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Feasibility study of Green Buildings with respect to Conventional Structure

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ABSTRACT

The goal of this research is to investigate the notion of feasibility studies and economic assessments in Green Building projects in order to reduce or equalize building costs. The advantages of preparing a financial feasibility study allow the client to make an informed decision about whether or not the project is feasible and worthwhile. The conclusion of the study and the decision to continue with the project is a huge step forward in the process.

When compared to a regular building, a green building consumes limited energy, water, and natural resources, produces less waste, and is healthier for the people who live inside. Controlling solar radiation temperature, energy efficiency, water conservation using home treatment plants, and indoor air quality are all aspects of green building that contribute to a healthy atmosphere. Green building's major goal is to lessen new buildings' environmental impact. Reduced energy emissions and consumption by buildings can help to attain environmental sustainability. The term "sustainability" refers to the efficient use of energy. Green building is a term used to describe a structure that is environmentally friendly and resource efficient throughout its entire cycle.

This paper's goal is to investigate the cost consumption of an existing residential structure. Green building assessment technologies are used to evaluate the chosen structure. Green building's initial cost should be reduced or equalized to that of traditional construction. The feasibility of green buildings in the current situation, as well as the overall economic impact during the initial construction stage, as well as a comparison to conventional construction to justify its cost in the long run.

Keywords: Feasibility, financial assessment, economic impact, sustainability

1. INTRODUCTION

India is a fast-growing country. Green building is a result of rapid industrialization, rising population, infrastructural expansion, and the depletion of natural resources. Throughout its life cycle, a green building is an environmentally responsible and resource efficient structure. Green construction is also noted for its long-term viability and excellent efficiency. The term "green" refers to things that are good for the environment

Buildings have a significant environmental impact, consuming over 40% of natural resources extracted in **industrialized** countries, nearly 70% of electricity and 12% of drinkable water, and producing between 45 and 65 percent of garbage dumped in landfills. Furthermore, they are responsible for a large number of harmful pollutants, accounting for 30% of greenhouse gas emissions directly from their operations and another 18% indirectly via material exploitation and transportation

In terms of environmental impact, the construction industry has a tremendous impact on the entire environment. Residential structures account for a significant portion of the built environment, thus material and plan choices are critical for long-term sustainability. The research community is taking significant steps around the world to find alternative sustainable building materials and low-tech approaches that will result in more sustainable and affordable construction that meets today's comfort requirements. Adopting green building materials is a fantastic way to achieve this goal.

At the pre-contract stage, a feasibility study is an essential aspect of the planning. Clients would employ a valuer or quantity surveyor to conduct a market and financial feasibility analysis for any development. A feasibility study is required so that clients may assess whether a development has a possible return on investment and is feasible to develop for the proposed project. The evaluation of a proposed project in terms of economic, financial, risk, social, and environmental issues is defined as a feasibility study. The assessment's findings should allow clients to make an informed decision about whether the project is feasible and cost-effective. It is critical for clients to have a full market and financial feasibility analysis prepared by a competent consultant while working on a green building project.

Green Building Index: - The environment, demand and price associated with green building would base on the standards stated by Green Building Index (GBI) as follows;

Energy efficiency: Most green construction schemes place a high value on energy efficiency. The results will be better if you use a holistic approach. Furthermore, careful selection of windows with optimum placement for air circulation, building envelope air sealing, duct sealing, and the usage of solar powered heating and cooling systems will all contribute to an energy efficient structure

Indoor environmental quality: An increase in respiratory illnesses and allergies, as well as the usage of chemicals that

may emit gas from materials, have all contributed to heightened awareness of the air we breathe in our homes.

Controlling the source, diluting the source, and capturing the source through filtration are all examples of green building methods that will reduce the implications of potential contamination. Aspects like as operation, maintenance, and building owner education are crucial. Inadequate and improper maintenance can sabotage the designers' and contractors' efforts to create a resource-efficient, ecologically friendly structure. By offering owners with alternative environmentally friendly products/systems for building care, as well as an efficient and proper procedure for operation and maintenance manual may help obtaining their contribution to achieve green building objectives

Sustainable Site Planning & Management: Choosing suitable locations with planned public transportation, community services, open spaces, and landscaping. By redeveloping existing lands and brownfields, we may avoid and conserve environmentally sensitive places. Correct construction management, storm water management, and lowering the impact on existing infrastructure capacity are all important considerations.

Regional materials: The purpose of using regional materials is to encourage the use of local resources, boost the local economy, and reduce transportation impacts.

Durable materials: The products should last for a long period and require little upkeep. When it comes to repairs, you will save time, money, and effort by doing so.

Water efficient materials: Water conservation will be achieved by the use of goods, materials, and systems that reduce water use in buildings and landscaped areas while also increasing water recycling and reuse.

Water efficiency: Water conservation is commonly emphasized in green homes, both inside and out. Indoor water delivery systems, as well as native, water-retaining, and drought-resistant planting choices, can help reduce wasteful waste of vital water resources. Using heavy and light-weight water-closet flushing options, for example, will assist conserve water utilized indoors. Natural processes have been found to be a very effective means of filtering and eliminating toxins from storm water and wastewater, which can subsequently be successfully reused for irrigation and other purposes, according to current research and practices.

Innovation: Innovative design and initiatives that satisfy the Green Building Index's goals. Achieving points in these areas will likely result in a building that is more environmentally friendly than those who do not address the issues. Points will be awarded under the GBI assessment system for achieving and adopting environmentally friendly characteristics that are above industry standards.

2. RESEARCH METHODOLOGY

The main aim of this study is **to research** the Initial Cost required and **to reduce** or equalize **the value** to construct green building by use of recycled construction materials **rather than** virgin materials.

Promotion of recycling and reusing of materials in Construction **won't** only reduce the burden on the consumption of natural resources, but **it'll** also reduce the embodied energy, which has become significant.

2.1 Objectives of The Project:

- To select and study **the cost** consumption of an existing residential building.
- Assessment of **the chosen** building using green building assessing tools.
- To reduce or equalize the initial cost of green building **as compared to conventional** building.
- To conserve the natural resources, reducing the soil waste or zero discharge of waste, improved air and water quality, protection of ecosystem and biodiversity thus mitigating the adverse impact of the built environment on human health.
- To become **responsive to** any potential problems **that would** occur while implementing the project.
- To determine if, after considering all significant factors, the project is viable—that is, worth undertaking.

2.2 Scope of the Study

- The green building movement originated from **the requirement** and desire for more energy efficient and environment friendly construction practices.
- Green building brings together **a huge** array of practices, techniques and skills **to scale back** and ultimately eliminates the impacts of buildings on the environment and human health.
- Construction methodology **supported** these concepts promotes to the health and well-being of the individual **and therefore the** society at large.

2.3 Advantages of the project:

- Measurement and verification attempt to ensure energy & water savings.
- Reducing building prints to reduce the impact on environment.
- Minimal impact on the environment and site circumstances.
- Construction materials that are recycled and environmentally beneficial.
- Make use of products that are non-toxic and recyclable.
- Efficient recycling of water.
- Improving indoor air quality for human safety.
- Using materials that can be quickly replenished

2.4 Methodology of the Study

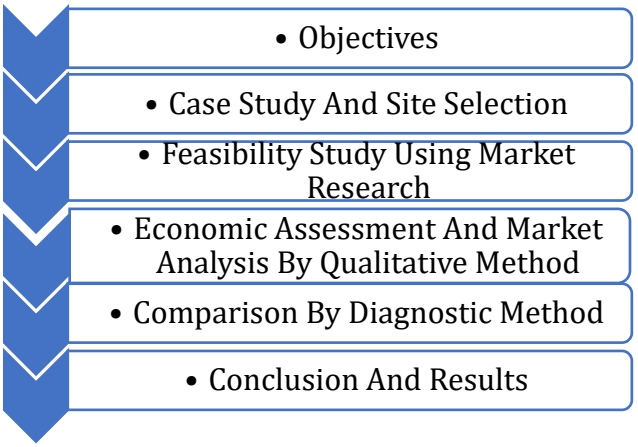

Chart 1 Methodology

3. DATA COLLECTION AND ANALYSIS

A. CEMENT:
Ordinary OPC vs PSC

Table 1: Rates of Cement

CEMENT	PRICE/BAG (Rs)
Ultra tech OPC 53	310
ACC concrete plus	340
JSW PSC	310
ACC PSC	345

B. BUILDING RUBBLE AS AGGREGATE

The application of building rubble collected from demolished structures is an important issue. After crushing and screening, this material could serve as recycled aggregate in concrete. A series of experiments using recycled aggregate of various compositions from building rubble was conducted. The test results show that the building rubble could be used into useful recycled aggregate through proper processing.
Recycled Aggregate Supplier

1. Rajshree Stone Crusher, Kalyan Karjat Highway.
2. Gajanan Stone Crusher, Bhiwandi Wada Road.

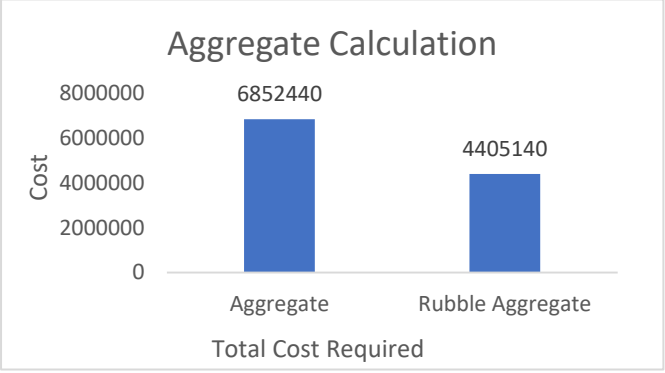

Chart No. 2 Aggregate Calculation

C. BRICKS:

It is a type of block used to build walls, pavements and other elements in masonry construction. The term brick technically refers to a block made of dried clay, but it is increasingly frequently used colloquially to refer to other chemically cured masonry blocks.

- Calculation:

Using built-up area total area in m3 =5574.18
Carpet area deduction = built up – 0.85 * built up = 5574.18- (0.85*5574.18) = 836.127 m3
Total volume of 1 brick = 0.002 m3;
Total bricks required = 836.127 / 0.002 = 4,18,070
The total cost for procurement = 7.8 * 418070 = ₹32,60,900/-

1. Fly ash bricks:

Fly ash bricks or FAB converts the industrial waste of fly ash into an effective building material. The manufacturing process uses less energy and the bricks come in uniform shapes and various sizes. A Fly ash brick can cost from Rs 7/piece up to Rs 32/piece depending upon the size.
Total bricks required = 836.127 / 0.0036 = 232260
The total cost for procurement = 7 * 232260 = ₹16,25,900/-

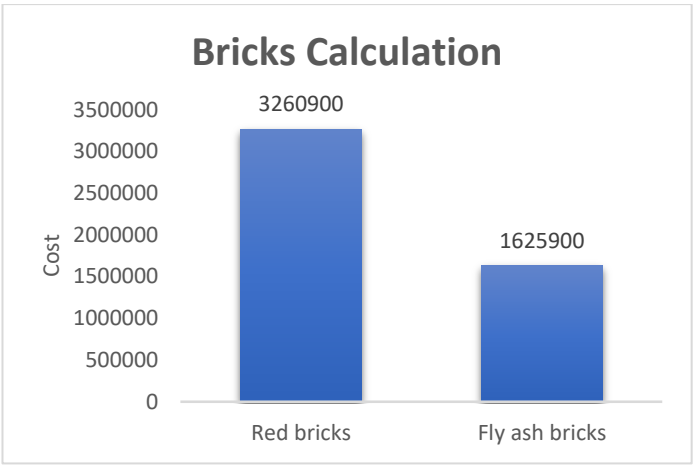

Chart No. 3 Bricks Calculation

D. SAND

It is used for creating concrete, mortars, and plasters and also for filling under floor, basements. To avoid transport expenses because it plays a significant a part of the price of sand, as far as possible local sand is preferred to keep up the economy in construction.

- Calculation:

Sand required for construction of 60000 sq. ft. is 60000*0.15 = 9000 m3 (wet weight);
For dry weight of concrete: 9000*1.54 = 13860m3
For M25 concrete (1:1:2), Sand = 13860*(1/1+1+2) = 3465 cum i.e., 1224 brass
Average Rate of Sand = 7200/- per brass
Amount required; 1224 * 7200 = ₹ 88,12,800/-
CRUSH SAND
Crushed sand is produced by crushing rocks, stones or large aggregates into sand size particles in a quarry.

Quarrying or manufacturing plants grind rocks, stones, and aggregates into sand size particles.

- Calculation:

Sand required for construction of 60000 sq.ft. is 60000*0.15 = 9000 m3 (wet weight);
For dry weight of concrete: 9000*1.54 = 13860m3
For M25 concrete (1:1:2), Sand = 13860*(1/1+1+2) = 3465 cum i.e., 1224 brass
Rate of Crush Sand = 3200/- per brass using 30%
Total amount required to procure 1224 brass of sand
7200*857 + 3200*367 = ₹73,44,000/-

E. PAINTS

Any pigmented liquid, liquefiable, or solid mastic substance that changes to a solid film after being applied to a substrate in a very thin layer. It's commonly utilized to protect, color, or texture objects. Volatile Organic Compounds (VOCs) are used as solvents in traditional paints.

- Calculations:

Paint required for external wall = 1120 liters
Considering Dulux paint, therefore amount required = 1120*4000 = ₹44,80,000/-
For internal paints; a room of 2bhk having 675 sq. ft carpet area requires 20-25 liters of paint.
Therefore, paint required for 56 flats = 56*22 = 1232 liters (approx. 1240 l)
Considering Asian Paints, Amount required = 1240*4000 = ₹49,60,000
Therefore, total amount required for painting excluding labors = 49,60,000+44,80,000
= ₹94,40,000/-
ECO FRIENDLY PAINTS
Eco-friendly bricks are those bricks which have very less VOC and are anti-fungal as well as anti-bacterial in nature. Eco-friendly paints emit little or no environmentally unsafe materials into the air. Low-VOC paints must have a volatile compound content of less than 50 grammes per liter after receiving the green seal.

- Calculations

Paint required for external wall = 1000 liters
Considering Berger Weather Coat Glow paint, therefore amount required
= 1000*4700 = ₹47,00,000/-
For internal paints; a room of 2bhk having 675 sq. ft carpet area requires 14-15 litres of paint.
Therefore, paint required for 56 flats = 56*14 = 784 litres (approx. 780 l)
Considering Dulux Velvet Touch, Amount required = 780*7500 = ₹58,50,000
Therefore, total amount required for painting excluding labours = 47,00,000+58,50,000 = ₹1,05,00,000/-

F. SOLAR PANEL

On an average cost of electric bill per month on a construction site is around 30,000/- pm considering if construction work goes around for 3 years it comes at around ₹10,80,000/- and the electricity from panels are used for 60% the total saving comes to around Rs 6,48,000/- rendering the total cost of solar panels less than 20% of the actual cost.

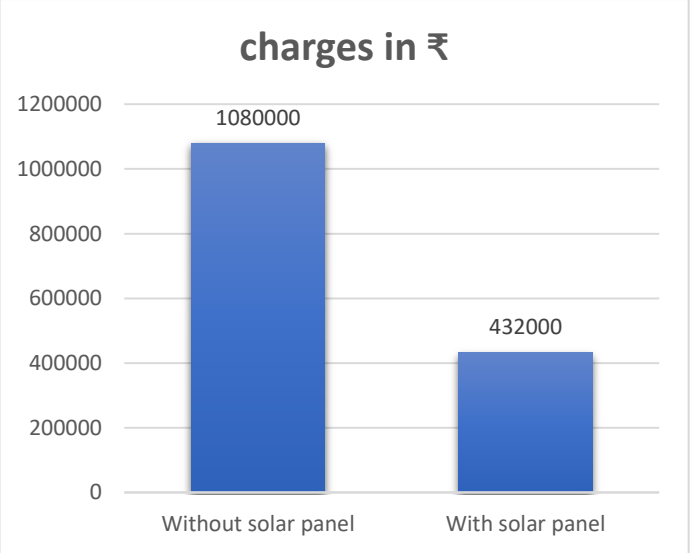

Chart No. 4 Consumption Saving

G. SOLAR WATER HEATER:

Solar water heaters, also known as solar domestic hot water systems, are a low-cost solution to create hot water for domestic use. The advantages of using this machine are, it can be used in any climate, and the fuel they use is solar energy which is renewable and clean. Solar water heating systems mainly include storage tanks and solar collectors.
Solar Water Heater usually cost from around ₹19,500 per 200 LPD to ₹36,000/- per 200 LPD. Usually, 100 liters of water are enough for bathing of 4 people and less capacity shall be given for optimum use. In a building of 15 floors having 55 flats having 4 occupants each the total water required in solar water panel is 27. The total cost comes around ₹5,26,500.

H. SEWAGE TREATMENT PLANTS:

Sewage treatment plants filter and treat wastewater/sewage, converting it to a cleaner "effluent" that can be returned to nature in a safer, more environmentally friendly state. They aid in the restoration of groundwater balance, the prevention of diseases, and the reduction of environmental degradation and pollution. The treated water can be used for non-potable uses in housing societies, such as gardening, car washing, building, irrigation, and toilet flushing, resulting in significant savings in borewell pumping and power consumption charges. Cleaner water would reduce deaths from water-borne diseases, reduce pollution's negative environmental impact, and, on a much smaller scale, eliminate the need for water tankers because there would be an abundance of groundwater on macro scales and reusable water at community levels.
day A housing society should have a fully automated prefabricated sewage treatment plant to save up on time

and energy. This kind of plants come up to around 6 lakhs for 1,00,000 lit/day

I. WATER TREATMENT PLANT

A water treatment plant is used to provide clean, reused water that is potable (safe to drink) and has a nice taste, as well as ensuring that there is enough water to suit the community's demands. This reduces corrosion in the distribution system and in the plumbing of customers.
A semi-automatic containerized Mini water treatment plant for a residential society is from Rs 90,000 to Rs 1,50,000 only.
A recommended water treatment plant shall be Stainless Steel Mini RO Water Treatment Plant, Number of Membranes in RO: 3, Ozonation and retails around 1.4 lakhs with transport.

J. RAINWATER HARVESTING

Rainwater harvesting is a popular term these days, although the principle of water gathering is not new to India. Techniques for collecting water had evolved and developed over millennia.
Percolation replenishes the groundwater supply naturally. However, as a result of indiscriminate construction and rapid urbanization, the exposed area for soil has been severely reduced, resulting in a reduction in rainwater percolation and thus depletion of water resources. Rainwater harvesting is the technique of supplementing natural rainwater filtering into underground formations using some artificial means. "Rainwater Harvesting is the conscious gathering and storage of rainwater to meet water demands for drinking, home use, and irrigation."
The usual cost for construction of rain water harvesting for an existing building comes around ₹3,50,000 to ₹4,00,000/-
Cost of construction for green building with initial planning and designing is ₹1,50,000/-

MINIMISING THE COST OF GREEN CONSTRUCTION

Minimization with the help of proper planning and design:
The design is one of the major reasons for time and cost over-run. Preplanning with remembering the sunlight and wind pattern can help in lowering the cost of construction. A well-drawn and well executed project brings an overall cost down by up to 5%. A well-lit design will help in lowering the electricity consumption as well.

- Minimization with solar panels:

Solar panels are usually installed after completion of construction. They are usually easily erected and disassembled and can be transported from one place to another. A builder can use this feature to advantage and procure and install panels before construction on ground itself over an underground water tank or some other structure with necessary precautions. The energy generated by panels can be used for construction and use of various equipment. On an average cost of electric bill per month on a construction site is around 30,000/- pm considering if construction work goes around for 3 years it comes at around **₹10,80,000/-** and the electricity from panels are used for 60% the total **saving** comes to around Rs **6,48,000/-** rendering the total cost of solar panels nil. The electricity charges for 3 years will be around **₹4,32,000/-**

Minimization with the help of materials:

1. Bricks: - Use of eco-friendly materials can lead to huge savings as they are purpose made. For example, use of Autoclaved Aerated Concrete blocks can help in saving of cost as these blocks are lighter than usual mud bricks. Due to this overall design of structure can be reduced helping in saving of overall project cost. Over this, these blocks take less mortar for binding and have smoother surface so they use less cement mortar in plastering as well saving money in cement.
2. Cement: - Slag cement has high strength than normal OPC resulting in better workability and Higher long-term compressive and flexural strengths, Reduced permeability, Fewer shrinkage cracks, Improved durability and resilience. The slag cement cost same as normal 53 grade OPC so the cost doesn't hamper the overall cost of construction.
3. Aggregate: - The use of rubble aggregate in suitable quantity leads to saving of virgin materials as well as cost cutting in construction. Use of rubble aggregate can be done after screening crushing and washing of the aggregate.

CASE STUDY: CONVENTIONAL BUILDING

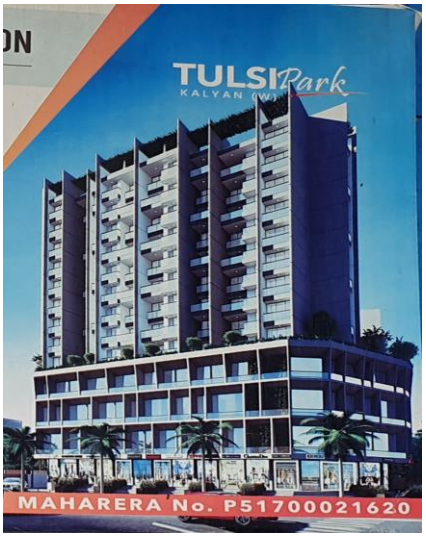

Figure 1: Case Building Tulsi Park

Fig Case Study Structure

PROJECTED INCOME

Table 2: Projection

LAND COST WITH REGISTRATION	7,80,00,000 (60%)
DEVELOPMENT CHARGES INCLUDING CLEARING OF PLOT, SURVEYING, ETC	2,60,00,000 (20%)
COST OF CONSTRUCTION	13,20,00,000
MISSCELENIOUS COST (Equipment Cost, MARKETING, ADVERTISING, STAFF ETC.)	40,00,000 (3%)
TOTAL COST	24,00,00,000
PROJECTED SALES	39,00,00,000-40,80,00,000
CONSIDERING LOWER SALES	39,00,00,000
TOTAL REVENUE IN 3 YRS	15,00,00,000
ANNUAL REVENUE	5,00,00,000

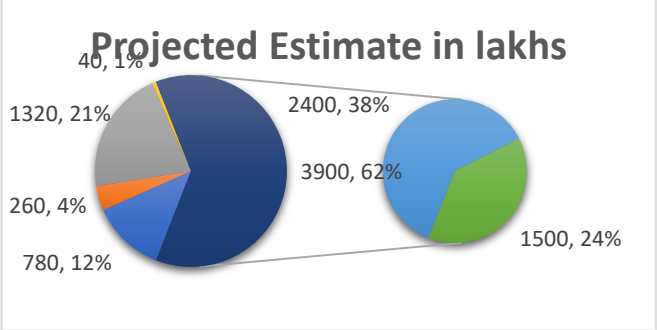

Chart 5 Projected Estimate

4. RESULTS AND DISCUSSION

Cement, Aggregate, Bricks, Electric consumption, Steel, Solar panels, Solar water heater, Sewage treatment plant, Water treatment plant & Rain water harvesting are used as components to compare and study the efficiency of green building and the impact of cost of construction at initial stage with respect to conventional building

The following data is generated through diagnosis:

Table 3: Cost Diagnosis

Material	Conventional	Green	Spent	Saved
Cement	₹310	₹310	-	-
Aggregate	₹68,52,440/-	₹58,72,800/-	-	₹9,79,640
Bricks	₹7.8 (₹32,60,900/-)	₹7 (₹16,25,900/-)	-	₹16,35,000
Solar panels	-	₹8,00,000/-	₹8,00,000/-	-
Electric consumption	₹10,80,000/-	₹4,32,000/-	-	₹6,48,000/-
Steel	₹56	₹56	-	-
Sand	₹ 88,12,800	₹73,44,000	-	₹14,68,800
Paints	₹94,40,000	₹1,05,00,000	₹10,60,000/-	
Solar water heater	-	₹5,36,250/-	₹5,36,250/-	-
S.T.P.	-	₹6,00,000/-	₹6,00,000/-	-
W.T.P.	-	₹1,40,000/-	₹1,40,000/-	-
R.W.H.	-	₹1,50,000/-	₹1,50,000/-	-
Total			₹32,86,250/-	₹47,31,440/-
Profit	**₹14,45,190/-**			

By proper planning you can buy solar panels initially which is usually bought after construction and use them during construction by installing them on ground which will help in bringing down the electric consumption by 60%. This move will ultimately bring the cost of solar panel only about 20 % the total cost.

Material	Conventional	Green
Cement	EA	EA
Aggregate	EA	MA
Steel	EA	EA
Sand	EA	MA
Electrical	MA	MA
Skilled Labor	EA	DA
Fitting	MA	MA

Table 8: Availability of Material

EA- Easy Availability; MA- Moderate Availability; DA- Difficult Availability

As can be concluded by the table above most of the materials are either easily or moderately available so it won't be much of a hassle obtaining them.

4. CONCLUSION

6.1 Average Construction Cost of Green building.

, in this study the average construction cost (INR p.s.f.) of residential green building was lowered 1.09% than conventional building. The results of this study were similar to the research in the UK (less than 1%) and in the USA (below 2%), which means that environmentally friendly buildings are not necessarily accompanied by more expensive construction costs.

6.2 Construction Cost of Green Residences in Different Grades of Green Building Certification

In terms of the construction cost comparison between conventional buildings & green buildings, the results of this study shows that the average construction cost of a green building (₹2167 INR/sqft) was lower than the average construction cost of a conventional residence (₹2200 INR/sqft). This means that when compared with conventional building, green residential buildings do not have higher construction costs.

6.3 The Relation between Construction Cost of Residences with a Green Building Evaluation System

The construction cost of a new residential building comes from four major components: planning and design fees; building construction; landscape; and interior decoration. In India, planning and construction costs are usually combined into the building's construction budget. Therefore, as long as the planning and design fees are not reduced, the designers and architects are willing to work hard to make the building meet the green building certification standards and obtain certification without increasing the total budget. The Government of Maharashtra offers an additional Floor Area Ratio of 3%, 5% and 7% for Green Buildings rated by Indian Green Building Council as Silver, Gold and Platinum respectively. Hence, it is now even more feasible as well as profitable to go for green initiative.

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