Modelling and Solar Studies of Structure Using Revit

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Abstract :- **In the last few decades, there has been a large development in the energy conservation sector. The development has introduced various different methods of energy conservation one of them is the solar power which is renewable source of energy. Study says use of solar energy is cost efficient, low maintenance, long-term investment as a solar panel can last up to 40 years or more and also it is environment friendly. For the generation of solar power solar panels should be installed with careful consideration of the sun's path, you can take advantage of strategies such as natural day lighting, passive heating, PV energy generation and natural ventilation. However, if you are not careful, these same opportunities can work against you, producing glare and overheating. The earth movement around the sun generates sun paths that vary throughout the day and the year, and it is one of the most crucial environmental factor to understand while designing high performance buildings. In this project we study about the solar analysis in the G+1 residential building and G+5 educational building by using revit.**

Keywords - Solar Analysis, Shadow analysis, Sun setting, Revit, AutoCAD

I. INTRODUCTION

Solar study in Revit offers architects and designers a powerful tool to evaluate the impact of sunlight on building designs. By accurately modelling the sun's path throughout the day and year, this feature provides valuable insights into how sunlight interacts with the building form. Through defining parameters such as location, orientation, date, and time range, users can conduct comprehensive analyses to assess sunlight exposure, shading patterns, and potential glare. Visualizations generated from these studies, including solar radiation maps and shadow diagrams, facilitate the identification of areas requiring optimization for enhanced energy efficiency and occupant comfort. By iteratively refining the design based on study results, architects can create more sustainable and environmentally responsive buildings. Additionally, the ability to document and present these findings aids in communicating design decisions effectively to stakeholders. Overall, solar study in Revit empowers architects and designers to make informed choices that optimize building performance and contribute to the creation of healthier and more sustainable built environments.

II. SOFTWARES USED

- AUTO CAD

AutoCAD is referred to as a computer-aided design (CAD) and drafting software tool. It is widely used in the industries by architectures, engineers, project managers and other professionals.

AutoCAD is known tool when it comes to 3D and 2D CAD designing. AutoCAD is a tool that facilitates the process of designing. Now a days most of the structures that are built are based on CAD drawings. The majority of them use AutoCAD.

- REVIT 2024

Autodesk Revit software allows architects, engineers, and other construction professionals to:

Model and shapes the structures, and systems in 3D with accuracy, precision, and ease.

Streamline project management with instant revision to plans, elevations, schedules and sections.

III. LITERATURE REVIEW

1. Ahmed D. Almutairi, (2023) Predicting energy generation from residential buildings attached photovoltaic cells in a tropical area using 3D modelling analysis.
   BIM revit software was used to install PV panels in sighted location. PV panels had more consumption of energy generated than PV panels.
2. Harri Junaedi, Tabrej Khan, (2023) State of the art review of solar design tools and
   methods for assessing daylighting and solar potential for building-integrated photovoltaics. Solar designs obtain architectural visual effects and help in accessing illumination for daylighting and solar radiation potential on building surfaces.

3. Jitao Zhao, Yutong Yan, (2023) A knowledge based CAAD system for passive solar architecture.
   For achieving solar architecture from an energy point of view, computer aided design tool helps them to fit local climatic conditions. The paper focuses on determining geometry and building orientation that is the conceptual stage.
4. Ganjar Pramudi, (2021) A BIM-based study on sunlight simulation to calculate solar
   Energy for sustainable buildings with solar panels. It is very essential to plan for sunlight as it helps in understanding and making allowable in building attributes so as to obtain sustainable benefits from sun in and around buildings.
5. Qihong Jiang, (2020) Analyzing the institutional building for solar radiation and photovoltaic energy using Autodesk Revit.
   By using Autodesk Revit software, paper authors examined and modelled all the aspects of institutional building for efficiency and sustainability of solar energy.
6. Pavel Koštial, (2020) Solar Analysis: Calculating shaded areas in Revit for sustainable design. By applying advanced processes using dynamo and Revit API, we can determine the sun's direction and shaded areas of whole building or objects like walls, roofs or windows in Revit models. It also helps with design and analysis of sustainable buildings.
7. P. Balaji1, Dr. S. Arul Selvan, (2018) Rooftop photovoltaic system as a shading device for uninsulated buildings.
   This research improves thermal performance of rooftop PV as a shading element and also helps in consumption of buildings in a moderate dry-warm climate. This analysis helps in awareness of a buildings overall energy needs and provide important guidelines.
8. Qihui Chen, Ting Linghu, (2017) Parametric BIM: Energy Performance Analysis using dynamo for Revit
   VPL tool named dynamo with Autodesk Revit and green building helps in the simulation process. This paper highlights on why to develop the methods of energy simulations in the early design phase.
9. Hai Fang, Huiyuan Shi, (2016) Enhancing the energy efficiency of buildings by shading with PV panels in semi-arid climate zone
   This research focuses on what effect the photovoltaic rooftop panels have on the surface of roof and on consumption of energy.
10. Zulzamri Salleh, Md Mainul Islam, (2016) An integrated approach for 3D solar potential assessment at the city scale.
    Making use of solar energy has shown the fastest global growth of all renewable energy sources By using light detection and ranging data (LIDAR), a new modelling technique with integrated 3D modelling was developed for roof buildings.

IV. PROCEDURE TO RUN SOLAR ANALYSIS

- Click on the sun path option and turn on the sun path.
- Click on the shadow setting and turn on shadows.
- Click on the sun settings.
- Select the type of study need to be performed. That can be Still solar study, single day solar study, Multi day solar study and lighting study type.
- After selecting type of study setup the date, time, and time interval.
- After making required settings run the analysis.
- For saving the videos of analysis go to the files then Export and the images and animation option choose the solar study and make necessary setting in the next window setting and save the video.

V. METHODOLOGY

For the purpose of solar study two structures are studied first is a G+1 residential structure and another is a G+5 Educational Building.

G+1 Residential building

A G+1 structure is studied for performing the solar study. The structure is located in Vetore of Sindhudurg District in Maharashtra, India. The structure has G+1 floors and consist of living room, Kitchen, Bed room, Washroom. The climate is semi-tropical and remains warm most of the year temperature rise to maximum of 32^{o}C and minimum of 16^{o}C.

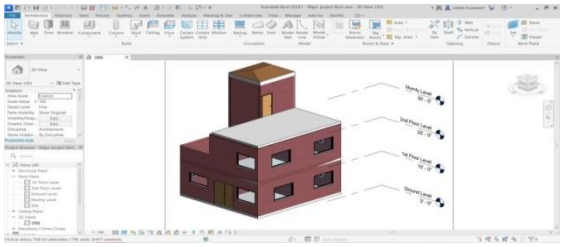

Fig 1 . 3D model of the structure created using Autodesk Revit

G+5 Educational Building

A G+5 structure is studied with an objective of performing the solar study. The structure is located in Miraroad of Thane district in Maharashtra, India. The structure consist of Class rooms, Labs, offices, canteen, Assembly Hall, Washrooms. The climate is semi-tropical and is warm most of the year the temperature rises maximum upto 38ºC and minimum 18ºC.

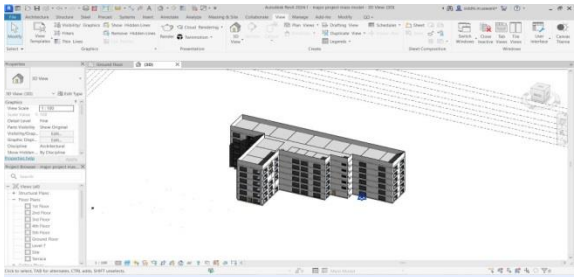

Fig 2. 3D model of the structure created in Autodesk Revit

VI. SOLAR STUDY

Solar energy is essential source of renewable energy, and its technologie are broadly described as either passive solar or active solar depends on how they capture and distribute solar energy or convert it into solar power.

Active solar technique includes the use of photovoltaic system, concentrated solar power, and solar water heating to make use of the energy.

Passive solar techniques include orienting a building to the sun position, selecting materials with favourable thermal mass or light-dispersing properties, and design spaces that will naturally circulate air.

Types of Solar study:

For performing the solar study we have selected particular solar study from available solar study types:

Still solar study:

It produces the single image of model that show the impact of sun and shadows at a project location for a specified date and time. We have the images view that shows shadow pattern for structure studied in Vetore, Maharashtra on May 6 at 10:00 am and in Miraroad, Maharashtra on May 6 at 10:00 am.

Presets are:

- Summer solstice
- Winter solstice
- Spring equinox
- Fall equinox

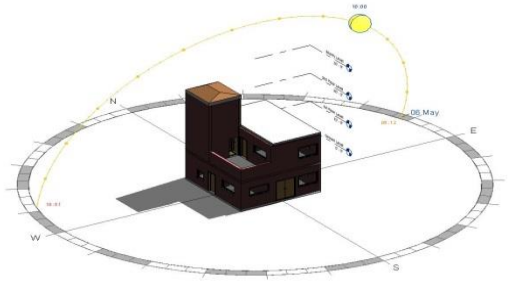

Fig 3: Still solar study on G+1 Structure.

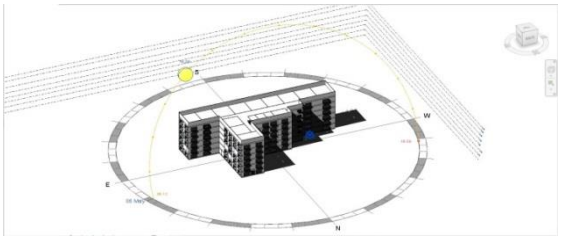

Fig 4: Still solar study on G+5 Structure.

Single day solar study:

It produces an animation that shows the movement and operation of shadows at the project location for a specified date, time range, and time interval. We can see the shadows at hourly intervals for the structure in Vetore, Maharashtra on May 6 from morning to afternoon i.e from 6:15 am to 5.50 pm and in miraroad, Maharashtra on May 6 from morning to afternoon i.e from 6:15am to 5:50pm.

Presets are:

- One day solar study
- Spring equinox solar study
- Summer solstice solar study
- Fall equinox solar study
- Winter solstice solar study.

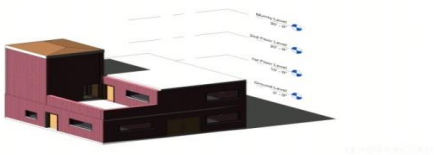

Fig 5: Single Day solar Study on G+1

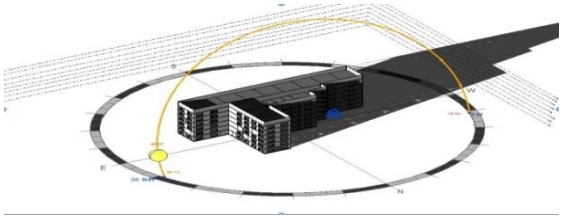

Fig 6: Single Day solar study on G+5

Multi Day solar study:

This study creates an animation that shows the movement of shadow at project location for a specified time range and time interval.

Presets are:

- Multi day solar study
- Spring solar study
- Summer solar study
- Fall solar study
- Winter solar study
- One year solar study

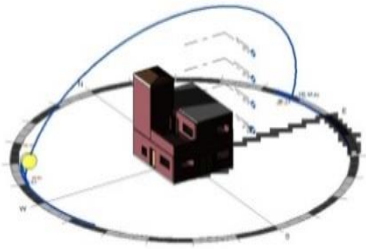

Fig 7: Multi Day solar study on G+1

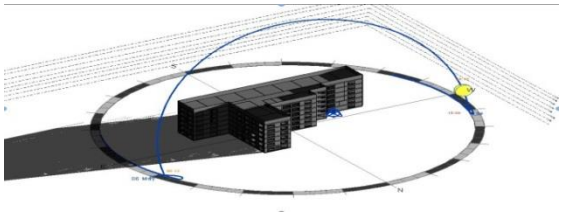

Fig 8: Multi day solar study on G+5

Lightning solar study:

It will produces a single image that shows the shadows cast from the predetermined sun position in the active view, rather than a sun position based on project location, date, and time. We can project any angle view i.e 0 to 360 degree shadow on different elevation.

Presets are:

- Sunlight from top right
- Sunlight from top left

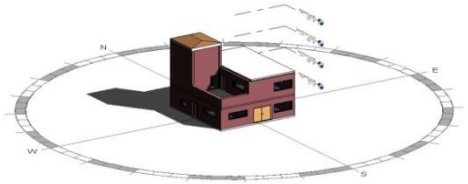

Fig 9: Lighting solar study on G+1

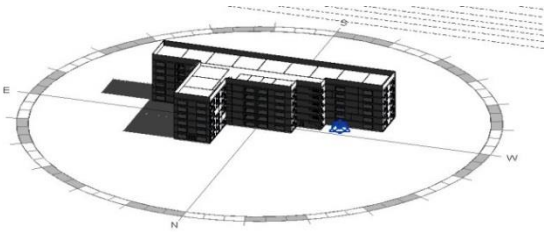

Fig10: Lighting solar study on G+5

VII. SUN SETTING:

Sun Settings allow you to adjust the sun's position, the geolocation, and the time of year for your project. The purpose of sun path are as follows:

- To observe the sun path
- To see the shadows from different positions of the sun, which are independent of place and time.
- For solar study

Sun setting is the process of adjusting the position and characteristics of the sun within a project. This features allows the users to simulate the effects of natural sunlight at different times of the day or year, aiding in the evaluation of daylighting, shadows, and solar heat gain within a building design. By setting the sun's position, orientation, and intensity, architects and designers can analyze how sunlight interacts with their models, optimizing the building's performance and energy efficiency. Sun setting can enhance the visualization of architectural designs, providing clients and stakeholders with realistic renderings that showcase the building's appearance under various lighting conditions.

Workflow of Solar study:

Solar studies required for the assessment of the impact of natural light and shadow on the project are as follows:

1. Collection of necessary information of structural drawing.
2. Specify the geographical location of the project.

3. Create different views that will support disposal of shadows. Further create view for solar study.
4. From the sun settings turn ON the sun path and shadow.
5. Create the type of solar study required as per observation.
6. Observe the animation and check if single day or multi day solar study is created.
7. Save the solar study result and export the solar study result.

VIII. SOLAR ANALYSIS:

Solar analysis is the process of evaluating the amount of solar energy that falls on surface of structure. Revit allows you to calculate incident solar radiation per building surface and articulate PV potential and payback period. Analysing the impact of the sun on the site can help designers to increase the energy efficiency, comfort, and financial value of the building. Designers can improve efficiency of buildings by incorporating the energy offsets relating to sun exposure. By estimating the building performance through the use of solar models, you can incorporate photovoltaic system into building plans.

Workflow for solar Analysis:

1. Set geographical location of project.
2. Set the true north of the project
3. Turn on the sun path
4. Set the time period of the sun path by selecting the type of solar study
5. Display the shadow

Performing the solar analysis:

First install insight 360 plug-in which is a cloud-based plug-in that helps in various analysis programs. To perform the solar radiation analysis we open the analyse tab select insight plug in.

IX. SHADOW ANALYSIS:

Shadow analysis is performed to determine the impact of natural light and shadows on the building. It helps us to visualize the impact of natural light and shadows on exterior and interior of the structure.

This information is important for optimizing building orientation, shape, placement of outdoor spaces, and informing other design decisions to improve the quality and performance of the proposed design. Shadow analysis is essential for building design, ensuring that buildings are optimized for solar access, , occupant comfort, energy efficiency and aesthetic appeal.

Shadow analysis is performed on both structures by cutting sections in 3D model and turning on the shadow option. Then by using Single day study option Shadow analysis can be performed.

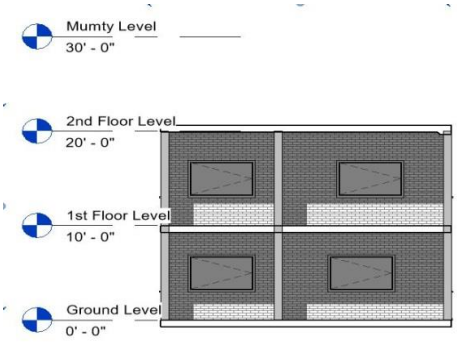

Fig 14: Shadow Analysis on G+1 structure.

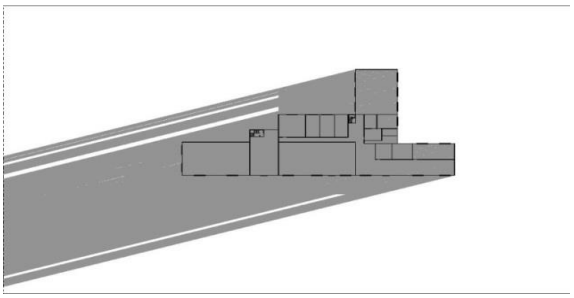

Fig 15: Shadow Analysis on G+5 structure.

X. CONCLUSION:

A detailed study on solar exposure and shadow analysis was conducted for G+1 and G+5 structure using Revit software. The analysis focused on understanding sun path and resulting shadow patterns throughout the year. The results of the study revealed that the maximum sunlight is received from the southeast and southwest directions. This finding is crucial for optimizing the installation of solar panels.

Based on these findings, we can conclude that the strategic placement of solar panels in the identified areas will significantly enhance the efficiency of solar energy utilization. By optimizing the installation of solar panels according to the sun path and shadow analysis, we can ensure that the buildings harness the highest possible amount of solar energy. This approach not only improves energy efficiency but also supports sustainable and environmentally friendly building practices. Implementing these recommendations will contribute to energy savings and promote the use of renewable energy sources in construction projects.

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