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BIM Design and Analysis for Residential Building

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ABSTRACT - The design communications gradually being changed from 2D based to integrated 3D digital interface. BUILDING INFORMATION MODELING (BIM) is model based design concept, in which buildings will be built virtually before the actual construction takes place, where data models are organized for complete integration of all relevant factors in the building life cycle which also managed the information exchange between AEC (Architects, Engineers, and Contractors) professionals, to strengthen the interaction between the design team. BIM is shared knowledge about the information for decision making during its life cycle. There is still much to be learnt about the opportunities and implications of this tool. This report deals with the use of the tool for a live project which would in turn help to understand the tool better and thus making the entire construction project an easy and a connected task.

Keywords **–** Building Information modeling, Project Plan, Modeling in Software, Loads and Analysis, Estimation and schedules.

I. INTRODUCTION

Building Information Modelling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition. Traditional building design was largely reliant upon two-dimensional technical drawings (plans, elevations, sections, etc.). Building information modeling extends the three primary spatial dimensions (width, height and depth), incorporating information about time (so-called 4D BIM) cost (5D BIM), asset management, sustainability, etc. BIM therefore covers more than just geometry. It also covers spatial relationships, geospatial information, quantities and properties of building components (for example, manufacturers' details), and enables a wide range of collaborative processes relating to the built asset from initial planning through to construction and then throughout its operational life.

BIM authoring tools present a design as combinations of "objects" – vague and undefined, generic or product-specific, solid shapes or void-space oriented (like the shape of a room), that carry their geometry, relations, and attributes. BIM applications allow extraction of different views from a building model for drawing production and other uses. These different views are automatically consistent, being based on a single definition of each object instance. BIM software also defines objects parametrically; that is, the objects are defined as parameters

and relations to other objects so that if a related object is amended, dependent ones will automatically also change. Each model element can carry attributes for selecting and ordering them automatically, providing cost estimates as well as material tracking and ordering.

For the professionals involved in a project, BIM enables a virtual information model to be shared by the design team (architects, landscape architects, surveyors, civil, structural and building services engineers, etc.), the main contractor and subcontractors, and the owner/operator. Each professional adds discipline-specific data to the shared model – commonly, a 'federated' model which combines several different disciplines' models into one. Combining models enables visualization of all models in a single environment, better coordination and development of designs, enhanced clash avoidance and detection, and improved time and cost decision-making.

II. REVIEW OF LITERATURE

The possible economic benefits and improvement of productivity with successful BIM implementation is well acknowledged and gradually better understood within the AEC industry (Bernstein & Pittman, 2004). BIM applications and solutions is one of the most challenging technological progresses in recent years for the architecture, engineering, construction, and facility management (AECFM) industry. Its lucrative deliverable is attracting majority of the construction companies, who aim to offer high quality product for their clients. The integrated database gives the opportunity to every individual involved in an entire construction project (including architects, engineers, contractors, project manager, and owners) to collaborate together, allowing them to view the model in different ways and to share information.

One of the main advantages of implementing BIM applications is the visual coordination and the capability to identify possible conflicts among the various building systems. Furthermore, the instantaneous data updating attribute of BIM along with cloud computing, helps AEC professionals tremendously in saving time, otherwise spent or wasted in exchanging project information. These deliverable products are just a few things that one can expect from this powerful tool which completely transforms the way business is performed (Franklin, 2010).

The advantages and possible benefits of this new technology compared to traditional 2D CAD has been researched intensely in various nations. BIM offers a plethora of benefits, both directly and indirectly, to all members of the AECFM industry. A reduction in conflicts and changes/rework during construction wastage and the whole-life costs of built assets, better-performing completed infrastructure, and improved overall project quality are among the advantages that can be experienced with appropriate usage of BIM applications and solutions.

VISUALIZATION: The ability to create, visualizes, and present architectural and engineering documents is one of the direct benefits for a 3D model. Many individuals have difficulty understanding overloaded 2D drawings even after intently studying the drawings. However, a 3D model, even with relatively few details, clearly represents the building project and allows better visualizations for many of its features. These building elements are not only represented as 3D objects; instead, they are also associated with accurate and relevant information, the reducing errors and requests for information (RFI), creating fewer change orders, and saving valuable time.

ACCURACY AND RELIABLITY OF DATA: BIM applications and solutions make certain that all of the data extracted from the various models of a particular project are faultless. This consistent of data eliminates the

suspicion thought of error between various sets of drawings. This reliability indicates that whichever design alteration is made in a particular view will be automatically be modified throughout all other views for that project.

COLLABORATION: BIM proves to be very beneficial for sharing a single database among multiple team members. The AECFM industry is tightly bound together, and the challenge to synchronize among these professionals seems to be achievable because of BIM. It has been demonstrated repeatedly that collaboration among teams at initial stages of construction project has great rewards for planning and scheduling. Therefore, by developing BIM models at initial stages of a project, AEC firms can totally ensure in-depth collaboration among the extended project team, on almost all of the construction issues. Thus leading to improved productivity, communication, and quality control.

EASE OF QUANTITY AND COST ESTIMATION: When the construction and design team is working collaboratively using BIM, many benefits can be experienced; for example, quantity take-offs and cost estimation are just few among many of them. BIM's trait of estimation from the model helps the estimator prepare the material/resources estimation faster, easier, and with fewer errors. BIM allows cost estimates to be more accurate and reliable than those prepared using conventional methods which are subjected to manual miscalculations.

ENERGY EFFICIENCY: BIM systems are proficient and aid in delivering projects with optimal sustainable design. BIM's analysis tools help analyze heating and cooling requirements, identify day-lighting opportunities, and choose building equipment those help in reducing overall energy usage. Various attributes (such as, climate conditions, electrical lines, etc) can be incorporated, in assessing the energy consumption and carbon emissions of the particular project.

III. OBJECTIVES OF THE STUDY

i. To understand the building information modeling tools used in the industry.

ii. To use the collaboration tools offered by REVIT thus making the overall construction easy.

iii. Make a 3D model and do structural analysis of the structure STAAD and then linking it with the REVIT model.

iv. Do initial survey to know the requirements of the residential building and propose the future developments.

v. MEP works of the new construction.

vi. Preparing different cost schedules for the project.

vii. Preparing a general time schedule for the project.

IV. METHODOLOGY

The project involves survey of the residential building to be modeled and then based on the requirements of the building it is decided whether a new building or renovation is required. The data was collected by site visits and

interaction with the administration. The site visit was conducted with the help of us and a data sheet for requirements was made. The structure was the analyzes in STAAD.PRO and a 3D model was prepared using AUTOCAD, 3D CIVIL and REVIT. The rendered drawings were also generated using REVIT. The structural analysis was linked with the Revit model by import and export tool for linking models. IS 456 was used for design norms and IS 8827 for the standards of the facilities.

V. PROJECT PLAN

AutoCAD is the original CAD software used by millions around the world. It can be used to create precise 2D and 3D drawings and models, as well as electrical diagrams, construction drawings, and more. So, we have chosen AutoCAD to preparing the Plan of the Residential Building.

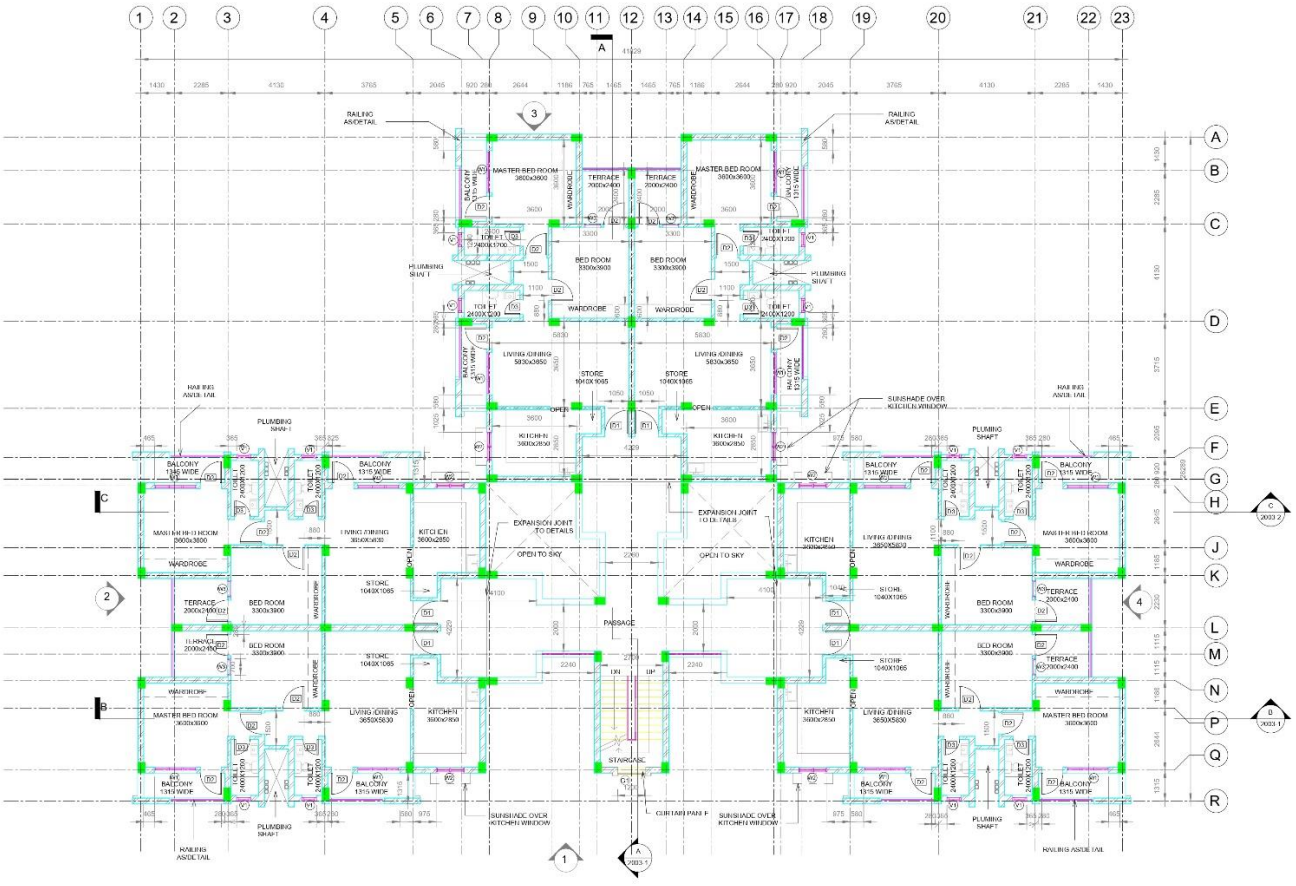

Fig 1. 2D Plan created in AutoCAD

VI. 3D MODELING USING REVIT

Revit BIM software is BIM tool for structural engineering. Construction design and Architectural Design. It is one of the most popular software packages developed by CAD giant Autodesk. Designed for MEP engineers, architects, designers, contractors, and landscape architects, among others. The robust platform offers an intelligent model-based approach for planning, designing, and constructing infrastructures and building. It is compatible with Microsoft Windows only. 3D model is created using Autodesk Revit software with the help of Floor plan available of the building.

Fig 2. 3D model created in Autodesk Revit Software

VII. MODELING IN STAAD

Our project involves analysis and design of the project using a very popular designing software STADD Pro. We have chosen STAAD Pro because of its following advantages:

- Easy to use interface,
- Conformation with the Indian Standard Codes,
- Versatile nature of solving any type of problem,
- Accuracy of the solution.

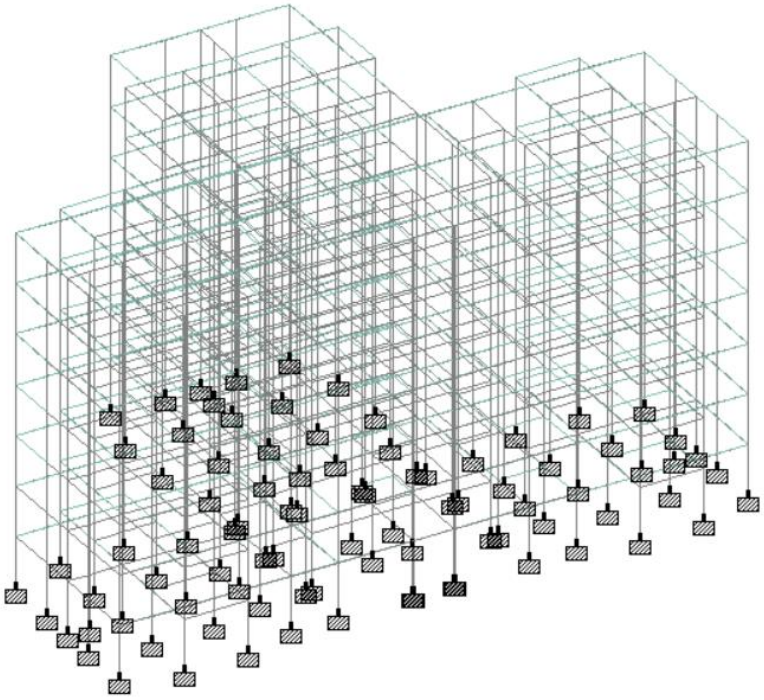

Fig 3. 3D Structural design for the Residential Building created in Staad.pro

VII. RESULTS AND DISCUSSIONS

The building information of the residential building was done and the dynamic usefulness of BIM was studied. The conclusion drawn is that the use of modern tools can make the planning and designing process an easy and efficient. The link of all the different kinds of details is a powerful tool for better co-ordination in the project. The use of software reduces a lot of manpower and human errors. It should be also kept in mind that even the computer can make mistakes, the designer should analyze the outputs of the software and make sure they are correct. Time estimation is still nit a part of popular BIM software but as the industry develops these tools will also be available.

IX. CONCLUSIONS

1. Planning, analysis and design of G+6 multi-store residential building was done.

2. It's a G+6 storied building and the rest of the floors are occupied with Flats.

3. All the structural components were designed manually and detailed using AutoCAD.

4. The conceptual design, 3D parametric modeling, detailed design documents, and modeling building components were done by using Autodesk Revit software.

5. The analysis and design were done according to standard specifications using STAAD.Pro for static and dynamic loads.

6. The dimensions of structural members are specified and the loads such as dead load, live load, floor load and wind load are applied.

7. Deflection and shear tests are checked for beams, columns and slabs. The tests proved to be safe.

8. Both theoretical and practical work has been done.

9. Hence, I conclude that we can gain more knowledge in practical work when compared to theoretical work

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