protection and sedimentation-control measures. The sequence of structural works is given below:
1. Site Clearance.
2. Demarcation of Site.
3. Positioning of central coordinate as per grid plan.
4. Surveying and layout.
5. Excavation.

6. Laying binding and placement of foundation steel.
7. Shuttering and scaffolding.
8. Concreting.
9. Electrical and plumbing.
10. DE shutter.
11. Brickwork.
12. Doors and windows frames along with lintels.
13. Wiring for electrical purposes.
14. Plastering.
15. Flooring and tiling work.
16. Painting.
17. Final completion and handing over the Project.

Chapter 05

Result and Discussion

Here we are presenting our finding and results about our projects. The details about costing and estimation are given below:

5.1 Conventional Building Estimation and Cost:

DRAWINGS:

The structural drawings are given below in the following figures.

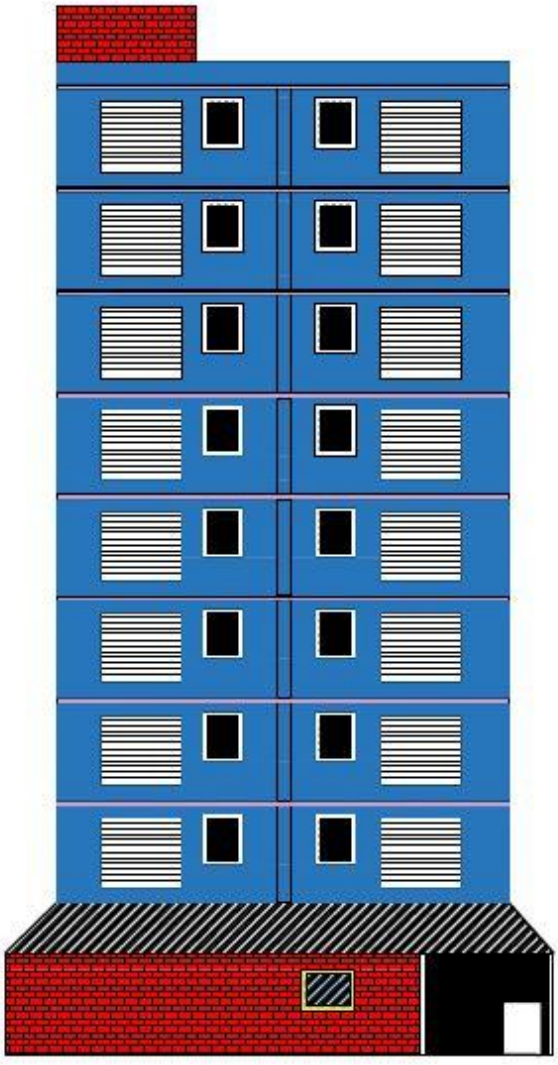


Fig 5.1: Front Elevation of conventional Building

ESTIMATION AND COSTING:

The total estimation and costing of Slab, Beam, Column, Pile and Pile cap are showing on appendix D sequentially.

The total costing of structural works and other are showing below in Table no. 5.1 and 5.2 simultaneously for Conventional Building.

Table no. 5.1: Estimation and costing Floor

SI No.	Name	Unit (BDT)
01	Piling	3,796,200.00
02	Ground Floor	2,065,232.00
03	1st Floor	3,814,148.00
04	2nd Floor	3,814,148.00
05	3rd Floor	3,814,148.00
06	4th Floor	3,814,148.00
07	5th Floor	3,814,148.00
08	6th Floor	3,814,148.00
09	7th Floor	3,814,148.00
10	8th Floor	3,814,148.00
11	Roof	1,902,997.00

Table no. 5.2: Other Estimation and costing

SI No	Name	Unit (BDT)
01	Wood, Aluminum, Grill & Ralling, Painting	7,963,067.00
02	Sanitary & pluming	6,000,000.00
03	Internal Electrification	6,800,000.00

04	Consumable Materials, Temporary Electrical Gas Bill for Construction Period	1,011,894.00
05	Lift 8 person 1nos	2,500,000.00
06	CCTV, Intercom & Fire Fighting System	250,000.00
07	Project Logo, Apartment No. Car parking No.	150,000.00
08	Consultancy Fee	611,453.00

Table no. 5.3: Total Estimation and costing of table 5.1 & 5.2

SI No	Name	Unit (BDT)
01	Table No.5.1: Total Estimation and costing of floor	3,82,77,613.00
02	Table no. 5.2: Total Estimation and costing of Others	2,52,86,414.00
	Total	**63,564,027.00**

Total Cost is about **63,564,027.00(Six Core Thirty Five Lac Sixty Four Thousand Twenty Seven Taka Only)** (Approximate). So the Cost about square feet is **1590.691 Taka** Only (Approximate).

N.B: Total amount can be change for the price up down in local market.

5.2 Sustainable Green Building Estimation and cost:

The sustainable green building related drawings, cost, and estimation are given below:

DRAWINGS

The structural drawings are given below in the following figures

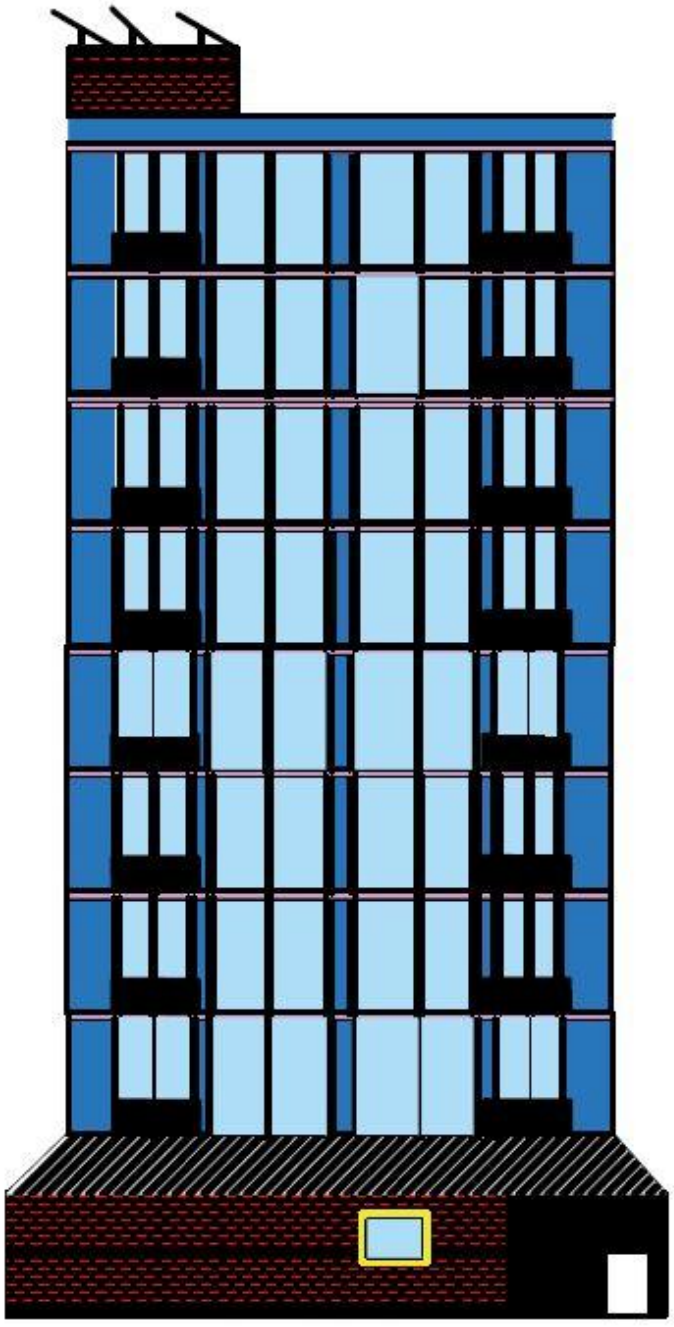


Fig 5.2: Front Elevation of Sustainable Green Building

ESTIMATION AND COSTING

The total estimation and costing of Slab, Beam, Column, Pile and Pile cap are showing on appendix D sequentially.

The total costing of structural works and other are showing below in Table no. 5.4 and 5.5 simultaneously for Conventional Building.

Table no. 5.4: Estimation and costing Floor

SI No.	Name	Unit (BDT)
01	Piling	3,796,200.00
02	Ground Floor	2,065,232.00
03	1st Floor	3,814,148.00
04	2nd Floor	3,814,148.00
05	3rd Floor	3,814,148.00
06	4th Floor	3,814,148.00
07	5th Floor	3,814,148.00
08	6th Floor	3,814,148.00
09	7th Floor	3,814,148.00
10	8th Floor	3,814,148.00
11	Roof	1,902,997.00

Table no. 5.5 Total Estimation and costing of others

SI No	Name	Unit (BDT)
01	Wood, Aluminum, Grill & Rallying, Painting	7,963,067.00
02	Sanitary & pluming	6,000,000.00

03	Internal Electrification	6,800,000.00
04	Consumable Materials, Temporary Electrical Gas Bill for Construction Period	1,011,894.00
05	8Kw Solar Panel Power Plan set	6,00,000.00
06	12 m thick tamped Glass for curtain wall	13449781.00
07	Lift 8 person 1nos	2,500,000.00
08	CCTV, Intercom & Fire Fighting System	250,000.00
09	Project Logo, Apartment No. Car parking No.	150,000.00
10	Gray Water Reuse Plant	2,00,000.00
11	Consultancy Fee	611,453.00

Table no. 5.6: Total Estimation and costing of table 5.4 & 5.5

SI No	Name	Unit (BDT)
01	Table No. 6: Total Estimation and costing of floor	3,82,77,613.00
02	Table no. 7: Total Estimation and costing of Others	3,95,36,195.00
	Total	**7,78,13,814.00**

Total Cost is about **7,78,13,814.00 (Seven Core Seventy Eight Lac Thirteen thousand Eight Hundred Fourteen Taka Only)** (Approximate). So the Cost about square feet is **1947.293 Taka** Only (Approximate)

N.B: Total amount can be change for the price up down in local market.

5.3 Comparison of conventional and sustainable buildings: The analysis are showing the difference between the estimation and cost of two same designed building called one is Conventional Building and another is Sustainable green building. From this analysis we are getting an idea about the cost that what if we change a conventional building in a sustainable green building. The difference of the cost of this process is showing below.

Name	Conventional Building	Sustainable Green Building
Window	Normal grill and Thai	Tempered glass 12mm Thickness
Door	Wooden Door	Sliding Door and PVC Door
Wall	10" brick wall	10" Brick Wall with tempered glass wall in master/Child bedroom
Power Supply	No alternate power supply without generator.	8Kw Solar Panel Power Plan sets
Water resources	No alternate water supply without WASA	Rain water Collection and gray water reuse plan
IoT Integrated Automated System	No	Yes
Total Cost(BDT)	**63,564,027.00 Taka** Only(Approximate)	**77,813, 814.00 Taka** Only(Approximate)
Cost Per Sqft	**1590.691 Taka** Only(Approximate)	**1947.293 Taka** Only(Approximate)

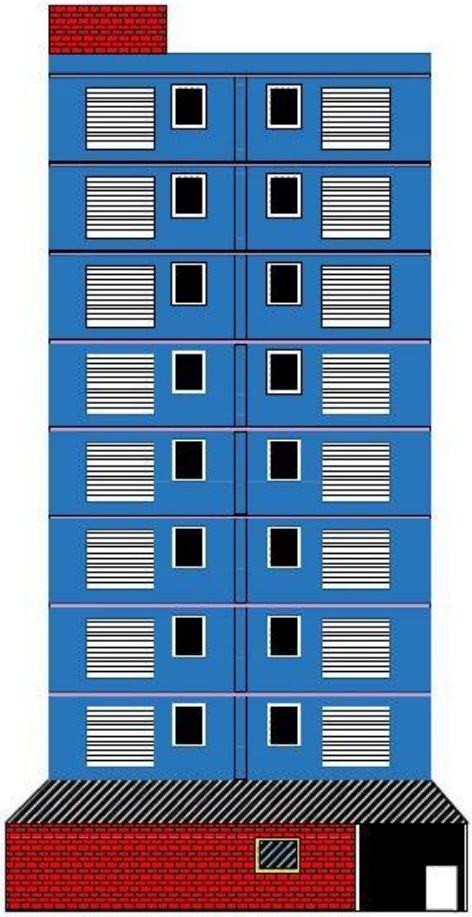
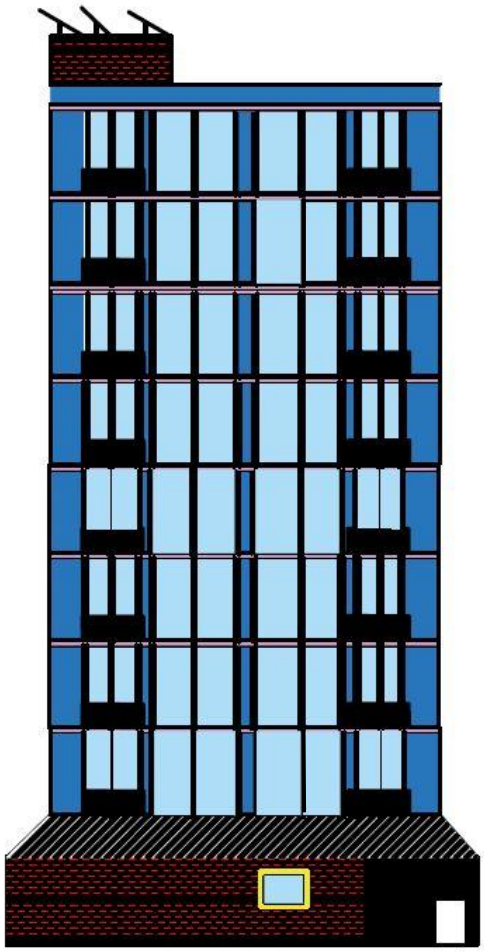
Elevation	 **Front Elevation**	 **Front Elevation**

Table no. 5.7: Comparison of conventional and sustainable buildings

5.4 LEED Points: Our Sustainable building is designed for also thought about the LEED points. We have a goal to achieve a place according to LEED point. For that we tried to design a new, Stylish, and at a time also a environment sustainable building. We have selected a sustainable site for our projects. We implemented a rainwater harvesting system, gray water use in our projects. We designed all bedrooms near to wall to supply sufficient air and natural sunlight. We also used glass curtain wall for more sunlight.
We used PVC doors which are non-decomposable. We tried to make a best indoor environment by using small plants, plastic paint, and also printed paints. Now if we calculate our achieved points according to LEED those are,

5.5 LEED points for conventional building: According to LEED numbering system conventional building has achieved 45 out of 110. The details of every sector in LEED numbering have been given below:

LEED Points for Conventional Building

SI No.	Name of points	LEED point	Our Achieved Points	Remarks
01	Sustainable Sites	21	10	Near the main Roads so sound pollution is high but Near a river, Available hospital, bazer, mosque etc.
02	Water Efficiency	11	05	No alternate water source without WASA
03	Energy & Atmosphere	37	11	Using only electricity, Some sun light pass through the window.
04	Materials & Resources	14	07	BSRM rods and normal grill, ralling, and as usual window
05	Indoor Environment Quality	17	02	As usual normal room decoration.
06	Innovation in Design	6	06	For design and structure build(Bonus Point)
07	Regional Priority	4	04	(Bonus Point)
	Total	**110**	**45**	**Only LEED© Certified**

Table no. 5.8: LEED Points for Conventional Building

From this chart we have achieved **“45 points out of 110 points”** and we have achieved only **“LEED Certified”** according to “**LEED Points**”



Fig 5.3: Our Achieved **LEED Certified** Logo..

5.6 LEED points for conventional building: According to LEED numbering system sustainable green building has achieved 73 out of 110. Building total LEED number can be achieved more by taking the given steps. The details of every sector in LEED numbering have been given below:

LEED Points for Sustainable Green Building

SI No.	Name of points	LEED point	Our Achieved Points	Remarks	What we should develop to achieve more points
01	Sustainable Sites	21	14	Far from main road to prevent various kind of sound pollution, Near a river, Available hospital, bazer, mosque etc.	_
02	Water Efficiency	11	08	Rain water harvest, Gray water reuse.	***We can make a submersible pump to backup water***
03	Energy & Atmosphere	37	25	Use Solar Panel, Sufficient air etc.	***We can make a mini wind Turbine on the roof top of the building***
04	Materials & Resources	14	09	Glass Wall instated of Brick wall in bedroom, Veranda	_

05	Indoor Environment Quality	17	07	Small plants, plastic paint, and also printed paints	***We can use artificial grass in drawing & dining for an excellent look.***
06	Innovation in Design	6	6	Bonus Point For design and structure build	_
07	Regional Priority	4	4	(Bonus Point)	_
	Total	**110**	**73**	**LEED© Gold Certified**	**LEED© Platinum Certified can be achieved**

Table no. 5.9: LEED Points for Sustainable Green Building

From this chart we have achieved **"73 points out of 110 points"** and we have achieved **"Gold Certified"** according to "**LEED Points**"



Fig 5.4: Our Achieved **Gold Certified** Logo…..

5.7 LEED Points Graph of Conventional & Sustainable Green Building

This chart is showing the comparison of LEED points between conventional and sustainable building. From this chart its clear that in every steps the sustainable green building are achieving more points then conventional building.

Here from chart the orange curve is the sustainable green building curve and the blue curve is the conventional building curve. The chart showing that in sustainable site conventional achieved 10 points but sustainable green building achieved 14 out 21 points according to LEED system. In water efficiency conventional got 5 pointes and sustainable green building got 8 out of 11. In energy and atmosphere sustainable green building got 25 points but conventional building got 11 points out of 37 points. In materials and resources sector conventional building and sustainable green building got respectively 7 and 9 points. In indoor environmental quality sector conventional building and sustainable green building got respectively 2 and 7 points. But in innovation in design and regional priority both conventional and sustainable green building got 6 and 4 points as a bonus point.

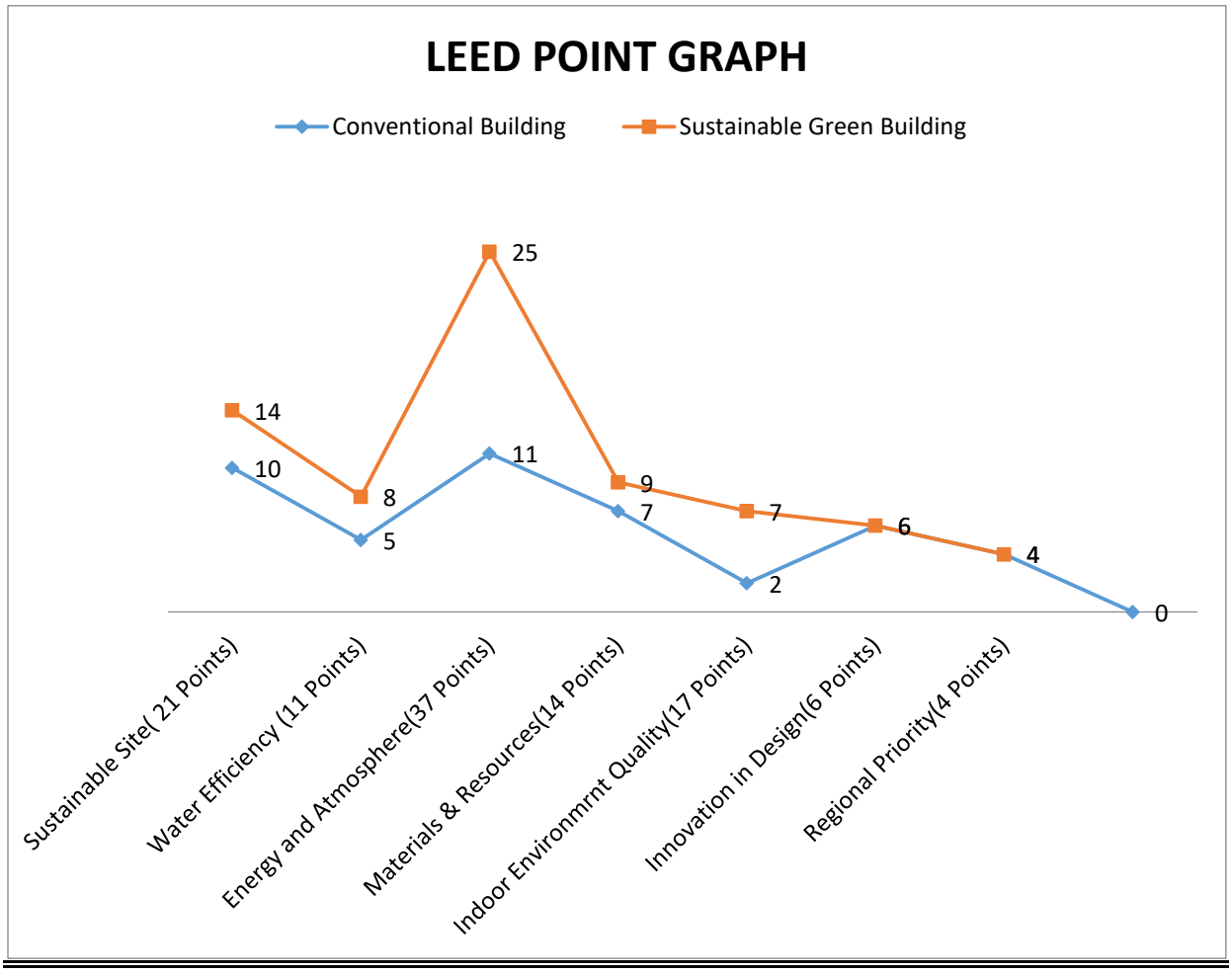


Fig 5.5: LEED Points variation

Chapter 06

Conclusions and Recommendations

6.1 Conclusions:

By collaborate withdrawing, analysis, literature survey we are developing an array of sustainable green buildings. These systems of converting a conventional building into a sustainable green building enhance performance, durability, aesthetics, and sustainability across the entire hole projects. From roads to roofs, we tried solutions that reduce waste, improve efficiency and ultimately achieve the goal of development that is as environmentally friendly as it is visually appealing and structurally and functionally robust and also achieve great LEED points.

1. Finding from our sensitive analysis is that sustainable building is a big budget project but it saves other external cost like extra electricity bill cause of using electricity in day time

2. It promotes people a healthier living with nature.

3. From this research we able to use reduces wastes. Over the past decades, global warming has remained a steadfast concern due to its increasing evident effects of plants. Construction firms have stared relying resources and methods which are beneficial for us and promote a cleaner environment.

4. From these researches we see that promotes cost efficiency. One of the most sustainable benefits of sustainable building is their lower maintenance costs with specially engineered design elements that helps reduce water and energy bills. Reduce maintenance and operational costs mean huge saving invested elsewhere such as higher employee wages or product developments.

5. Sustainable building methods utilize eco friendly materials without compressing quality or structural integrity. Many of these materials are recycled and reduced. Among which are bio composites that are commonly substituted as sustainable building materials have proven to be as reliable and durable as their non renewable counterpart. For green architects, energy efficiency remains their number one priority and goal in building design. Building structure that obtains their energy from nature resources such as wind, sun, and water are exceptionally favorable to our environments.

6.2 Limitations:

In completing this thesis we have faced many problems. We have faced some limitation. Those are

1. The study period is short to complete perfectly two same storied building in two different way properly.
2. People are reluctant to provide information about many topics.
3. Because of “Covid-19” pandemic we are provided online class instead of offline class. We couldn’t discuss our projects and researches with each other properly of our group members.

6.3 Recommendations for Future Work:

The respondents of the survey recommend many suggestions to inspire sustainable green building. Creating social awareness is the most recommended, government incentive in forms of tax reduction, supplying materials and resources are the second highest suggestion. Few respondents suggested that training and workshop from the government can be arranged to encourage sustainable green building. One respondent suggested that government certified paid personnel from City Corporation can visit and help in the development and maintenance of conventional building and how to convert them in a green building. Some respondents emphasized ensuring the access of the tenants for the purpose of gardening. This recommendation section of this research has been developed based on recommendations suggested by users and the best practices from worldwide.

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Appendix

Appendix A

Drawing of Conventional Building:

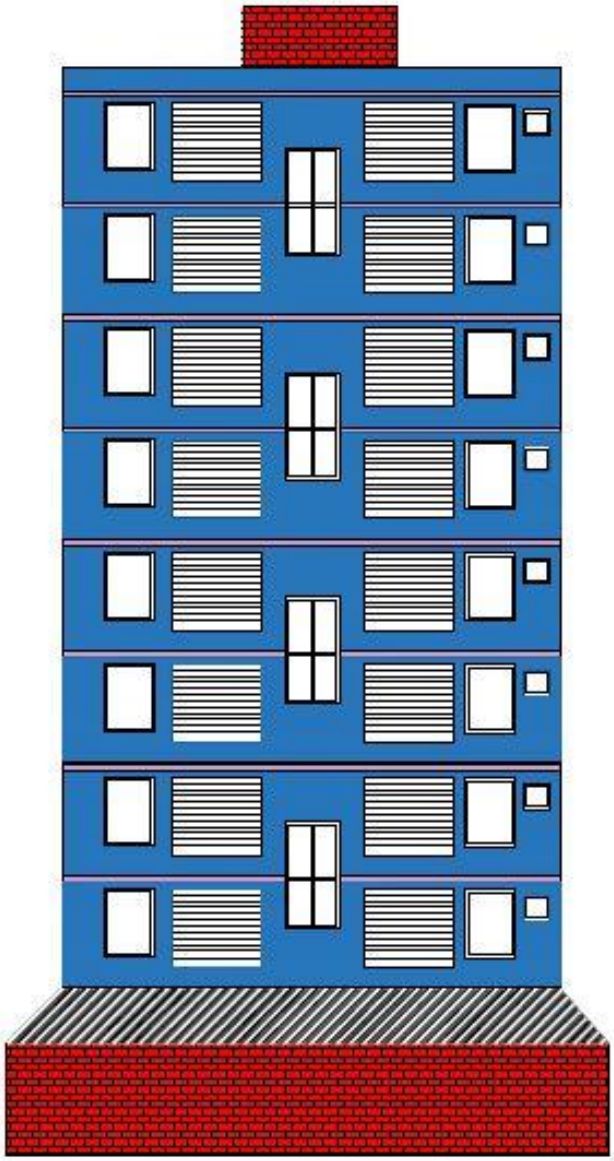


Fig: Side Elevation of Conventional Building

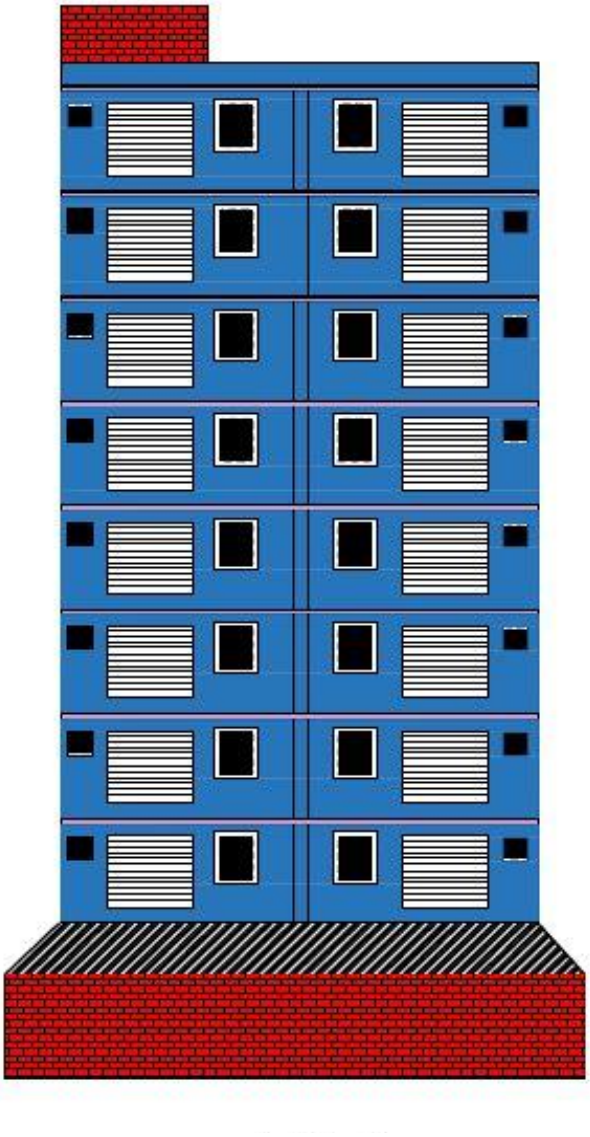


Fig: Back Elevation of Conventional Building

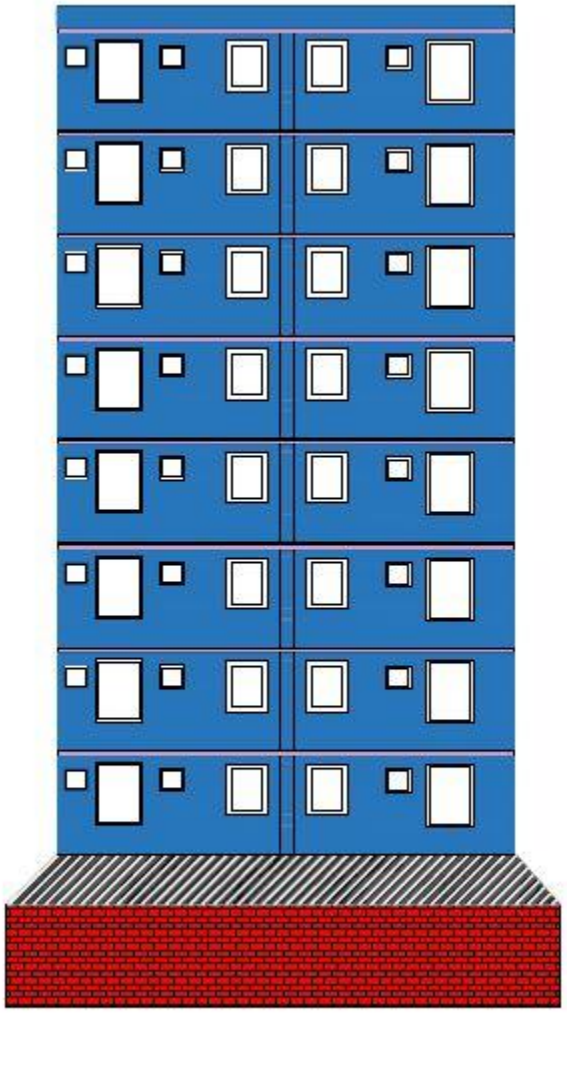


Fig: Side Elevation of Conventional Building

Appendix B

Drawing of Sustainable Green Building:

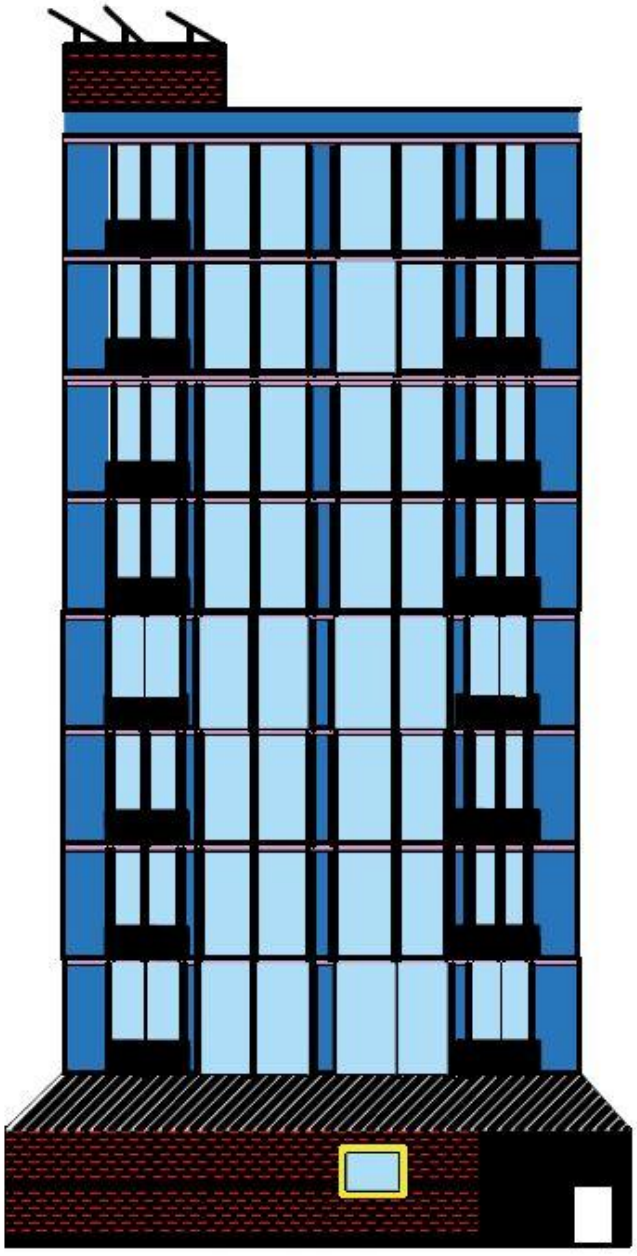


Fig: Front Elevation of Sustainable Green Building

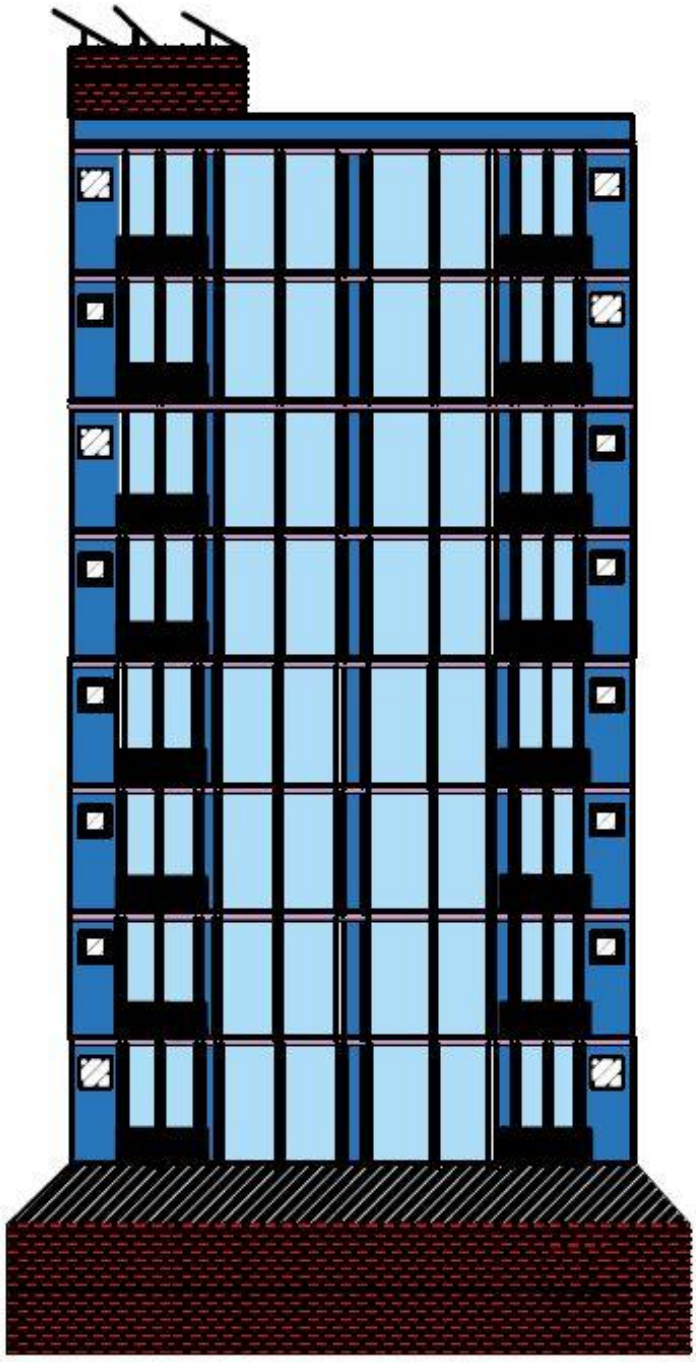


Fig: Side Elevation of Sustainable Green Building

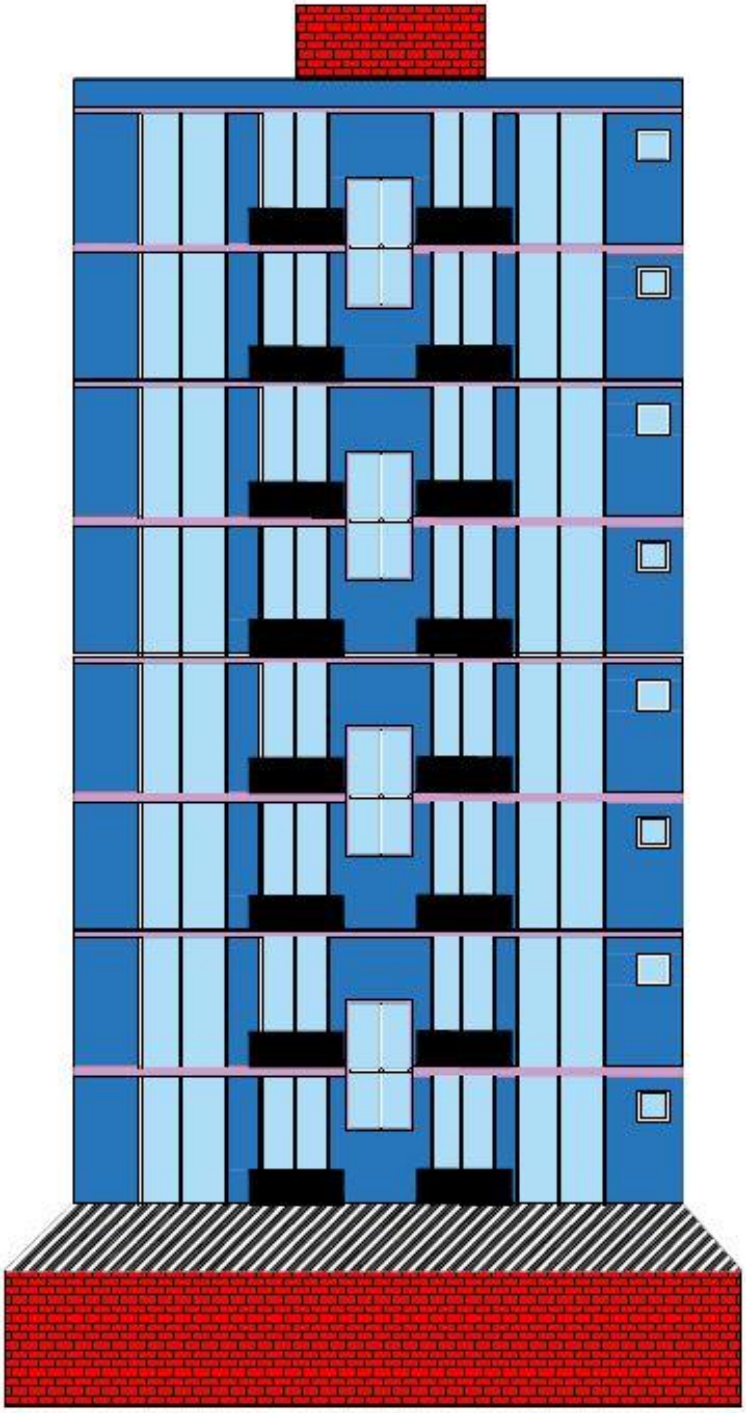


Fig: Back Elevation of Sustainable Green Building

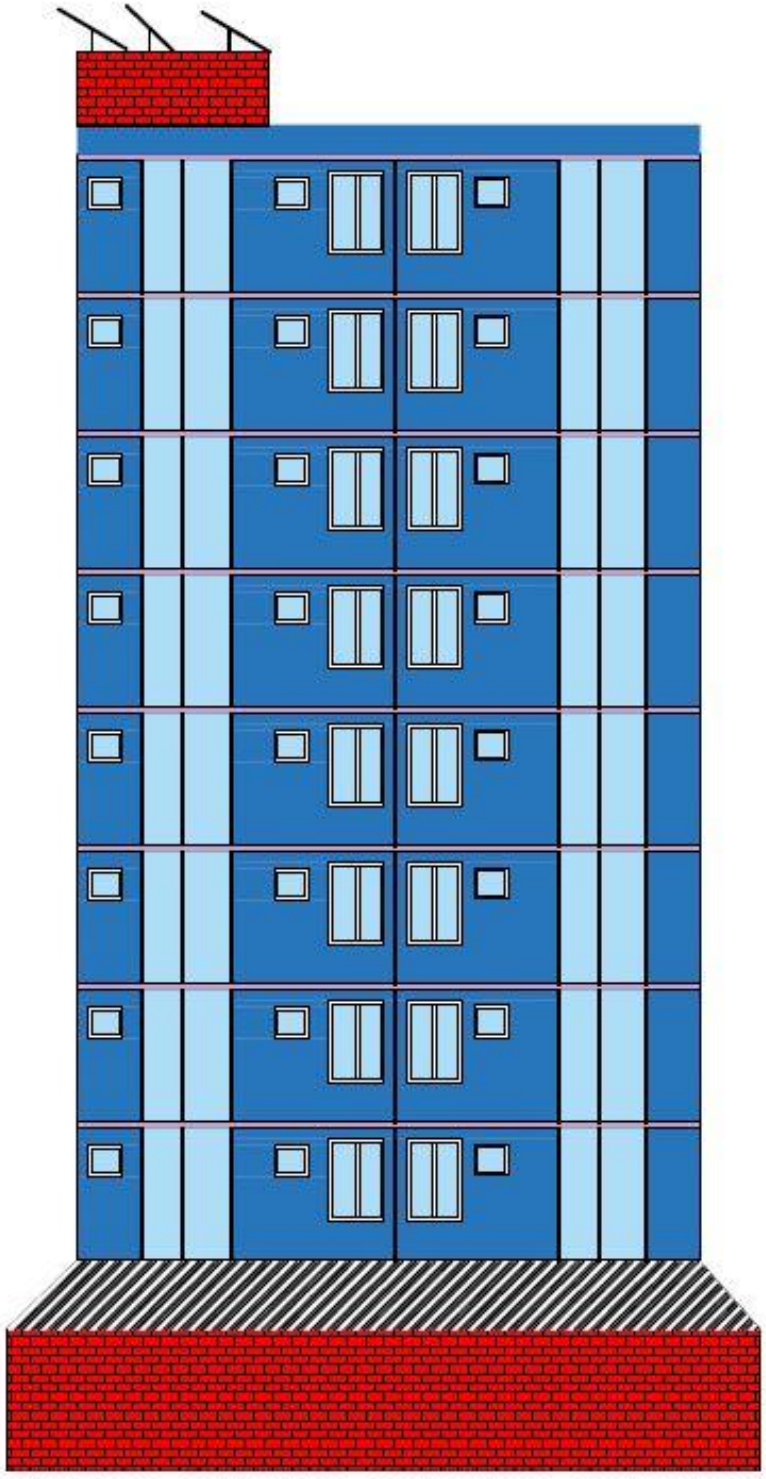


Fig: Side Elevation of Conventional Building

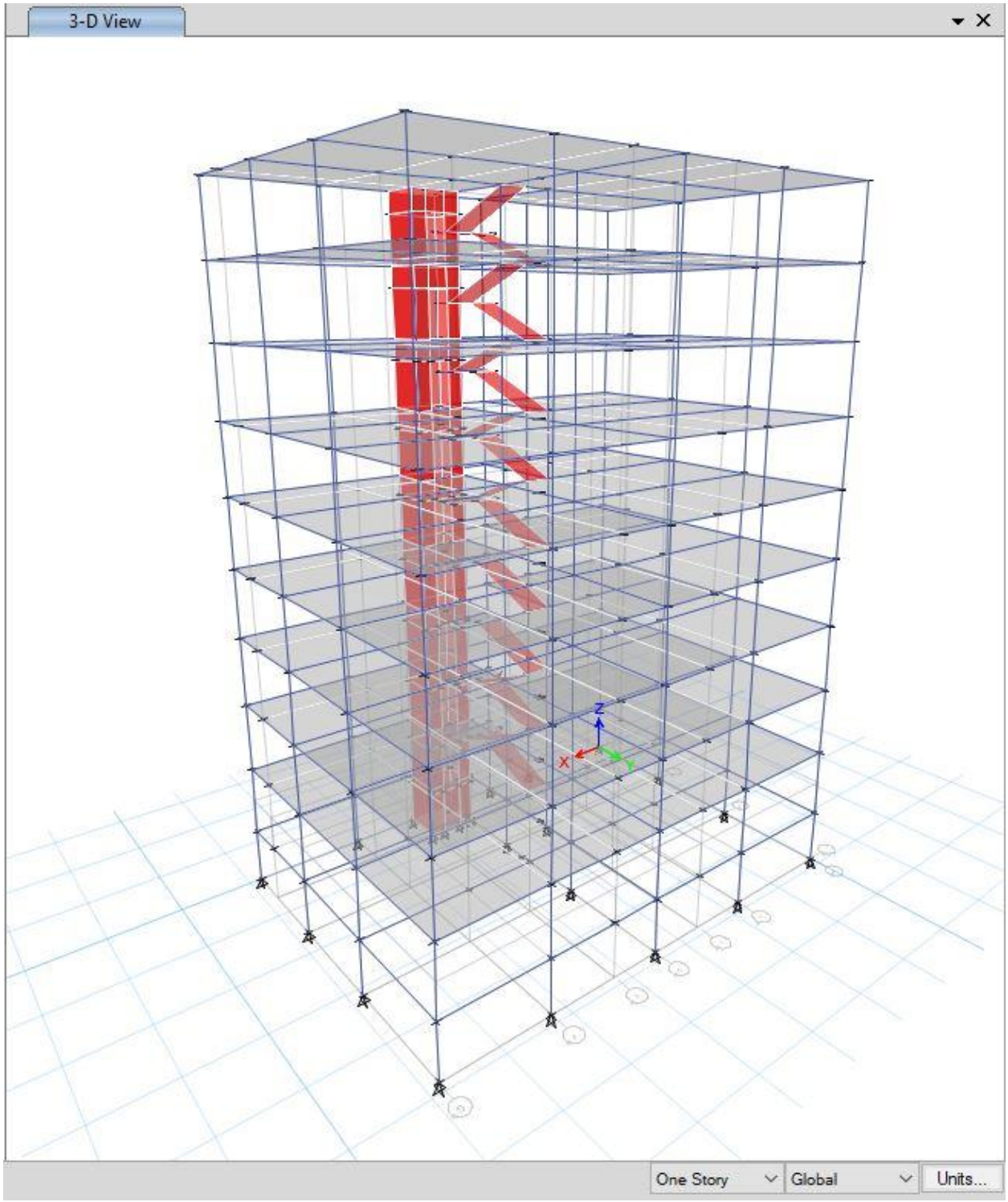
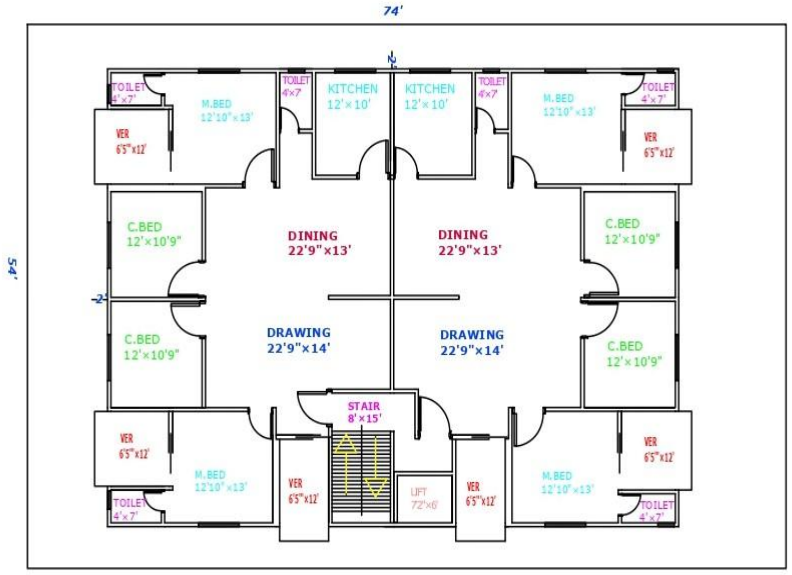


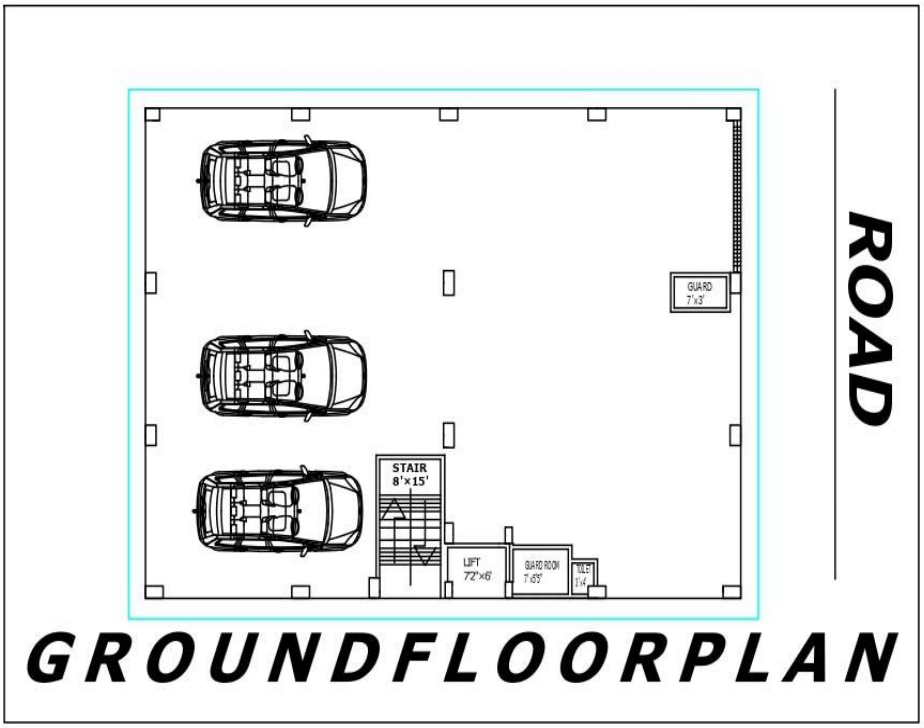
Fig: 3D Elevation of Our Projects Building By ETABS

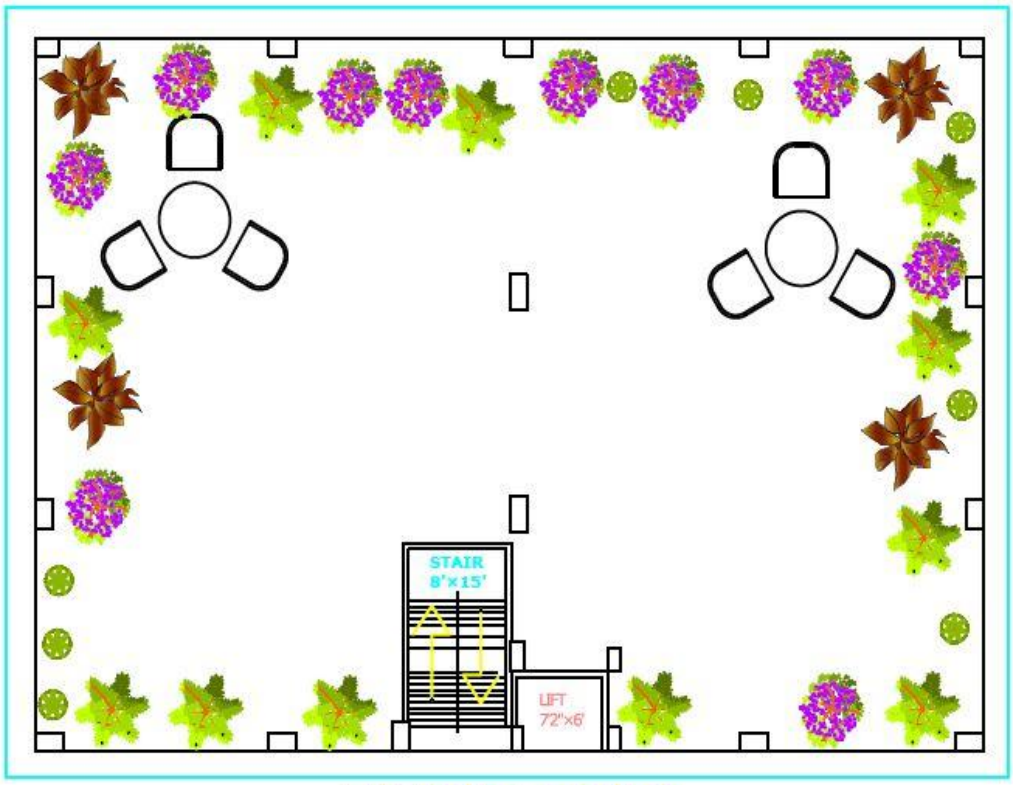
Appendix C

Projects Related Drawing:



1ST FLOOR To 8TH FLOOR PLAN





ROOF-TOP PLAN

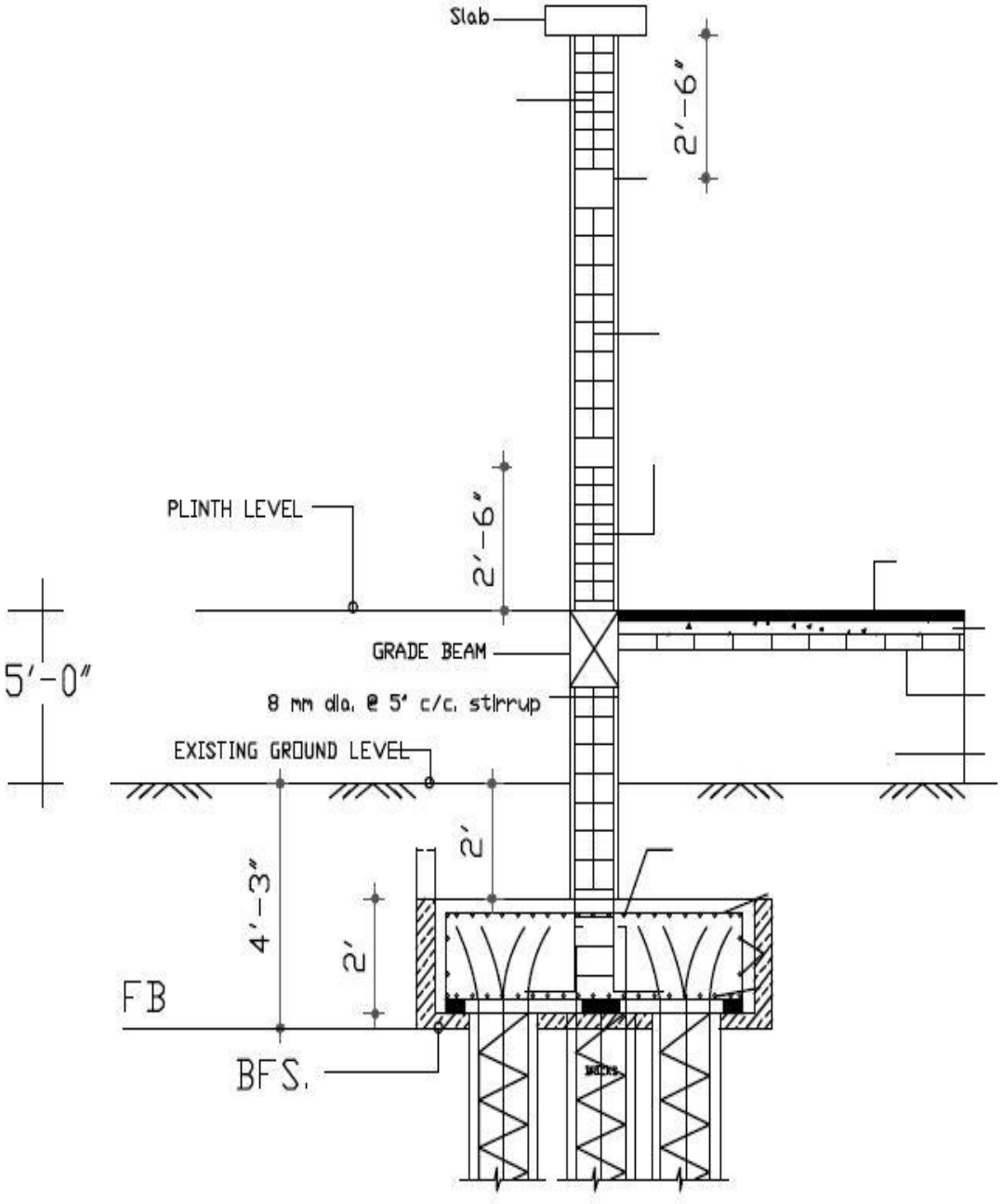
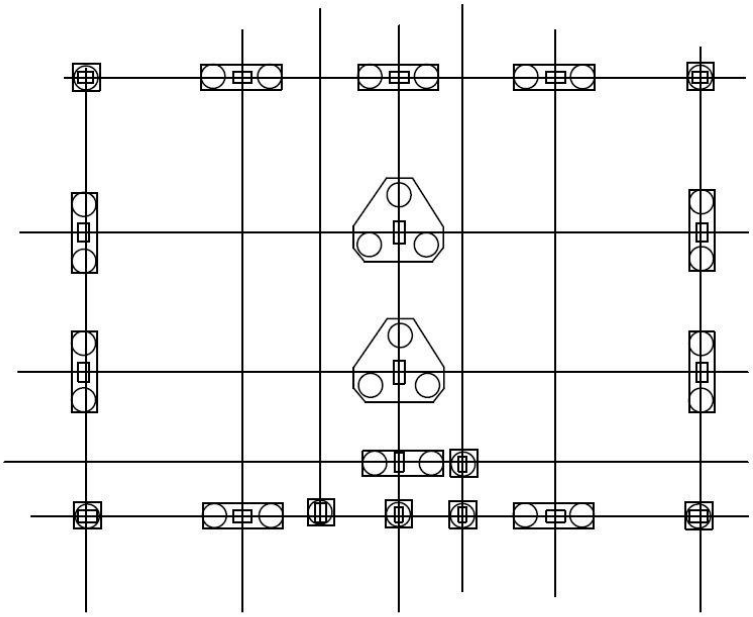


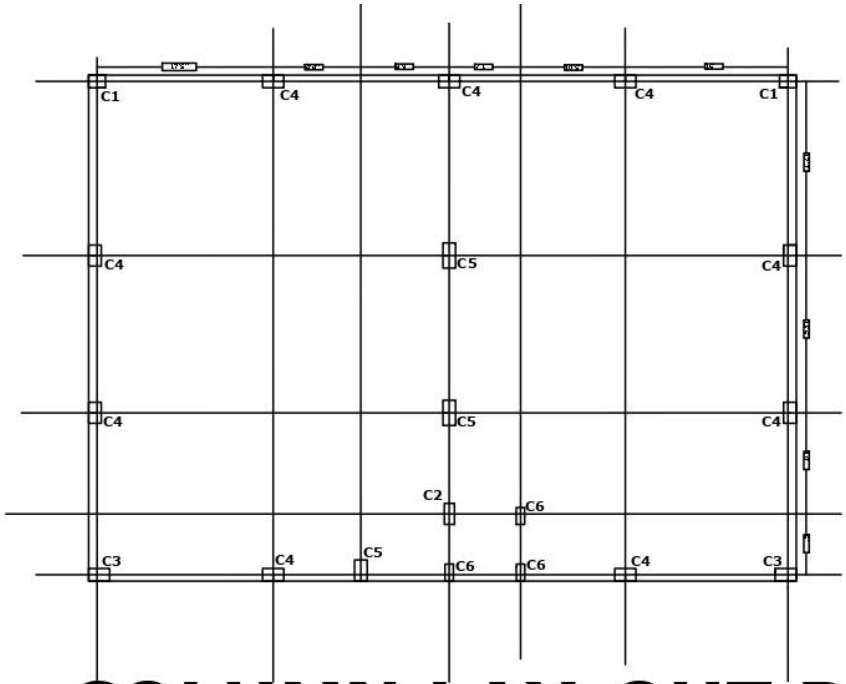
Fig: Pile Design of Our Projects Building



Pile Dia/Size

CP1-20"-

Pile Foundation



C1	15"×20"
C2	12"×25"
C3	15"×25"
C4	15"×25"
C5	18"×30"
C6	10"×20"

COLUMN LAY-OUT PLAN

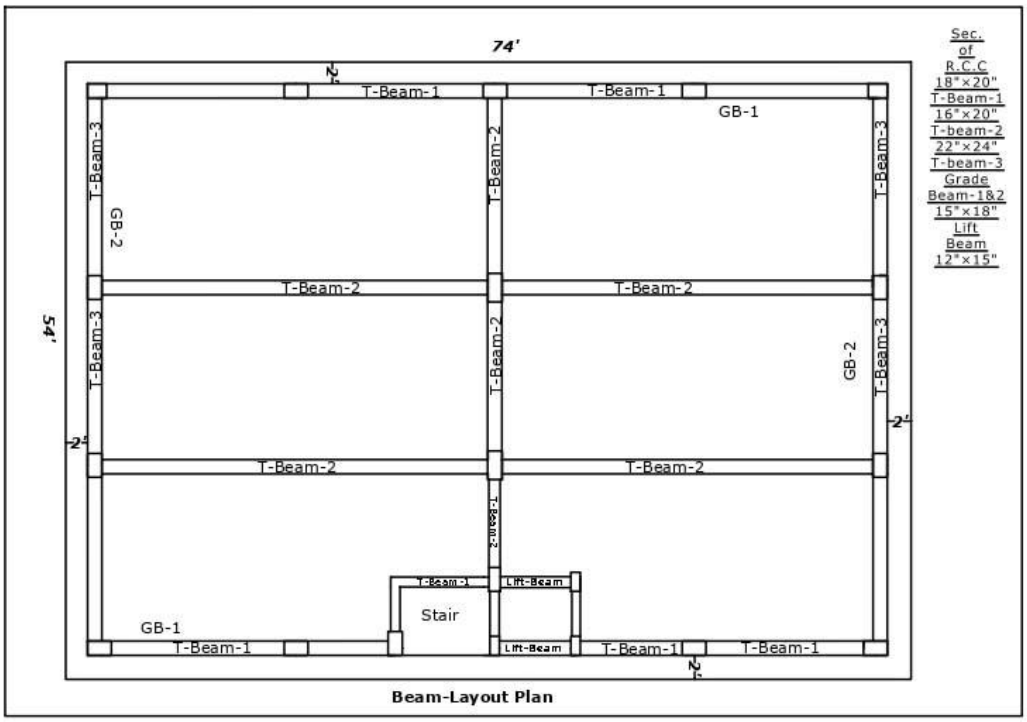
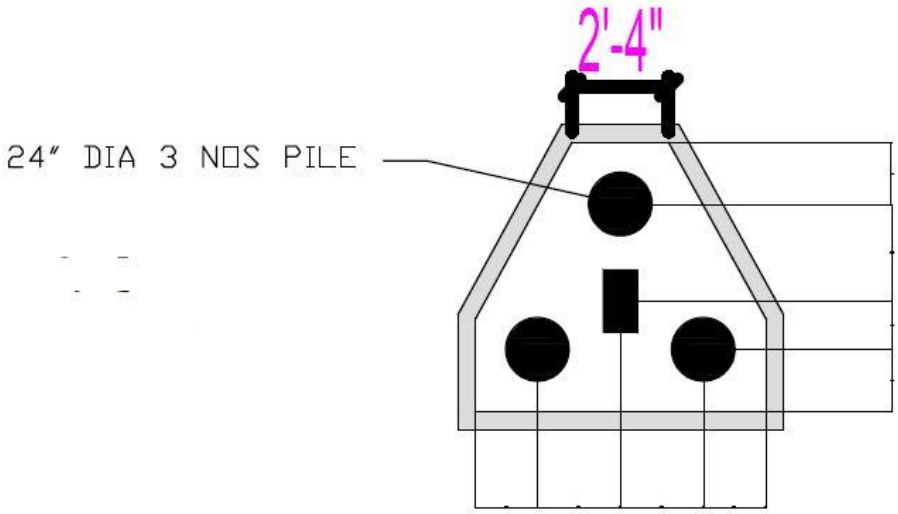
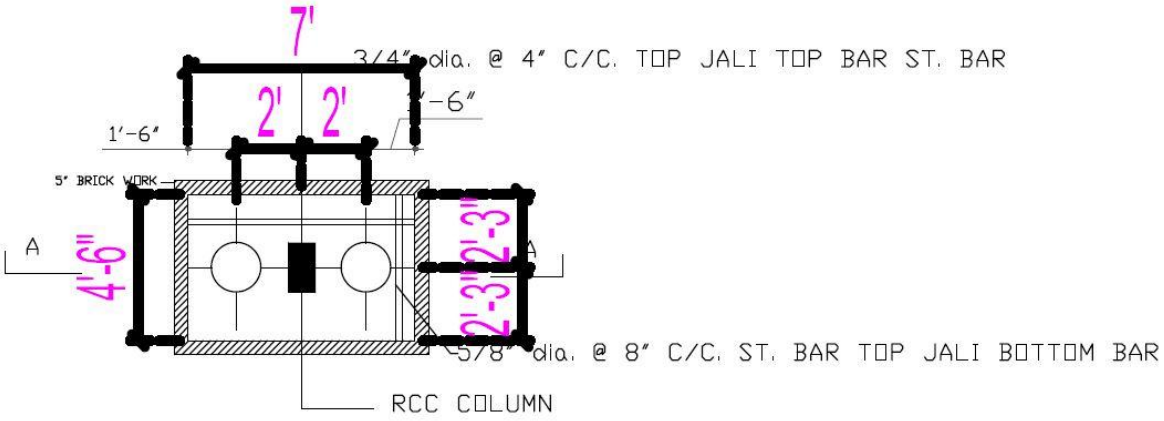


Fig: Beam Layout Plan Our Projects Building



PILE CAP PC-3



PILE CAP PC-2

Appendix C

Load Calculation

According to BNBC-2020

Dead Load:

Floor Finish:

Floor Slab:
1. Clay tiling (0.52" thickness)= 0.268 KN/m^2
2. Cement Plaster/10mm (0.4") thickness= 0.230 KN/m^2
3. Ceiling Cement Plaster 13mm (0.52") thick = 0.287 KN/m^2

Total Floor finish for floor slab= 0.785 KN/m^2
= 0.785*20.89
= 16.4 psf

Roof:

1. Lime plaster/ 0.4" thickness= 0.191 KN/m^2
2. Ceiling Cement Plaster (0.52") thick= 0.287 KN/m^2

Total load of floor finish for roof = 0.478 KN/m^2
= 0.478*20.89
= 9.99 psf

Partition Wall Load:

1. Brick mansonary, excluding plaster burnt clay/ 4" thickness = 1.910 KN/m^2
2. Cement Plaster/0.4" thickness = 0.230 KN/m^2

Total load of partition wall = 2.14 KN/m^2
= 2.14*20.89
= 44.70psf

Brick unit weight= 18.9 KN/m^2
= 121.34 lb/ft^3

Wall Load For Beam:
= Brick unit weight x Brick wall area
= 121.34 x 10'x (5/12)'/1000
= 0.51k/ft.

Live Load:

1. Floor Slab: Residential Building (One & Two Family)
= 2 KN/m^2* 20.89
= 41.78 Psf

2. Roof Slab:
Roof use for gardening, GYM, party and other purpose = 4.80 *20.89
= 100.27psf
3. Stair and exit way (Lending)= 4.80 KN/m^2*20.89
= 100.27 psf

Total Load:
1. Partition Wall= 45 psf
2. SDL= 243 psf
3. Floor Finish= 16.4 psf
4. Live Load= 242.54 psf

Appendix D

Estimation and Costing of Slab

Estimation and costing of slab are shown below in the following Table no. 4.1.
Slab Size (max): 51.42 ft.*32.67 ft. *0.42 ft.
Total Slab: 9 Nos.
Ratio: 1:1.5:3
Admixtures per bag: 250ml

Table no.4 1: Estimation and costing of slab

Name	Admixture /Litter	Volume (Cft)	Volume (cum)	Reinforcement (kg)	Cement (begs)	Sand (cum)	Aggregate (Cum)	Admixture (litter)
Slab	0.25	14406	432	11525	2239	280	559	560

Estimation and Costing of Beam:

Estimation and costing of Beam are shown below in the following Table no. 4.2
Beam Size (max): 1.83 ft.*2 ft. *74 ft.
Total Beam: 7 Nos.
Ratio: 1:1.5:3
Admixtures per bag: 250ml

Table no. 4.2: Estimation and costing of Beam

Name	Admixture/ Litter	Volume (Cft)	Volume (cum)	Reinforcement(kg)	Cement (begs)	Sand (cum)	Aggregate(Cum)	Admixture (litter)
Beam	0.25	9447	283	11336	1468	183	367	367

Estimation and Costing of Column:

Estimation and costing of Column are shown below in the following Table no.4. 3
Column Size (max): 1.5 ft.*2.5 ft. *10 ft.
Total Column: 20 Nos.
Ratio: 1:1.5:3
Admixtures per bag: 250ml

Table no. 4.3 : Estimation and costing of Column

Name	Admixture/ Litter	Volume (Cft)	Volume (cum)	Reinforcement(kg)	Cement (begs)	Sand (cum)	Aggregate(Cum)	Admixture (litter)
Column	0.25	4330	130	6927	673	84	168	168

Estimation and Costing of Pile:

Estimation and costing of Pile are shown below in the following Table no. 4.4
Pile Length:52 ft
Total Pile:36 Nos.
Ratio: 1:1.5:3
Admixtures per bag: 250ml

Table no. 4.4 : Estimation and costing of Pile

Name	Admixture/ Litter	Volume (Cft)	Volume (cum)	Reinforcement(kg)	Cement (begs)	Sand (cum)	Aggregate(Cum)	Admixture (litter)
Pile	0.3	1768	53	2670	275	34	69	82

Estimation and Costing of Pile Cap:

Estimation and costing of Pile Cap are shown below in the following Table no. 4.5
Pile Cap Size (max): 9 ft.*9 ft. *2.16 ft.
Total Pile Cap: 7 Nos.
Ratio: 1:1.5:3
Admixtures per bag: 250ml

Table no.4.5: Estimation and costing of Pile Cap

Name	Admixture/ Litter	Volume (Cft)	Volume (cum)	Reinforcement(kg)	Cement (begs)	Sand (cum)	Aggregate(Cum)	Admixture (litter)
Pile Cap	0.3	2765	83	221	430	54	107	129