

GIS Based 4D Model For G+2 Residential Building Project

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Abstract: As a major factor in construction management, construction technology plays a significant role in the planning, scheduling, and monitoring of the construction process. GIS application in construction projects develop a database, analyze the project and scheduling, and ensure the quality of projects in terms of cost and time. The 4D model could increase the understandability of the scheduling of a project risks while the task in progress on the location. This paper gives the idea of incorporating ArcGIS development project the executives and created a 4D model to provide a better solution in monitoring the various tasks in the G+2 residential building. The generated 4D model includes a 3D image and a time component. This would help clients, site engineers and project managers to imagine the advancement in a characteristic manner, thus limiting the deferrals and cost overwhelms. As well as observing of work process, checking the amounts, expenses and resources can be additionally utilized.

Keywords: ArcGIS, AutoCAD, MS Project, 4D Model, ArcScene

1. Introduction

Infrastructure development through construction industry contributes significantly to the world economy. Success of a construction project generally depends upon the time bound conveyance, material, labor, quality control, and cost (Hedge et al., 2021; Alan and Gordon, 2003). The project management covers material administration and time management. The present necessity of construction industry is to have effective project planning, scheduling, and management in order to optimize the tasks, resources, cost and time (Erdogan et al., 2019). Planning, scheduling, managing and executing are the major roles in the construction project, however those are the challenging tasks, include identifying the best technology, analyzing the resources, finalizing tasks sequence, understanding the interaction between tasks, estimation of duration for the individual tasks, deciding budget and schedule of the project (Milan and John, 2012).

The best time planning could be created by the undertaking administrators utilizing material and time bar diagrams, basic way strategy , program assessment audit methods ,thus result in on-time completion of all tasks in the project and optimization of financial investments

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in the construction project (Frank et al., 2021). There will be a serious concern in the decision making process, if the project managers could not provide necessary spatial information (Russell and Olli, 2010) in terms of materials, labors and other resources (Ogaja, 2011). In order to make a quality project, compromise on delivery time, and the cost could not be accepted. Hence, it is essential to interact with local resources data such as materials, labourers, etc. (Karimi et al., 2018) and plan for the on-time completion of the construction projects (Ojo et al., 2022).

Behnam et al (2016) guaranteed that in the development business setting aside time and cash could be accomplished just utilizing compelling undertaking the executives like expense assessment, arranging, booking and control. Further, accomplishment of a construction agreement by and large depends upon for the most part on the information open to the works, site engineers, project chiefs, and clients (Lee et al., 2018). In this perspective, a genuine structure is expected to get to the information and screen the advancement of tasks (Junior et al., 2020; Sharma 2020; Yuv et al., 2019). Usage of a PC based information structure could help in diminishing the reiteration as well as saving time and cost (Li et al., 2020; Nikmehr et al., 2021).

1.1 GIS Application in Construction Projects

In the last three decades, automated tools for effective geographic data storage, analysis and visualization have been developed (Olofu et al., 1994). As per Environmental Systems Research Institute (ESRI), GIS is a compelling programming to gather, break down, update, show, store and deal with all types of geographic referred to information, further it very well may be imagined utilizing computerized maps (Chang, 2006; Cheng and Yang, 2001). GIS applications have been expanding in the upcoming years in development industry and it is a data set framework for spatially referred to information as well as a bunch of undertakings for dissecting the information (Yadhukrishnan and Amba, 2015). GIS application in construction projects develop a database, analyze the project and scheduling, and ensure the quality of projects in terms of cost and time (Mansour and Jaded, 2016). GIS permits project managers, site engineers and clients involved in the project to receive accurate information of the project, make decision and monitor the sequence of construction activities (Poku et al., 2006). Further, GIS records the entire work process and any improvements could be accomplished by the project manager or the client in a short period of time before implementing tasks in the construction site. This information helps in tracking the project tasks. GIS could be utilized for construction progress monitoring, three aspect (3D) information examination, site area and client distance, information correlation, booking and progress control with 3D representation (Bansal and Buddy, 2007). GIS permits project administrators, clients, development specialists to get to data about the headway of the venture and helps in direction. Envisioning development progress in 3D gives the development project directors a more regular perspective on the development grouping. 3D representation permits the development chiefs to see the development exercises during any phases of the development progress.

Bansal and Pal (2007) developed a 3D visualization of building using GIS and linked the tasks in CPM, which makes the sequence of tasks to be recognized easier. Olofu et al., (1994) created a database for subsoil and borehole data using GIS and Cheng and O' Connor developed an automated site layout also known as material plan, in locating materials. Ruixue Liu and Yicheng Zhong (2021) developed a digital technology using building information modeling and GIS in the recent years and demonstrate benefits to

stakeholders by reducing project costs, improving productivity and quality, lowering project delivery time, facilitating sustainable building development during the design, construction and operation stages and supporting sustainable building assessment and analysis. Meanwhile, GIS could provide users 2D and 3D visual and digital images of the physical world.

1.2 Project Management Software

The first project management software, Microsoft (MS) project, released in 1984, was a disk operating system (DOS) program utilized internally by the organization to deal with a rising number of programming projects. MS Project assists with booking in development project where project directors could perform errands posting, undertakings allocate to workers, featuring task span and due date. Further, the undertaking administrator could oversee the timetables (Subramani and Karthick, 2018). MS Task permits the undertaking director to estimate asset needs, anticipate bottlenecks early, oversee usage, and guarantee ideal venture conveyance (Grain et al., 2015). As of late, MS Venture shared another vision for task the board to assist groups with teaming up on projects all the more productively. In any case, the constraint of MS Venture used for booking is in the disappointment of bringing in computer aided design drawings that prompted the advancement of four aspect (4D) GIS model (Vaidhyathan, 2018).

1.3 GIS based 4D Model

GIS based 4D model, is an emerging tool provides better visualization of progress in the task with amounts put away in information base administration. Be that as it may, the 4D model isn't so natural to use in the development cycle since it isn't the case modified (Naik et al., 2011). The development business requires programming instruments that can undoubtedly create control, approve and interfaces the timetables. Meaning of GIS is to foster areas of strength for an of data set that is created over the venture with satellite symbolism (Kumar and Reshma, 2017).

The 4D data incorporates the 2D, 3D and time amendments information. The 4D device gives information in limiting the timetable contentions, imperatives examination and different way in development assessment (Celeste et al., 2022). The fundamental point of this study is to make utilization of GIS for the planning, the superior representation of progress in development work of G+2 private structure and show the advantages of coordinating GIS to accomplish compelling development project the executives. The system uses the functionalities of ArcGIS, MS Undertaking and AutoCAD. Further, 4D geographic structure is created for G+2 building utilizing ArcScene.

2. Methodology

2.1 Project Details

A G+2 residential building of 185 sq m (1987 sq ft) area is considered for visualizing the potential of GIS technology and the development of 4D model using ArcGIS in construction projects. The residential building is covered with service road in the front, followed by a green belt from the main road. A service lane is present at the rear side of the building. Other residential buildings are located at the left and right side of the building.

The column and beam size in the building is considered as 0.30 m x 0.23 m and 0.30 m x 0.40 m respectively.

Drafting the construction project and listing the activities, the respective sequences are mandatory in the project to ensure better results. The major construction activities are grouped into Structural, Architectural, Mechanical-Electrical-Plumping (MEP), Infrastructure and External work.

To foster a 4D model of development project, the product, for example, AutoCAD, MS Venture and ArcGIS have been utilized. AutoCAD is utilized to make 2D drawing and draft various layers of the development work (Balance, Section, Walls, Windows and Entryways). These layers are imported involving ArcGIS programming for making 3D models. MS Undertaking is used for making and refreshing a venture plan, which characterizes the advancement of the structure development as for time. The MS Undertaking planning and produced 2D model in AutoCAD are coordinated in ArcScene in GIS in order to create 4D model of the development project. The means engaged with the 4D model advancement utilizing ArcGIS is introduced as stream outline in Figure 1.

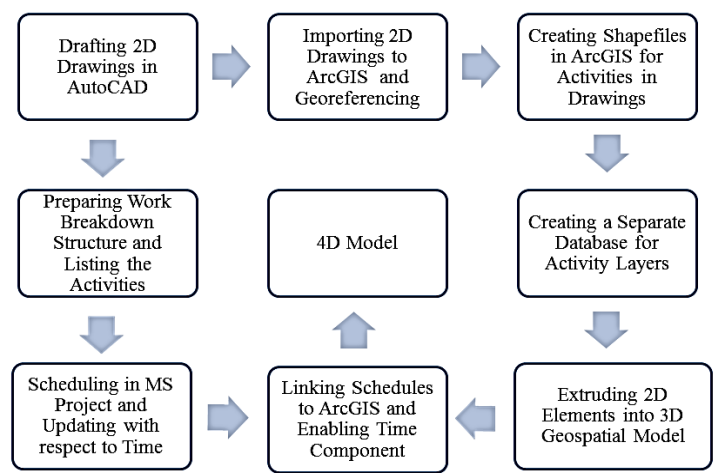


Fig. 1. Flow Chart for 4D Model Development using ArcGIS

3. Model Development

3.1 Drafting using AutoCAD

AutoCAD is a plan and drafting programming and it has graphical UIs for the drafting and planning of any design. The product has different inbuilt devices for complex drafting too. AutoCAD can be used for 2D, 3D and viewpoint plan and drawing. The 2D arrangement of the G+2 private structure is drafted involving AutoCAD programming as displayed in Figure 2 and 3.

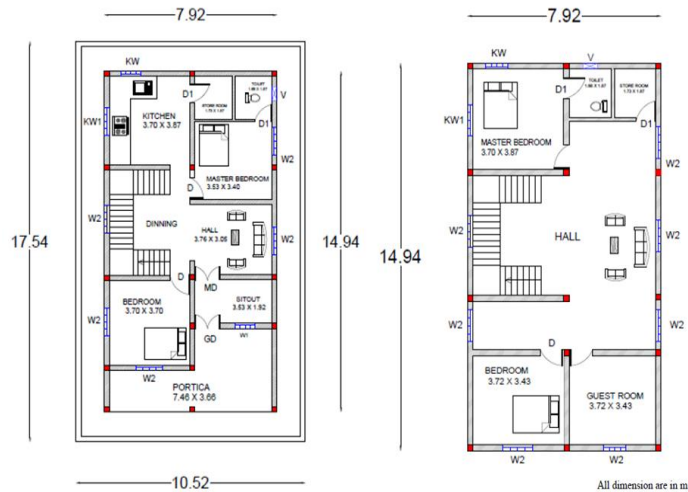


Fig. 2. Ground Floor and First Floor Plan of G+2 residential building using AutoCAD

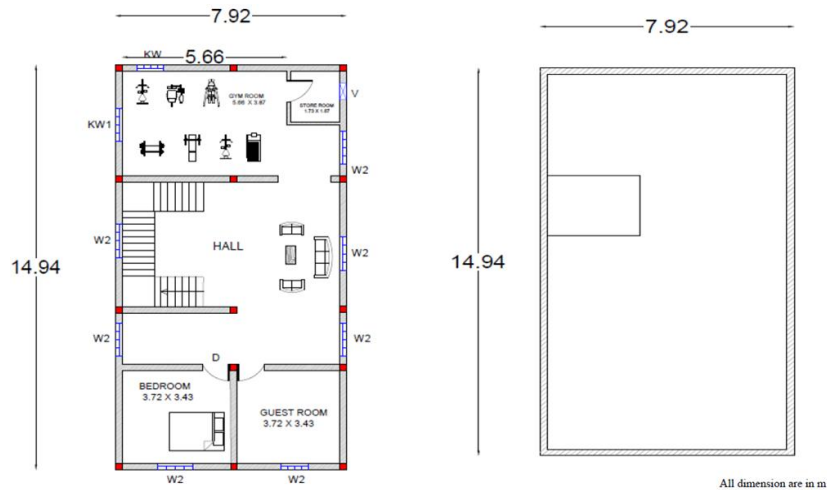


Fig. 3. Second Floor and Terrace Plan of G+2 residential building using AutoCAD

3.2 Scheduling using MS Project

For a development result, legitimate booking and arranging are fundamental, to diminish and reduce defers in the venture. During the execution of the undertaking, appropriate booking of exercises is required and it is finished with MS Task. The primary goal of this study is to organize, timetable, screen, and update the phases of the private development project by the clients, site specialist and undertaking administrator. MS Venture has been utilized for the planning of timetable which shows start date and finish date, alongside basic ways. The action groupings and interrelation between exercises can likewise be thought of. Every one of the exercises are gathered under the work breakdown designs, for example, Primary, Structural, Mechanical-Electrical-Plumping (MEP), Framework and Outer work, as displayed in Figure 4.

Structural Work	Architectural Work	Mechanical, Electrical and Plumbing Work	Infrastructure and External Work
• Substructure (Marking, Earthwork, Footing, Plinth Beam, Sand Filling, etc.) • Superstructure (Wall, Column, Slab, Beam, Staircase, Sunshade, Lintel Beam, Formwork, etc.)	• Plastering • Floor Finishing • Tile Laying • Fixing Joineries • White Washing • Applying Primer • Final Coating • Petty Works	• Ventilation • Exhaustion • Heating • Cooling • Power Supply Work • Fixing Electrical Sockets • Water Pipe Lines • Drainage Work	• Pathways • Soft Landscaping • Surfacing • External Fixtures • Fencing • Railings and Walls • Planting and Irrigation Systems

Fig.4. Work Breakdown Structure for G+2 Residential Building

All the individual activities are scheduled in MS Project as shown in Figure 5. The tasks name in MS Project and in ArcGIS is same for the purpose of interlinking. The MS Project file name has to be converted into CSV format because the ArcScene software can read only the CSV format. The attribute table of the shape files and planning file should be joined with a particular field of attribute table like feature ID (FID), line type, shape etc. Hence, the software could relate both tables with the particular field.

3.3 3D Model using ArcGIS

The 3D perspective on the undertaking is made in ArcScene which is one more module of GIS programming. The 2D drafted drawing is imported in ArcGIS and the isometric perspective on the arrangement is introduced in Figure 6. The movement layers which are made before are changed over into 3D layers in ArcScene, as displayed in Figure 7. The 3D document created has similar asset information as in plan. The layers attracted AutoCAD was brought into ArcGIS and a planning was finished to guarantee that element classes (Polygons, lines or focuses) are comparing to the exercises characterized before in MS Undertaking plan. Accordingly, the exercises that have a place together yet are situated at various positions were consolidated as one component class. The made 3D Model perspective on G+2 working in ArcGIS is introduced in Figure 8.

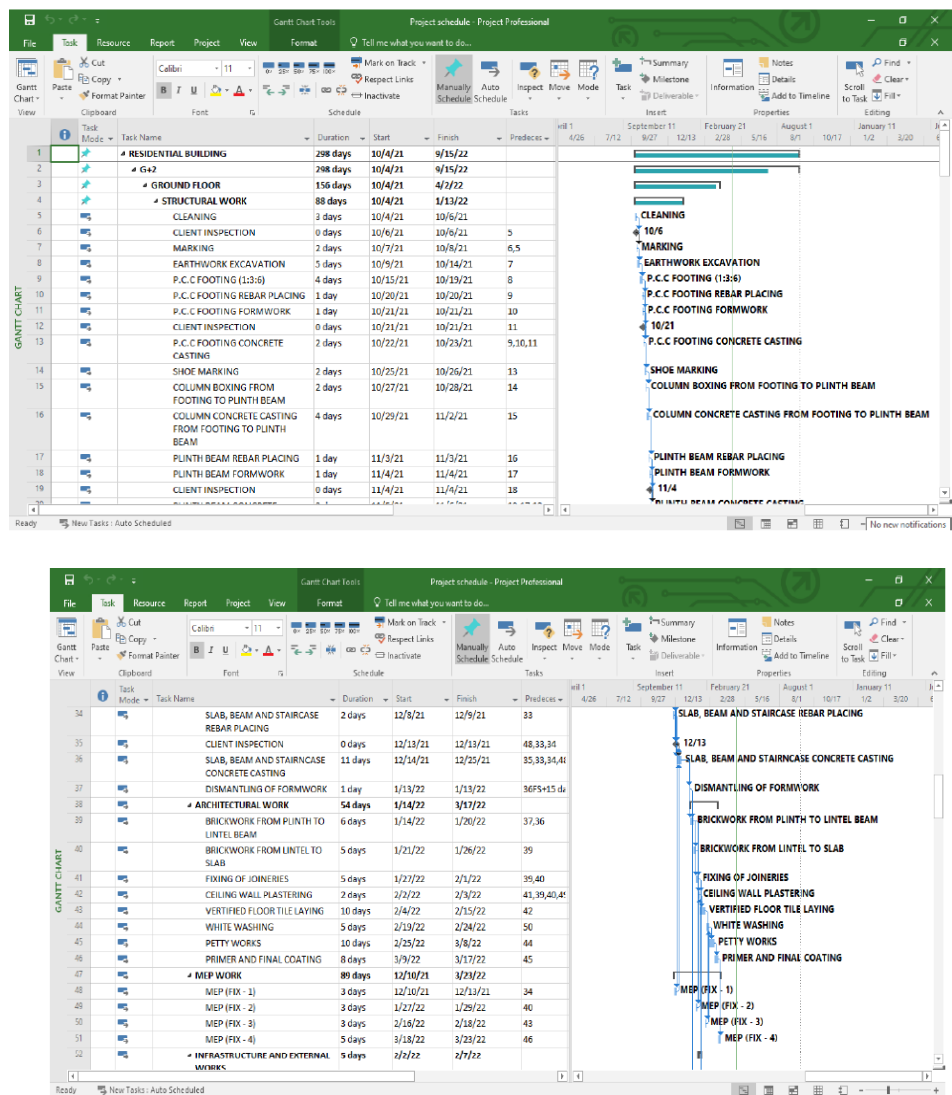


Fig. 5. Scheduling using MS Project

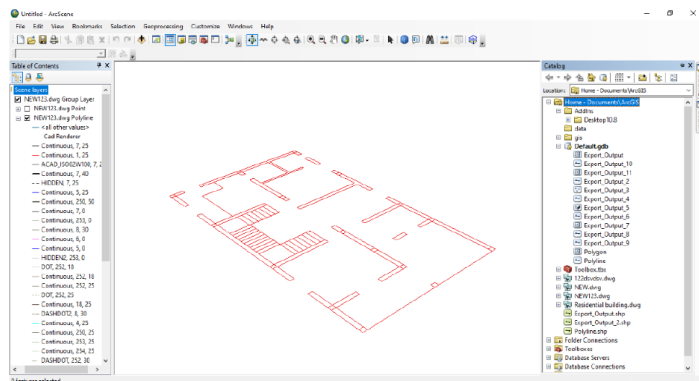


Fig. 6. Isometric View of Plan in ArcGIS

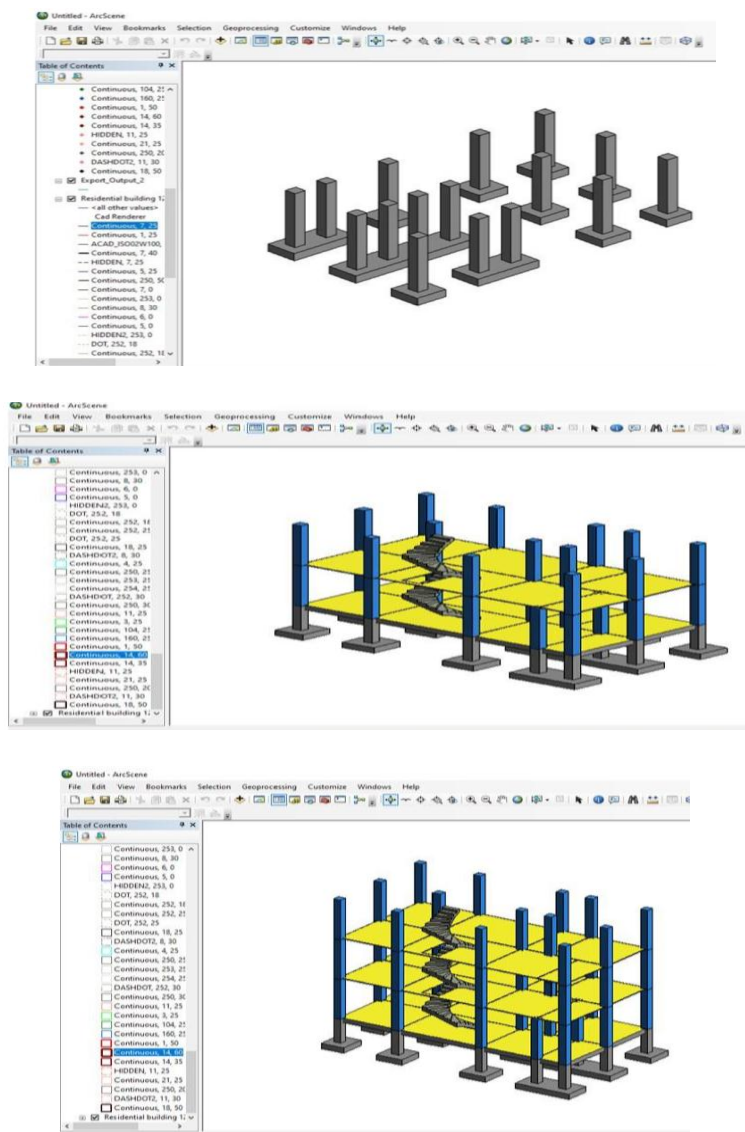


Fig. 7. Layer wise of 3D views of Base Height and Extrusion of the Building

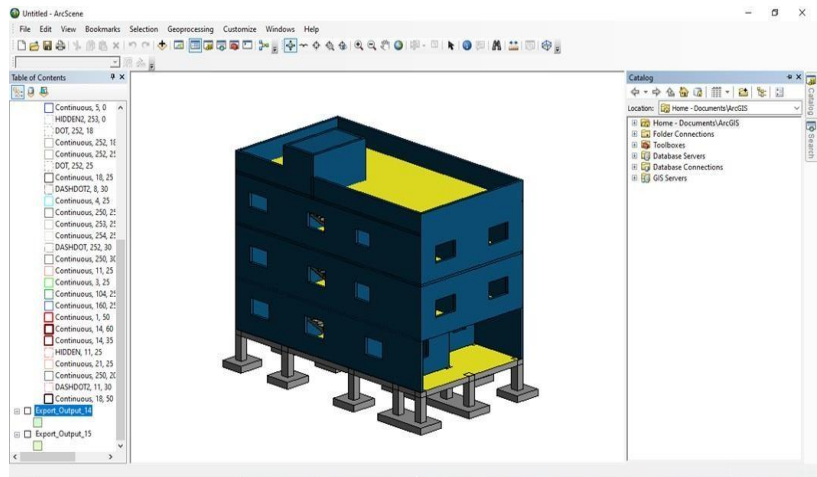


Fig.8. 3D Model view of G+2 Residential Building in ArcGIS

3.4 Importing the Schedule to ArcScene

The strategy incorporates getting 3D model together with the relating plans made using the MS Undertaking, as shown in Figure 9 and 10. With the ultimate objective of coordination, the two drawings and plans use a comparative component classes and development layer names. The course of occasions slider and conveyed 3D entertainment think about study of a definitive consequence of the errand. For dreary works, the arranged GIS based organizing and booking mechanical assembly could be used. This step thinks about an unrivaled portrayal of the undertaking and a prevalent view of the endeavor activity.

3.5 4D Model Development

In the advancement of 4D model, the succession of exercises is remembered with the drawings for 3D view. Along with fitting timetables for every movement, 4D model could be shaped. The created 4D model incorporates a 3D picture and a period part. The mix of 3D drawings which are made and expelled in GIS and timetable arranged in MS Task to give better representation of development progress of the undertaking. Interlinking between planned information and drawings are done provided that the movement layer names and assignment mode for exercises are something similar. Just the matching records in both advanced information and booked information are thought of. Subsequent to interlinking of both spatial and non-spatial information of the G+2 private structure, 4D model of the structure is introduced in a solitary screen climate as displayed in Figure 11.

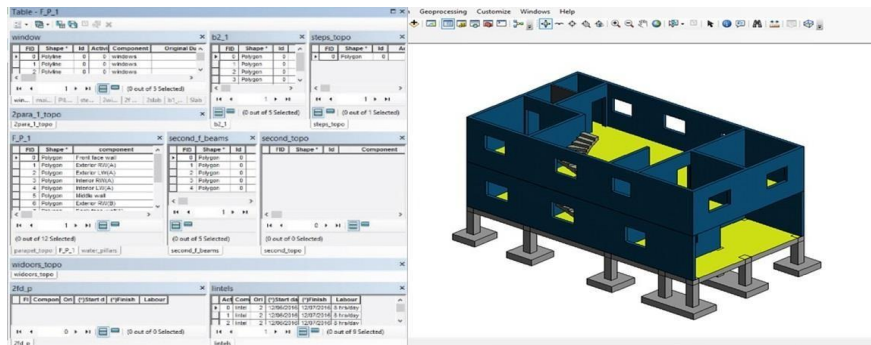


Fig. 9. Extrusion of First Floor Components

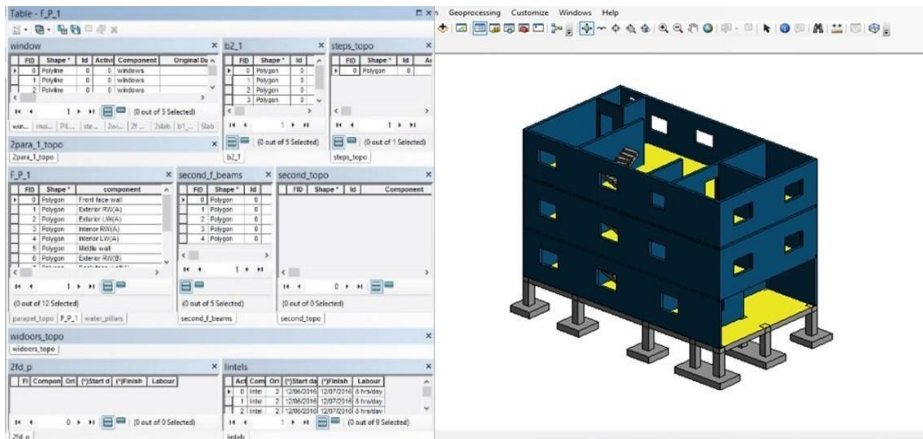


Fig. 10. Extrusion of Second Floor Components

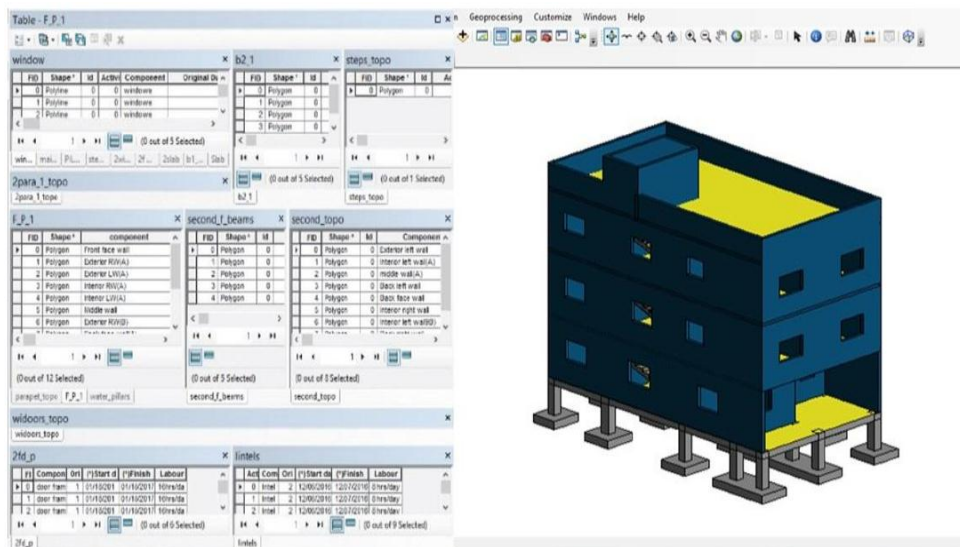


Fig. 11. 4D Model of G+2 Residential Building

4. Results and Discussion

A 3D representation of the components scheduled to be operational on and before a date will be displayed. As well as simplifying the understanding of 3D model components around the X,Y, or Z axes, the GIS-based approach can also be used for observing the developed 3D models in any direction and from any angle. In this 3D drawing, builders, contractors, clients, and workers will get a clear idea of how their work is progressing, the work they have already completed, and what they must do next in the specified period. Furthermore, the result assists the worker in making a decision regarding the next step. The model output of the work is also clearly displayed. In addition to the 3D drawing, the schedule details mentioned in detail help the greater understanding of the schedule.

Using GIS, it is easier to understand the project as well as to detect potential problems as well as to interact with project team members from different fields and collaborate with

them. With GIS, construction databases can be maintained and updated using its database management capabilities. However, most 4D CAD tools cannot handle project management tasks, so they are primarily used for planning and designing.

5. Conclusion

Based on the results of this study, GIS can be an effective tool to complement project scheduling tools like Primavera and Microsoft Project. Even an inexperienced user can identify hidden issues in the CPM schedule. Schedules can only convey what is built when, whereas schedules in GIS convey when and where things are being built. According to the study, we can conclude that GIS is a good tool for zooming, panning, flying, navigation, and many more ways to interact with various components.

It is also possible to rotate 3D development so that not only can the users visualize construction schedules, but also use it as a project management tool at any stage of the project to manipulate schedules and 3D components simultaneously.

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