3E-Analysis of Building with BIM application

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Abstract **- Booming technology in the building drawing using the computer-aided tools have escalated to a new level of platform and eminent with 3D rendering features scored for the Building Information Modeling application. Visualization of the building with the client inputs also as per their need headway to various software development. On another side, the analytical and design aspects for sustainable and green building aspects have burgeoning to need of alternative resources and utilize the natural resources in the appropriate manner. 3E-Analysis (Edifice-Energy-Estimate) is start ball rolling in the present study along with BIM application. Importance of Laminated glass windows, Wood-plastic composites, Autoclaved Aerated Concrete blocks were utilized in the project and the estimation for the construction G+1 building in the zone of Andhra Pradesh, southern India is explained. Due to the hot climatic zone, scantiness of water is another major issue addressed, so the water harvesting for the building is also essential along with the installation of a solar power panel to use the optimized sunlight energy for the building.**

Index Terms **- Edifice, Energy saving, Estimate, BIM, water-saving, Aerators, position, and location, REVIT SOFTWARE, solar energy.**

I.INTRODUCTION

Now a day's people are preferring more overly about good design and comfortable & safety building within budget. Then making energy saving can help them to save the budget of living make easy in day-to-day life. So, this 3E-Analysis of Building i.e., Edifice, Energy saving, & Estimate Analysis of Building with BIM (building information modeling) whereas (1E) Edifice refers as good and well-organized design structure of the building. (2E) Energy saving refers as reducing waste consumption on the building and save the cost of energy in day-to-day life. (3E) Estimation refers as the cost of the structure and quantity of materials used for the building. These parameters can be taken care (1E) Edifice &(3E) Estimation. Design of structure & Estimation of quantity of material and it is cost of the Building will be done in REVITSOFTWARE [1-2] a BIM Tool. (2E) Energy saving this will be done in extra field of study solar energy, water-saving, selection and positioning of doors, and windows will help to get good lighting it will help to gain of energy-saving.

II BIM IN CONSTRUCTION INDUSTRY

The construction trade is commencing to see the advantages of BIM. Estimators, designers, project managers, and subcontractors square measure exploitation BIM to boost their processes. As BIM technology gets higher and a lot of corporations to start out adopting it, construction corporations can see a lot of advantages. There are some general edges of BIM within the industry. many case studies show that BIM will cut back retread. Designers will produce a style in CAD, however, use BIM to check the clash [3]. Since the designer will add individual elements like ductwork to the inside and exterior layouts, they will see if everything will match. Another nice profit that everybody shares in is that the reduction of changes and conflict. because of designers and contractors will simply spot conflict on a BIM model, they will create changes before the project breaks ground. during this method, BIM will increase the communication between designers and contractors [4] that helps each side manufacture a far better product.

Fig.1: Building Model

III. MATERIAL AND PARAMETERS

Ordinary hydraulic cement (OPC) is that the most generally used cement within the world for producing concrete, mortar, stucco, and nonspecial grouts. Ordinary hydraulic cement has 3 grades supported its strength namely 33, 43 and 53 grade that indicates the compressive strength obtained after 28 days of setting.

Sand (Fine Aggregate):
Sand could also be a granular material composed of finely divided rock and mineral particles. Sand has various compositions but is defined by its grain size. Sand grains are smaller than gravel and coarser than silt. Sand also can ask a textural class of soil or soil type, i.e., a soil containing quite 85 percent sand sized particles by mass.
Though sand is available at the price fixed by the government ₹ 375 per ton. when transportation charges are added, the cost is coming to ₹ 15,000 per tractor load and ₹ 30,000 per truck load.

Coarse Aggregate:
Coarse aggregates are particulates that are greater than 4.75mm. The usual range employed is between 9.5mm and 37.5mm in diameter. Fine aggregates are usually sand or crushed stone that are but 9.55mm in diameter. Typically, the foremost common size of aggregate utilized in construction is 20mm. Cost of Coarse Aggregate: 20mm Crushed Stone Aggregate, Up to 50 Ton, ₹ 620 /cubic meter DRP Infratech ID: 19095395562

ACC block (Autoclaved Aerated Concrete Blocks):
Autoclaved aerated concrete (AAC) could even be a lightweight, precast, foam concrete artifact suitable for producing concrete masonry unit [5] (CMU) like blocks. Composed of quartz sand, calcined gypsum, lime, cement, water, and aluminum powder, AAC products are cured under heat and pressure in an autoclave. Improved thermal efficiency reduces the heating and cooling load in buildings. Porous structure gives superior fire resistance. Workability allows accurate cutting, which minimizes the generation of solid waste during use [6]. Resource efficiency gives it lower environmental impact altogether phases of its life cycle, from the processing of raw materials to the disposal of waste. Lightweight saves cost and energy in transportation, labor expenses, and increases chances of survival during seismic activity [7]. Larger size blocks cause faster masonry work. Reduces project cost for large construction.

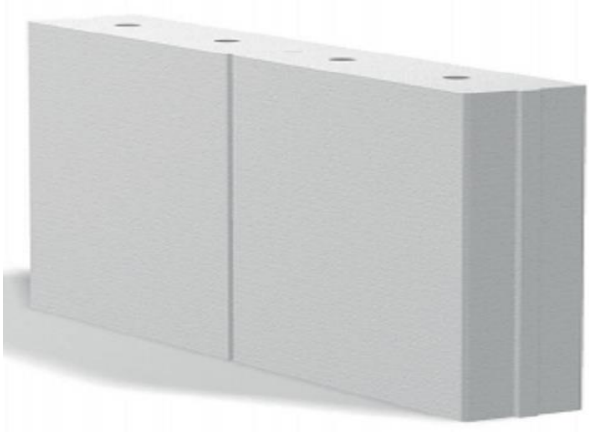

Fig-2: Autoclaved Aerated Concrete

Table-1: Cost Price for AAC Blocks

Size (inches)	Min Price	Max Price
12” x 4” x 2”	₹ 2600/m^3	₹3150/m^3
12” x 4” x 2”	₹ 40/Piece	₹ 80/Piece
9” x 4” x 3”	₹ 2800/m^3	₹ 3050/m^3
9” x 4” x 3”	₹ 40/Piece	₹ 55/Piece

TMT Steel Bars:
TMT Steel or TMX steel is that the best bet for house construction. They are the newest generation of reinforcement steel (high strength and ductile than their predecessors). They are graded as Fe415, Fe500, Fe500D, Fe550 i.e., yield strength of 415, 500 and 550 N/ sq. mm, respectively. Both Fe 500 and Fe 500D are sorts of TMT steel bars as per the IS: 1786 and that they are ideal to be used within the construction of

housing apartment buildings. "Fe" stands for Iron, out of which the TMT bars are made.

Table-2: Cost of TMT Steel Bars

Material	Minimum Price	Maximum Price
Plastic	₹ 70/Sq. ft	₹ 180/Sq. ft
Wood	₹ 42/Sq. ft	₹ 123/Sq. ft

Marble tiles:

Marble may be a rock composed of recrystallized carbonate minerals, most ordinarily calcite or dolomite. Marble is usually not foliated, although there are exceptions. In geology, the term marble refers to metamorphosed limestone, but its use in stonemasonry more broadly encompasses unmetamorphosed limestone. Marble is commonly used for sculpture and as a building material Marble Tiles: Everything You Need to Know "Marble is very popular natural stone which is used as tiles and slabs for floors, countertops, and walls. Marble Tiles are known for its quality, normal sparkle, and nature of stone. ... Marble Tile may be a luxury material, and it is also heavier and of upper quality.

Marble Type	Min Price	Max Price
Imported Marble	₹ 230/Sq. ft	₹ 250/Sq. ft
Indian Marble	₹ 27/Sq. ft	₹ 250/Sq. ft

Table-3: Cost of Marble Tiles

Wood-plastic composites (WPCs) Doors:

Wood–plastic composite (WPC) could also be a promising and sustainable green material to understand durability without using toxic chemicals. The term WPCs refers to any composites that contain plant fiber and thermosets or thermoplastics. In comparison to other fibrous materials, plant fibers are generally suitable to strengthen plastics thanks to relative high strength and stiffness, low cost, rarity, low CO2 emission, biodegradability and annually renewable. Plant fibers as fillers and reinforcements for polymers are currently the fastest growing sort of polymer additives [8-9]. Since automakers are getting to make every part either recyclable or biodegradable, there still seems to be some scope for green composites supported biodegradable polymers and plant fibers. From a technical point of view, these bio-based composites will enhance mechanical strength and acoustic performance, reduce material weight and fuel consumption, lower cost, improve passenger safety and shatterproof performance under heat changes [10-11], and improve biodegradability for the auto interior parts.

S. No	Products	Prices starting from
1	Amba shakti TMT price	₹.35500/MT
2	Jindal panther TMT price	₹.37000/MT
3	Sail TMT price	₹.41000/MT
4	Shyam steel price	₹.38000/MT

Table-4: Cost of Wood-Plastic Composite

Laminated Glass Windows:

Laminated glass is a type of safety glass [12] that holds together when shattered. Skylight glazing and automobile windshields typically use safety glass [13-14]. In geographical areas requiring hurricane resistant construction, safety glass is usually utilized in exterior storefronts, curtain walls and window.

Fig-3: Laminated Glass Windows

Table-5: Cost of Laminated Glass Window

Type	Price Per Sq. ft
Laminated/Insulated	₹.730 – ₹.1460
Thermopane/Thermal	₹.730 – ₹.1120
Plate/Flat	₹.1820 – ₹.7270
Double-Glazed	₹.220 – ₹ 440

IV. EXPERIMENTAL STUDIES

Discussion about geometry:

Location and position of the building can make the placing can decide structure and planning of the building and its architectural view. So as per Location we decide to take is South India Andhra Pradesh So we can get an idea of how a particular site will be to build on by its gradient range. Less than 10% incline is taken as slight and is the easy to build on, while 11-20% is considered as moderate. above 20% is deemed as steep to build.

North or north-east facing Buildings are considered the most desirable because they get the most direct sunlight through the day [15], especially in winter when the sun is at its lowest. In an urban area where sunlight is at a perfect proportion light. So, all these considerations our plan of the building

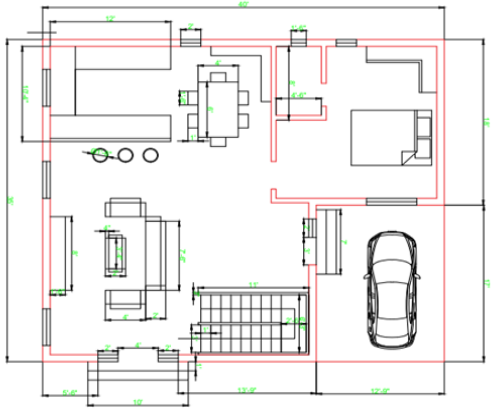

Fig-4a: Ground floor Plan

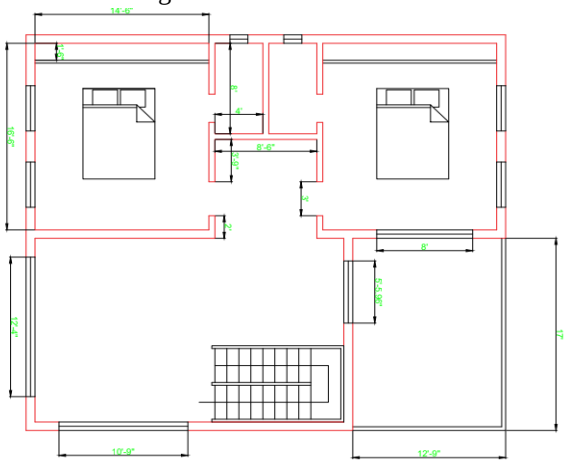

Fig-4b: G+1 Floor plan

Solar energy:

Solar energy is radiant light and heat from the Sun that is` harnessed using a range of ever-evolving technologies such [16] as solar heating, photovoltaics, solar thermal energy, solar architectur, molten salt power plants and artificial photosynthesis.

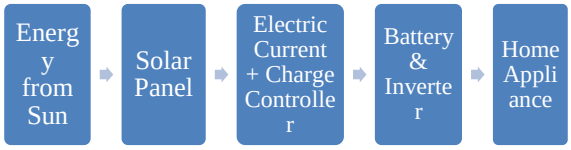

Fig-5: Utilization of Solar Energy

A solar collector or photo-voltaic module receives the maximum solar-radiation when the Sun's rays strike it at right angles. Tilting it from being perpendicular to the Sun will result in less solar energy collection by the collector or the module. Therefore, the optimal tilt angle for a solar energy system depends on both the site latitude and the application for which it is to be used [17]. Many solar applications are mounted either on a fixed rack or on a tracking rack. Fixed collectors or modules producing heat or electricity throughout the year are usually installed and tilted at an angle equal to the latitude of the site in which the collector or module directly faces the Sun. Of course, the optimal position is suitable for the time when the Sun is at midpoint in the sky (i.e., spring and fall seasons). The energy collected by the solar system [18] in both winter and summer is far less due to several reasons such as clouds in winter and temperature scattering in summer in addition to the Sun is changing altitude. But nevertheless, in such cases, it is desirable that the average yearly collection of energy is maximized (i.e., the angle position of the collector or module is adjusted to receive maximum energy). A Sun-tracking mechanism increases the amount of solar energy that can be received by the solar collectors or photo-voltaic modules: consequently, this would result in a higher daily and annual output power harnessed [19]. The use of a tracking system is more expensive and more complex than fixed mounts: however, they can become cost-effective in many cases because they provide more power output throughout the year and in many cases, this increase exceeds 25%. Commercially, tracking systems are available either as a single-axis or a dual-axis design. The single-axis tracker follows the Suns apparent east-to-west movement across the sky, while the dual-axis tracker, in addition to east–west tracking, tilts the solar collector or module to follow the Sun is changing altitude angle. To investigate the improvement in the daily output power of a photo-voltaic module, a single-

axis Sun-tracking system [20-21] was designed based on a programmable logic controlling unit. A suitable controlling program was also developed to accomplish the control operation with the possibility of implementing this arrangement as a data-acquisition system for solar radiation values during daytime.

Water Saving:

Water is one of the most remarkable resources in the world. Even though it covers almost 70% of the earth's surface; more than 97.5% of this water is salt and is not suitable to be used as potable water. The remaining 2.5% is freshwater of which 68.9% is kept in glaciers and 0.9% is in permafrost. Therefore, the remaining 29.9% is fresh groundwater and 0.3% constitutes freshwater lakes and rivers which are regarded as renewable.

Water plays a vital role in our life. Worldwide, 70% of water is used in irrigation, 20% for commercial-industrial activities, and 10% for residential uses [22]. Moreover, water is essential for building construction since the production of one ton of bricks needs 2200 Liters of water. One ton of steel requires 1.32 million Liters. Furthermore, huge quantities of water are needed for electricity production in power plants. In this 21st century, civilization has entered the flow of development and we are moving forward with a population of more than 6 billion. So sustainable development is utmost essential for reducing the water consumption. With the rapid increase of population and the development of society and industry, many countries are facing a water shortage. A water shortage does not only result in a shortage of domestic water for people's lives, but also serious food shortages, impacts on eco systems and public health problems. Among other things, food shortages are particularly serious with about 800 million people are currently suffering from malnutrition and the world will become in need of food to sustain 2.4 billion people by 2025 because of an increase in the percentage of developing countries. (United Nations Population Estimation, 2017) Various other problems are also emerging, including water pollution caused by insufficient sewage disposal capacity, an increasing number of people dwelling on flood prone lowland areas and resultant flood damage, etc., and there is growing concern that these problems including water shortages will become more serious in future due to the increase in the world population and the impact of climate change. While the world's population tripled in the 20th century, the use of renewable water resources has grown six-fold. Within the next fifty years, the world population will increase by another 40 to 50 %. This population growth – coupled with industrialization and urbanization – will result in an increasing demand for water and will have serious consequences on the environment. If we do not adopt new water usage method our future generation will face a great problem. So, adoption of water efficient plumbing fixtures is the only solution to handle the water scarce problems. These types of fixtures may be costly but in the long period it saves too much water as well as money.

Table-8: Cost of estimation done for Building

Overall Cost Estimation		
S. No	Item	Price (INR)
1	Plot	₹.23,40,000
2	Foundation	₹.2,36,216
3	Steel Structure	₹.54,600
4	Roofing	₹.2,68,046
5	Super Structure	₹.2,41,243
6	Wall Construction	₹.1,93,000
7	Flooring	₹.1,68,000
8	Wall Tiles	₹.32,276
9	WPC & Glass Work	₹.2,26,080
10	Painting	₹.1,03,260
11	Plastering	₹.2,30,960
12	Electrical & Plumbing	₹.2,52,000
13	Solar Panels	₹.1,07,100
	Total cost of building	₹.44,52,781

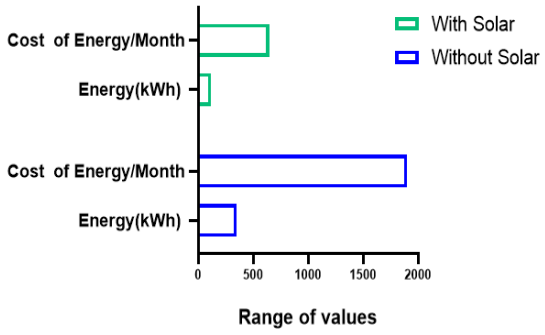

Fig-6: Graphical comparison results with and without solar system

V. RESULT AND CONCLUSION

From the detailed study the following conclusions are identified and as follow:

- The 3E- Analysis (Edifice-Energy-Estimate) is a method of making a project and significantly aligned process simultaneously by using BIM.
- The Selection of materials made the work simple appropriate to get work done likewise:

1. ACC block (Autoclaved Aerated Concrete Blocks):
   - Improved thermal efficiency reduces the heating and cooling load in buildings
   - Porous structure gives superior fire resistance Workability allows accurate cutting, which minimizes the generation of solid waste during use.
2. TMT Steel Bars
   - Environment Safe & Secure like it has better recyclable than any other up to 88%
   - Corrosion Resistant Bars these made from mixture with Copper, Chromium and Phosphorus making it highly corrosion resistant.
   - Ductility & Bending Property this TMT bars have better elongation properties, and it has a high strength to take the stress beyond bearable range. It can be bent as much as possible which becomes a great advantage of construction. Due to high ductile property, the reinforced concrete allows greater stability during adverse environmental strains.
3. Marble tiles:
   - Colours remain unchanged forever. It has better resists UV radiation, keeping its colour like on the first day, Fire- and heat-resistant, no smoke or toxic substances are emitted if it was affected by fire.
4. Wood-plastic composites (WPCs) Doors:
   - Good insulation and sound insulation, moisture-proof, waterproof, anti-corrosion, pest control, durable and long service life, Good fire, and flame retardancy, WPC doors can be made in many different colours and models.
5. Laminated Glass Windows:
   - Laminated glass Window is excellent break-in protection. It helps to reflect UV radiation, Reduced noise pollution.

- The water harvesting for the building is also essential this is done by decreasing the runoff of water by installing Aerators to taps. In taps that supply 15 litres of water per minute, aerators can cut the flow by more than half, to six litres per minute.
- Then the installation of a solar power panel to use the optimized sunlight energy for the building. By installing 10 to 12 of 330 watts panels we can save energy 3.3KW to 4.95KW energy per day as showed in figure 6.
- These processes may see as over charge of cost for building but in perfect budget preparation it may be like regular cost of the building.
- For example, regular 3bhk g+1 building cost up to 35-40 lakhs as per our search
- Our design cost of building is overall 45Lakhs.
- At the day of a head, it will be helpful to economical charges will be reduced for the building in day to day of life.

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