PROGRESS MONITORING OF CONSTRUCTION PROJECTS BY USING GEOGRAPHIC INFORMATION SYSTEM

[1]ASWATHY T M, [2]Mrs.D.A.ANILA DANI M.E., [3]Dr.A.G.MOHAN DAS GANDHI M.E., Ph.D.,

[1]PG Scholar, [2]Assistant Professor, [3]Head of the Department,

[1,2,3]Department of Civil Engineering, RVS Technical Campus, Coimbatore.

ABSTRACT:

The developing construction industry faces various challenges with planning, scheduling and management of the project, which can enable the overall optimization of the cost and time. Nations with mature infrastructure have followed traditional technology models for planning, design, construction and operation of facilities.With Geographic Information System(GIS) technology, the development of new infrastructure will follow new technology models eliminating data redundancy, and costly conversion when moving through the planning, design, construction, and operation of infrastructure data.The construction industry has a huge number of tasks involved and cost involved in these projects is also very large. The project managers have a hard time monitoring the projects between site and office.They have to come on site to know the progress of work and decide the sequence of work.They are generally confused on what to do next or what would be the changes faced by them in future. So the cost involved is large and it varies with respect to the completion of the project i.e. Time There is pressure on the project managers to shorten the delivery times and thus the current scheduling and progress reporting practices are in need of substantial improvements in quality and efficiency. Instead of using the older, traditional methods of CAD drawings and schedule sheets, one can integrate them on a platform to create a 4D view of the project using GIS (Geographic Information System) environment, which can be recognized as one of the important tool in the optimization and real time monitoring of the projects

CHAPTER 1

1. INTRODUCTION

1.1 GENERAL

Developing countries face unique challenges with the design, construction and operations of new infrastructure. Nations with mature infrastructure have followed traditional technology models for planning, design, construction and operation of facilities. With Geographic Information System (GIS) technology, the development of new infrastructure will follow new technology models eliminating data redundancy, and costly conversion when moving through the planning, design, construction, and operation of infrastructure data. Specific site data requirements for the design and construction of infrastructure are developed for quality engineering design and to minimize and accurately predict construction costs. GIS provides thecentral data system for the process of developing and constructing infrastructure gives the engineers a common means to communicate geospatial data, maintain current data, and allow iterative design/data collection procedures without exchanging data files of differing format, version, and content. Due to superior spatial data handling capabilities, GIS technology is increasingly

being considered for implementation in many infrastructure projects. The Construction Industry has a huge number of tasks involved and cost involved in these projects is also very large. The Project Managers have a hard time monitoring the projects between site and office. They have to come on site to know the progress of work and decide thesequence of work. They are generally confused on what to do next or what would be the changes faced by them in future. So the cost involved is large and it varies with respect to the completion of the project i.e. time. The traditional approach for scheduling and progress control techniques such as bar charts and the critical path method are still being used by the project managers for planning which a serious disadvantage for the decision is making purpose as the spatial aspectsfail to provide the required information. There is pressure on the project managers to shorten the delivery times and thus the current scheduling and progress reporting practices are in needof substantial improvements in quality and efficiency. Integration of GIS and project management software's with visualization was recognized as one of the most important tools for achieving this goal. It should be seen that integration of GIS and Project management might assist a planner in a better perception of a project as well as in the integration of other parties activities in the planning process. Furthermore, in large scale projects, a visual representation of the schedule can be extended to monitoring not only the construction process itself, but alsoall the auxiliary activities, including onsite plant and equipment. In addition, the practical and educational benefits of being able to visualize construction at a fine level of detail aresignificant. The application of geographic information system in project management will be new in the Indian Construction

industry. GIS will allow construction managers and different people involved in project with different backgrounds to get the information about the progressof the project and support Decision Making. GIS will provide a common basis of understanding and communication among these people. Many people think of GIS as a presentation tool. A GIS does in fact create high quality maps that communicate considerable amounts of information in an efficient and attention-getting manner. GIS is both a database system with specific capabilities for spatially referenced data, as well as a set of operations for working withthe data. Visualizing construction progress in three dimensions provides the construction project manager with a more intuitive view of the construction project manager with a more intuitive view of the construction sequence. 3-D visualization allows the construction managerto view the construction activities during any stage of the construction process.

1.2 BACKGROUND

In most of the construction projects, critical path method CPM networks and bar charts are widely used to represent the schedule. Different activities of the CPM network are related to one or more components of the project under consideration. The CPM schedule provides non spatial information which lacks in the spatial aspects of construction activities. Therefore, to have the spatial aspects of the project, the construction planner uses two dimensional 2D drawings and associates the components of drawings with the related activities present in the schedule (Koo and Fischer, 2000); (Cherneff et al, 1991). The information such as drawings, specifications, and CPM networks or bar charts required during planning are in different forms,which makes it difficult to mentally integrate them during the planning phase. Further, there isno dynamic linkage between the CPM-based schedule

and its spatial aspects in the commercially available scheduling tools. Interpreting the schedule without any link of its activities with the spatial components is cumbersome because the actual project may contain hundreds of activities. This makes the CPM schedule difficult to check for completeness. The interpretation of the non spatial CPM schedule may vary with the experience of persons involved due to the difficulty in mentally linking each element in 2D drawing with the corresponding activities of the schedules.

1.3 RESEARCH OBJECTIVES

Successful completion of a project is possible only by the proper planning and scheduling of activities. This Successful completion of project results in overall optimization in cost and time.Construction progress of the project should be monitored at every time. Project monitoring actsas safety step in construction projects which alerts and advices the organizations about occurrence of construction failures and delays. It includes the process of collecting, analysing, and recording information regarding the project. some of the conventional methods which are widely used by the construction managers for scheduling are bar charts, critical path method, and program evaluation and review technique. Construction scheduling tools such as MicrosoftProject and PRIMAVERA are used for the preparation of construction schedule. These scheduling tools cannot be able to provide digital information (drawings) for the respective construction components and construction activities which are identified in scheduling software. For better understanding of construction sequence and for providing better visualization of the construction progress planner makes use of 2D drawings and integrates it with their corresponding component schedules in GIS software. New advancements in GIS software are use of time

component which helps planners in depicting real world components.Using 3D models and CPM schedules as inputs, linkage between the two has been made possible in GIS to develop a 4D model. GIS acts as a platform in which both spatial and non- spatial data, that is, drawing components and their activity schedules, are integrated for successful execution of the project by providing good visualization. Advanced visualization techniques such as 4D (3D geospatial + time component) and virtual reality should be utilized for more effective evaluation and communication of construction project schedule information.Therefore, it becomes easy to find errors in schedule, and small activities can also be completed without any delay. This 4D GIS view provides better visualization progress of a construction project and makes the planning sequence and execution easier to understand and allows a planner to visualize the construction process in the way it would actually be built . Comprehensibility in the project schedule will decrease the potential errors and conflicts in the schedules during the construction. Building plan with the corresponding themes related to elevation as a shape file using GIS software was connected with the schedule for construction activities developed using PRIMAVERA project planner and synchronized the same with time.

CHAPTER 2

GEOGRAPHIC INFORMATION SYSTEM

In the past fifty-five years, a host of professions have been in the process of developing automated tools for efficient storage, analysis and presentation of geographic data. These effortshave apparently been the result of increasing demands by users for the data and information ofa spatial nature. This rapidly evolving technology has come to be known as "Geographic Information Systems

(GIS)". Geographic information system goes beyond description; it also includes analysis, modelling, and prediction. According to the Environmental Systems Research Institute (ESRI), a GIS is defined as "an organized collection of computer hardware,application software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographic referenced information. (Tsung,K ,2000) describes GIS is a computer system for capturing, storing, querying, analyzingand displaying geographically referenced data. GIS is essentially a marriage between computerized mapping and database management systems. Thus, a GIS is both a database system with specific capabilities for spatially referenced data, as well as a set of operations for working with the data. Geographically referenced data separates GIS from other information systems. Let us take an example of road. To describe a road, we refer to its location and its characteristics (length, name, speed limit etc.). The location, also called geometry or shape, represents spatial data, whereas characteristics are attribute data. Thus a geographically referenced data has two components: spatial data and attribute data.

•   Spatial Data: Describes the location of spatial features, which may be discrete or continuous. Discrete features are individually distinguishable features that don't exist between observations.

•Discrete features include points (wells), lines (roads) and areas (land-use types). Continuous features are features that exist spatially between observations (elevation and precipitation).

A GIS represents these spatial features on a plane surface. This transformation involves two main issues: the spatial reference system and the data model. Attribute Data: Describes characteristics of spatial

features. For raster data, each cell value should correspond to the attribute of the spatial feature at that location. A cell is tightly bound to a cell value. For raster data, the amount of attribute data is associated with a spatial feature can vary significantly. The coordinate location of a Land parcel would be spatial data, while its characteristics, e.g. area,owner name, built-up, land use etc., would be attribute data. The GIS modelling of a real worldis being shown in the figure 2.1.
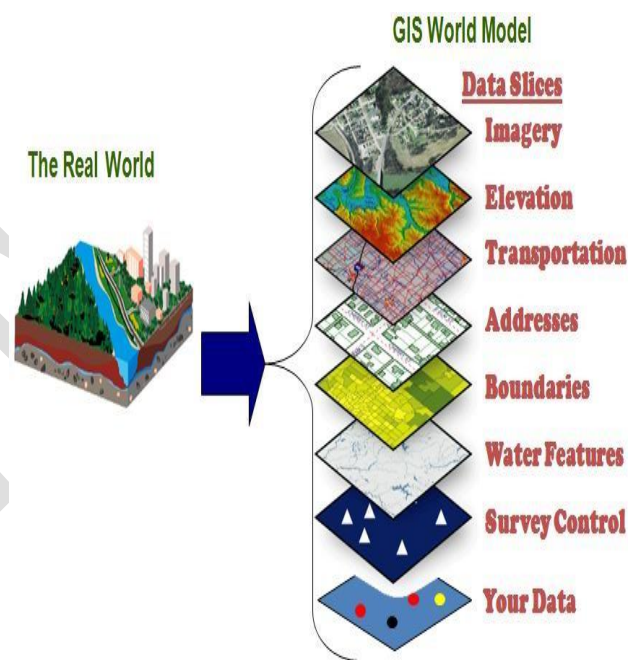

Fig.2.1 GIS real world modelling (Palve,S , 2013)

2.1   GIS Applications In Construction Management

GIS applications have proliferated in the construction industry in recent years. This fact is illustrated by the growing number of articles finding their way into civil engineering and construction journals and conference proceedings, in addition to the handful of special publicationsdevoted to GIS (Oloufa et al,1994). GIS can be used for:

•   Progress monitoring system in construction Networking solutions

    •   3-D data analysis

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• Site location and Client Distance

• Comparison of data

• Construction scheduling and progress control with 3-D visualization
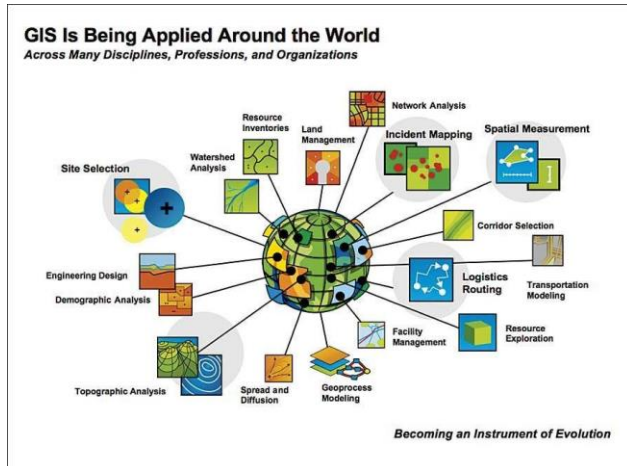
Fig.2.1 Applications Of GIS (Vijay,K ,2007)

The construction industry requires a tool that can manipulate the schedule and 3D componentsin a single environment (Koo and Fischer, 2000). GIS, which combines CAD like spatial data with a database management system, seems to have the potential to solve this problem (Chengand Yang ,2001). Several other studies also suggest the usefulness of GIS in the construction industry to handle various construction project requirements such as data management, integrating information, visualization, cost estimation, site layout, construction planning (Bansal and Pal .2006); (Miles and Ho,199)9; (Varghese and O.Connor ,1995); (Zhong et al

,2004). GIS improves the construction planning and design efficiency by integrating the spatial and nonspatial information in a single environment (Jeljeli et al ,1993); (Camp and Brown

,1993); (Oloufa et al, 1992). Despite several applications of GIS, the construction industry still depends on tools other than GIS for scheduling, as integrating GIS with project management tools such as

Primavera Project Planner and Microsoft Project is a tedious and time-consumingprocess. Keeping in view the above limitations, this study explores the potential of GIS to handle CPM basic scheduling computations and links the developed schedule with a 3D modelin the same environment.

2.2 Application Of GIS In Construction Industry

Remote sensing and GIS techniques become potential and indispensable tools for solving manyproblems of civil engineering. Remote sensing observations provides data on earth's resourcesin a spatial format, GIS correlates different kinds of spatial data and their attribute data, so as to use them in various fields of civil engineering. The examples below show the used of GIS inmany branches of civil engineering.

➢ Transportation

➢ Watershed Analysis

➢ Environment Impact Assessment

➢ Remote Sensing

➢ Urban Development

➢ Target Site Selection

➢ Landfill Site Selection

➢ Mineral mapping

➢ Pollution Monitoring

➢ Natural Hazard Assessment

➢ Resource Management

2.3 4-D GIS

A four-dimensional geographic system (4D-GIS) is

employed as both spatial and non-spatial data processing platform. 4D-GIS effectively integrates, manages, and analyses spatial information and nonspatial information, outlined as 4D information (2D, 3D, and time amendment data). 4D modelling tool is a dominant tool that provides good visualization, simulation, and communication which gives concurrent access to style and to schedule information. It provides graphical presentation of work order which enables immediate identification of issues together with interface exposure and supports situation analysis. This 4D tool helps knowledge in collaborative construction techniques, analyses and provides a mean for graphically representing the overall construction process, and facilitates all participants in project for better decision making process. This 4D planning tool also helps theplanners in reducing the schedule conflicts, analysing of constraints, and evaluating different construction ways . Visualizing construction progress in 3-dimensional view along with CPM generated schedule helps the construction manager in a project with an automatic view of project sequence. 4D visualization helps the project planners in viewing the progress of construction activities in a project at any level. The benefits of linear scheduling and 4D visualization include the ease with which different scheduling techniques are used and the linkage between activities and schedule information provides up to date information and also reduces incompleteness in information. (Bansal ,2008) makes the user observe serious risks during execution of the project. Spatial and non-spatial information related to the project is integrated in GIS platform and they are analysed, managed, and finally displayed. The spatial data means drawings which are directly related to geometry

of features of a layer in GIS. Spatial features are represented in GIS with the help of vector data and raster data models. The occurred4D GIS view provides better visualization progress of a construction project and makes the planning sequence and execution easier to understand. This 4D GIS model reduces cost overruns of the projects by early identification of problems, such as time space conflicts, safetyconcerns, and working place restrictions. Here in this project the 4D modelling is done by enabling the time component in the ArcScene. While enabling the time component in ArcScenethe respective fields must be choosed.

2.4 GIS as modelling tool

GIS uses vector data model , non-topological represented by simple graphical objects such as,point, line, and polygon to represent the spatial features. In the spatial geographic database, feature classes are logically organized as themes, where each theme is allowed to have only one type of graphical element point, line, or polygon. The ArcGIS used to create spatial data has to some extent CAD like tools to create 2D or 3D building models Arc-GIS. By integratingthe time component the 4D modelling can also be done in Arc GIS. The functions such as delete, move, cut, and paste available in Arc-GIS can be applied to one or more selected features like point, line, or polygon. For reshaping the lines and polygons, the vertex edit tool can be used. Each point, line, or polygon theme in the spatial database is stored as shapefile, where shapefile is the nontopological format for storing the geometric location and attribute information of geographic features in Arc-View or Arc-GIS. The characteristics of the spatial features are represented by nonspatial data stored in the feature attribute table of the theme in Arc-View. Each row of the table represents a feature, whereas each column represents the characteristic of

the respective feature. Sometimes storing the entire attribute information in asingle attribute table makes it difficult to maintain and update. An alternative to this is to store the attribute data in separate tables called database tables. These database tables can be managed by a database management system. The proposed methodology maintains construction resource data in such tables, so as to link them with the activities in the construction schedule.

CHAPTER 3

ARC-GIS 10.3.1 SOFTWARE

3.1 INTRODUCTION

ArcGIS is a geographic information system (GIS) for working with maps and geographic information. It is used for creating and using maps, compiling geographic data, analyzing mapped information, sharing and discovering geographic information, using maps and geographic information in a range of applications, and managing geographic information in a database. Here in this project ArcGIS of version 10.3.1 is used.

The system provides an infrastructure for making maps and geographic information available throughout an organization, across a community, and openly on the Web.

ArcGIS includes the following Windows desktop software:

- ArcReader, which allows one to view and query maps created with the other ArcGISproducts.

- ArcGIS for Desktop, which is licensed under three functionality levels :

➤ ArcGIS for Desktop Basic (formerly known as ArcView), which allows one toview spatial data, create layered maps, and perform basic spatial analysis.

➤ ArcGIS for Desktop Standard (formerly known as ArcEditor), which in additionto the functionality of

ArcView, includes more advanced tools for manipulationof shapefiles and geodatabases.

➤ ArcGIS for Desktop Advanced (formerly known as ArcInfo), which includes capabilities for data manipulation, editing, and analysis.

Arc-GIS including ArcMap, ArcCatalog, ArcToolbox, ArcScene, ArcGlobe, and ArcGIS Pro.

3.1.1 ArcMap

ArcMap is the main component of ESRI. ArcGIS suite of geospatial processing programs, andis used primarily to view, edit, create, and analyze geospatial data. ArcMap allows the user toexplore data within a data set, symbolize features accordingly, and create maps. This is done through two distinct sections of the program, the table of contents and the data frame. ArcMapusers can create and manipulate data sets to include a variety of information. For example, the

maps produced in ArcMap generally include features such as north arrows, scale bars, titles, legends, neat lines, etc. The software package includes a style-set of these features. As well asthe ability to upload numerous other reference styles to apply to any mapping functions. ArcMap is run using primarily Shape Files and in more recent versions Geodatabases can be used to store larger sets of data. These file formats are what are uploaded into the program to view spatial data. Users can also upload .dbf or database files to link important attribute information to spatial data. Comma separated values (.csv) can be used, as long as they are converted to a .dbf before upload into the program.When a map is saved a new file extension is created (.mxd). This file does not save the layers or spatial data with it, only the relative pathnames. What this means is if the data used in the map is not in the

same location as the previous time it was opened there will be an error. This assists with keeping the file small and reduces the amount of redundancy in data management. The window of ArcMap is shown in the figure 3.1.
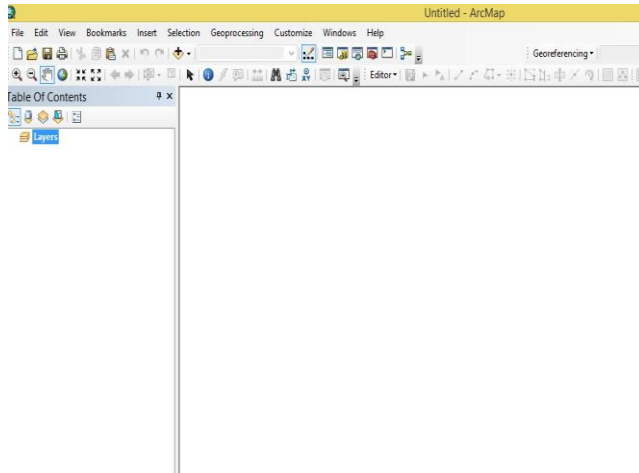
Fig.3.1 Window of ArcMap (ArcMap 10.3.1)

3.1.2 ArcScene

ArcScene is a 3D visualization application that allows you to view your GIS data in three dimensions. ArcScene allows you to overlay many layers of data in a 3D environment. When developing a 3D view, we might need to define the drawing order priority between two or more feature layers. An example would be adding building polygon and parcel polygon data, whereboth layers are rendered using filled symbols. If the drawing order priority is not set correctly,the parcel polygons could obscure the building polygons. Data can be displayed as either a floating layer or a draped layer in the 3D view. Floating layers usually define their height sourceseparately from other layers in the 3D view. Draped layers usually share the same surface dataas other layers. The drawing priority of layers becomes important in these circumstances as follows.

- Using partial transparency

- Multiple layers sharing the same 3D location

- Multiple layers draped on the same surface

Although feature layer drawing priority is supported in both ArcScene and ArcGlobe, the settings are exposed differently.

In ArcScene, both floating layers and draped layers use a layer property to define their drawingpriority. The drawing priority value ranges from 1 to 10, where 1 is the highest priority. This means that a layer with a drawing priority of 1 will obscure a layer with a drawing priority of 2, when the two layers share the same 3D location. The ArcScene window is shown in figure 3.2.
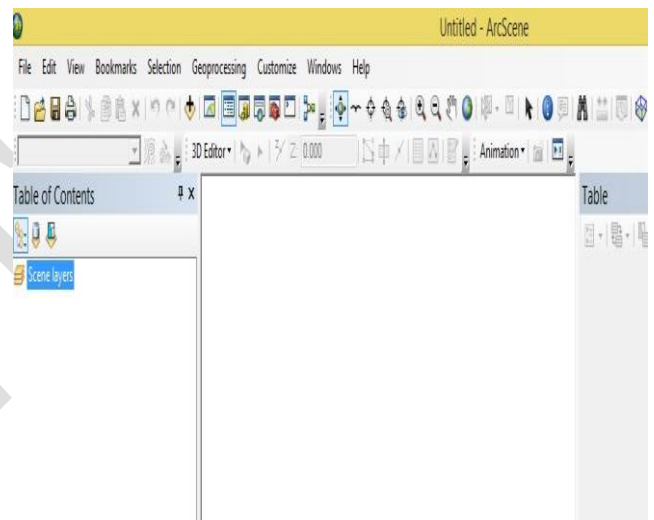
Fig.3.2 ArcScene window (ArcScene 10.3.1)

3.1.3 ArcCatalog

ArcCatalog is the data management application, used to browse datasets and files on one's computer, database, or other sources. In addition to showing what data is available, ArcCatalogalso allows users to preview the data on a map. ArcCatalog also provides the ability to view and manage metadata for spatial datasets. ArcGIS for Desktop. The kinds of information that can be organized and managed includes:

- Geodatabases

- Raster files

- Map documents, globe documents, 3D scene

documents, and layer files

- Geoprocessing toolboxes, models, and Python scripts
- GIS services published using ArcGIS for Server
- Standards-based metadata for these GIS information items

ArcCatalog organizes these contents into a tree view that you can work with to organize yourGIS datasets and ArcGIS documents, search and find information items, and to manage them.ArcCatalog presents this information in a tree view and allows you to select a GIS item, viewits properties, and to access tools to operate on the selected items. The window of ArcCatalogis shown in the figure 3.3.
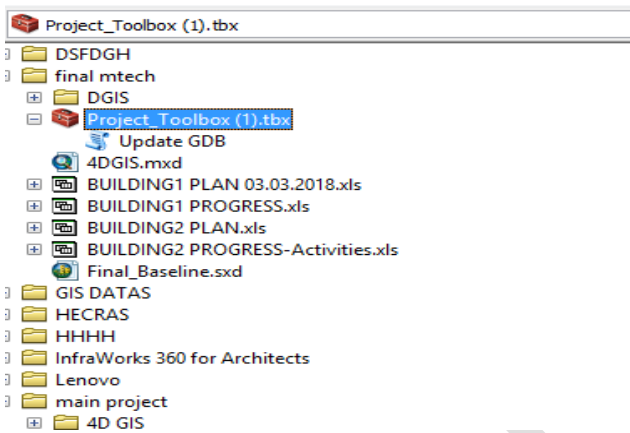
Fig.3.3 ArcCatalog window 10.3.1 (ArcCatalog 10.3.1)

3.1.4 Arc Toolbox

The ArcToolbox window is the central place where you find, manage, and execute geoprocessing tools. Tools can also be managed and executed from ArcCatalog. The ArcToolbox window contains toolboxes, which in turn contain tools and toolsets .ArcToolbox contains geoprocessing, data conversion, and analysis tools, along with much of the functionality in ArcInfo. It is also possible to use batch processing with ArcToolbox, for frequently repeated tasks. The project toolbox is shown in the figure 3.4. Thescript tool

is located inside that project tool box.
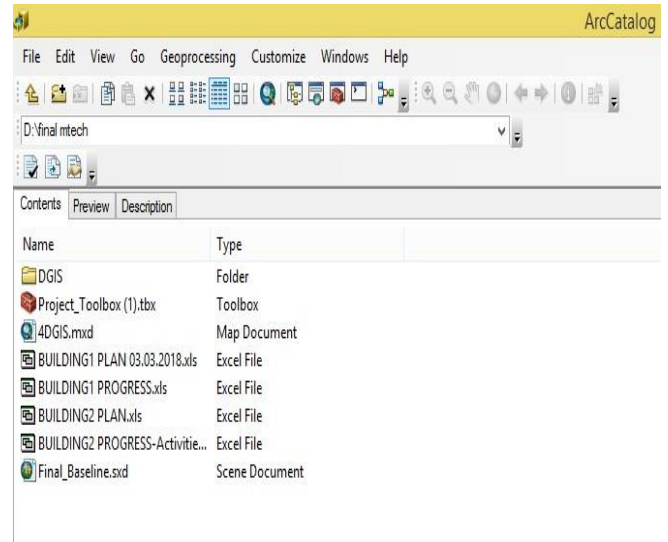
Fig.3.4 Project tool box (ArcToolbox)

CHAPTER 4

PROJECT MANAGEMENT

The term Project Management is defined as "The application of knowledge, skills, tools and techniques to project activities to meet project requirements." (PMBOK). "The planning, monitoring and control of all aspects of the project and the motivation of all those involved in it to achieve the project objectives on time and to the specified cost quality and performance." Project management processes can be organized into five groups of one or more processes eachas shown in Fig 4.1.

Initiating processes: recognizing that a project or phase should begin and committing to do. Planning processes: devising and maintaining a workable scheme to accomplish the business need that the project was undertaken to address.

Executing processes: coordinating people and other resources to carry out the plan. Controllingprocesses: ensuring that project objectives are met by monitoring and measuring progress and taking corrective action when necessary.

Closing processes: formalizing acceptance of the project or phase and bringing it to an orderlyend.
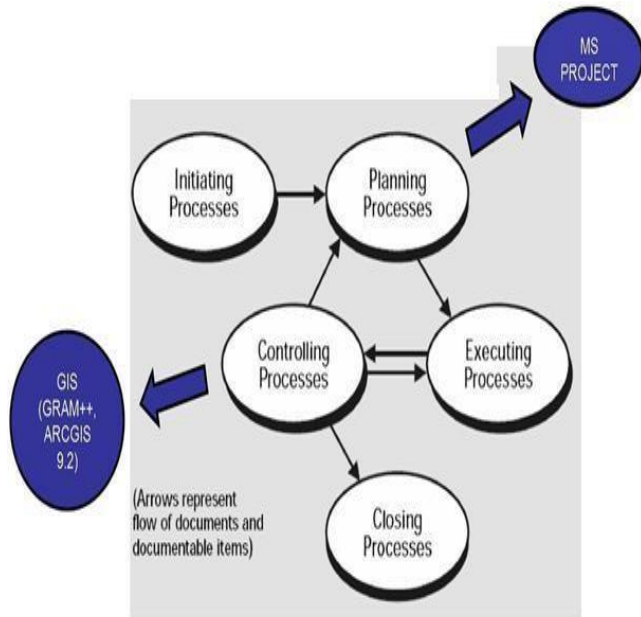
**Fig.4.1 Links among Process Groups
(Kolagotla,V ,2013)**

4.1 GIS In Project Management

GIS is a computer system for capturing, storing, quarrying, analyzing, and displaying Geographic data. GIS is a special class of information system, which can be divided into four Components involving a computer system, GIS software, human expert, and the data. GIS can be grouped into spatial data input, data management, data display, Data exploration, data analysis, and GIS modeling. GIS can handle both spatial and Attribute data, spatial data relate to the geometry of the features, while attribute data describes the characteristics of the differentfeatures and stored in the tabular form. Each Row of the table represents a feature while column represents the characteristic of features. The intersection of a column and a row show the valueof particular characteristics of a feature. In the georelational data model, split data system is used to store spatial and Attribute in separate files and linked together by the feature Identification Descriptor (ID).

These two sets of data files are synchronized so that both can bequarried, analyzed, and displayed.

4.2 Role Of GIS In Project Management

Geographical data system applications are mostly used in construction industries. The limitations of a schedule generated in PRIMAVERA and Microsoft Project forced researchersto combine it with CAD drawings which leads to 4D GIS model. However in 4Dmodel technologies number of researches are increasing rapidly. These models are not easier to use in construction industry and the visualization provided by them is not easily Customized. The 4D models in construction industry hinder the collaboration between the contractors and sub-contractors. The construction industry needs a software tool which can easily generate, manipulate, validate, and interlinks the schedules with respective 3-dimensional respective drawings in a single screen. The main role of GIS is to develop a strong GIS platform for seamless integration of databases generated across the projects with satellite imagery. This work using GIS provides 4D visualization progress of project along with scheduled quantities stored in database management. The major aim of this study is to make use of GIS for scheduling activities and interlinking it with 3D drawings provides better visualization of construction progress.

CHAPTER 5

LITERATURE REVIEW
5.1 CONSTRUCTION PROGRESS

A system called PMS-GIS (Progress Monitoring System) with Geographical Information Systems has developed (Poku and Arditi ,2011).The architectural design was executed using acomputer-aided drafting CAD program AutoCAD, that represent construction progress not onlyin terms of a CPM schedule but also

in terms of a graphical representation of the construction that is synchronized with the work schedule. The work schedule is generated using a project management software P3 and the design and schedule information including percent complete information are plugged into a GIS package ArcView-GIS, and for every update, the system produces a CPM-generated bar chart alongside a 3D rendering of the project marked for progress.

A new technology model was created eliminating data redundancy, miscommunication, and costly conversion when moving through the planning, design, construction, and operation of infrastructure data (Palve1,S ,2013). GIS provides the central data system for the process of developing and constructing infrastructure gives the engineers a common means to communicate geospatial data, maintain current data, and allow iterative design/data collection procedures without exchanging data files of differing format, version, and content. Due to superior spatial data handling capabilities, Geographic Information System (GIS) technology is increasingly being considered for implementation in many infrastructure projects. He also analysed that through the use of 3D modelling in GRAM++ GIS software, clients can experience a more interactive way of seeing data, visualizing change over time and space to identify patterns and trends, and disseminate knowledge to engineers, managers, and field basedpersonnel.

The Success of the construction is mainly due to the effective management which has effectivetime, cost and scope (Anne,T and Suchitra,L ,2017). Managing two or more projects at a singlemoment may leads to take more time, distraction and confusion which also has more planning, scheduling, monitoring and controlling. In the construction projects the activities

took place is repetitive to every project but the resources of the project changes from project to project. Themanagement software helps to planning and controlling the work that takes place. Primavera helps to schedule a project without errors and to execute and control by tracking the project during execution. This paper was about the planning and scheduling of two apartment buildingsin the software of primavera.

5.2. 4-D MODEL

4D models are useful alternative to project scheduling tools like CPM networks and bar charts (Koo and Fischer ,2000). They enable more people to understand a schedule quickly and identify potential problems. By developing a 4D model for a commercial construction project,They were able to detect the incompleteness of the original schedule, find inconsistencies in thelevel of detail among the schedule activities, and discover an impossible schedule sequence. They also anticipate potential time-space conflicts and accessibility problems. The results of the case study show that 4D models are effective in evaluating the executability of a construction schedule. The case study also highlighted the need for improvements to 4D tools.4D tools should include bar charts, component lists, and annotation tools in their graphical userinterface. Automating schedule data preparation and 4D model generation in the design stagesof a project can expedite 4D model development and use. Users need to be able to generate 4Dmodels at multiple levels of detail and generate and evaluate alternative scenarios rapidly.

The integration of GIS and project management software in the construction industry would show visualisation of construction progress with respect to time (Koo and Fischer,2000). In this integration the

drawings were drafted using a computer – aided drafting (CAD) program (AutoCAD), the construction schedule was prepared using Project Management Software (MS Project 2003), the updated schedule information (which mainly includes percent complete) which is updated in the Geodatabase (Arc Info). As the updating is being done, a custom application (.net with C# language) had been prepared to automatically update the Geodatabase. The GIS based 4D model for optimization and real time monitoring of the project was created (Nayik,G and Aditya ,2011). The factory building of CIGFIL Polymers, located at Hosakote, Bengaluru has been selected for this study and the different stages of the construction process and activities are generated. This method help the engineers, in proper visualization of the project and thereby helps in taking clear cut decision at site and reduce delay in work progress.

The use of 4-dimensional geographic information system in spatial-temporal data mining platform was created (Iwamura,K, Muro,K et.al ,2011). A techniques for integrating and analyzing spatial-temporal data are provided. First, the structures of 4D data and the essence of data integration are done. A change difference management method for historical data and the homotopical representation of complicated 3D configurations are proposed. Second, the generative aspects of 4D data integration and the real-time monitoring of an integrated database sytem The effectiveness of the system was verified by applying it to the large-scale infrastructure management of an elevated railway bridge and a sewer optical communication line**.** The 4D-GIS is also a real-time facility monitoring platform When a fiber breaks, the OTDR (Optical Time-Domain Reflectometer) outputs a distance to the break location. The 4D-GIS

identifies the location of break corresponding to this distance.

A 4D modelling of multistroied building by displaying the progress and sequence of the construction work in AutoCAD format and in 3D while synchronizing this information with primavera work schedule was developed (Vishnu , Vanreyk et.al 2015). The site for the proposed building is situated at Ponekkara, Ernakulam. This paper presents new system of planning and scheduling by creating 4D model of building using GIS software. The methodology of 4D model creation by importing AutoCAD drawings and schedule in primavera. This method help the engineers, in proper visualization of the project and thereby helps in taking clear cut decision at site and reduce delay in work progress.

5.3. GIS

A construction disaster relief plan was developed using GIS. Through this the viable application of GIS for project management and for the selection and allocation of relief measures was developed (Roozbez,K and Sani,A ,2012). The geographic information retrieved from the TIGER files is useful for developing spatial relationship between geographic entities and hence helpful for allocation of resource measures. The project identifies potential resource allocations and accessible roads network using TranCAD GIS computer program. Helps to identify the available resources which can support the decision making process in a viable manner.

The success of a construction sector fully depends on the proper management throughout the project life cycle. GIS makes the decision of management system easier by providing spatial

and attribute features together of a project (Islam,M

,2013). The objectives of this study were to investigate the extent of application of GIS in construction project management and find the potential areas of GIS application in that arena. In this regard, good numbers of published articles are reviewed and found that, construction progress monitoring, material procurement, construction vehicle, equipment and labour tracking, underground construction risk assessment etc. are efficiently managed by GIS. Finally, the study discover some potential research fields where GIS/GPS can also be applied for facilitating the construction management such as positioning heavy equipment (i.e. crane) at site, labour tracking during outside work at elevatedlevel, progress monitoring by cost analysis during construction, equipment and labor productivity analysis, risk quantifying and management.

A survey research effort was investigated and there the relationship between 11 selected Geographic Information System (GIS) functions and three (time, cost, and quality) highway and transportation construction-project success criteria (Hazar and Raja ,2013). The population included engineers and information technology professionals in the United States who workedin the highway and transportation area. It was observed that there is no significant relationship between GIS function use and construction project success criteria (time and cost) was found. The third success criterion (customers specification–quality) was not tested because of the lack of variability of the responses. It was also observed that there were significant differences between organizations that focused on highway, street, road, and public sidewalk jobs and otherconstruction organizations that focused on different construction jobs.

A Building Information Modelling (BIM) was used to create a graphical simulation of the construction process (Bansal,V.K and Pal,M ,2014). The dynamic linkage between the activities of a schedule and corresponding 3D components in GIS has been established. This link makes it possible to detect incompleteness and logical errors in a project schedule. scheduling and linking its activities with the corresponding components of a 3D model have been developed. The dynamic linkage between the activities of a schedule and corresponding 3D components in GIS has been established. This link makes it possible to detect incompleteness and logical errors in a project schedule. GIS allows planners to understand a schedule quickly by viewing its buildability on a computer screen.The database management capabilities of GIS have also been utilised to maintain and update the construction resource database.

The GIS technologies have the potential to solve space related problems of construction involving, integration of information, urban planning, and project site selection, soil studies, Hydrology and environmental studies. Proper use for these tools necessitates training the GIS techniques (Maisuria and Rathod ,2015). In the construction industry all layout plans and paperwork design come into existence in the real world. The GIS helps the professionals to understand the site conditions that affect the schedule baseline and cost baseline. To keep the construction within budget and schedule GIS guides us about how to utilize our resources on site efficiency by timely usage of construction equipments, working hours etc. The relationship between 11 selected Geographic information System functions and the three highway and transportation construction-project success criteria of time, cost, and quality was developed (Altuwaijri,H

,2016). The study's population included engineers and information technology professionals in the United States who worked in the highway and transportation area. No significant relationship was found between use of the Geographic Information Systemfunctions and the construction-project success criteria of time and cost. The third success criterion of quality (customers' specifications) was not tested because of the lack of variabilityof the responses. No significant relationship was found between use of the GeographicInformation System functions and the construction-project success criteria of time and cost. The third success criterion of quality (customers' specifications) was not tested because of thelack of variability of the responses.

5.2. PLANNING AND SCHEDULING
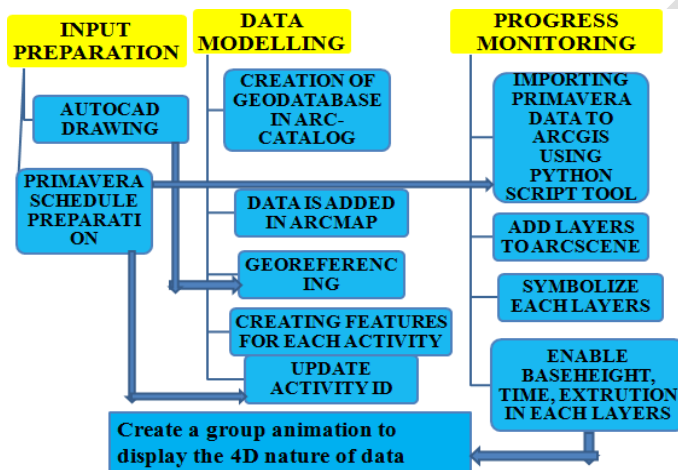
A Model is prepared which can be used in planning, tracking, optimizing & managing flyover projects (Velani1,N and Shah,D ,2017). A Comparative statements showing delay, cost overrun, improper utilization of resources (Manpower, Material Machine), utilization, lack of application of planning tools etc. Microsoft Project is a software application sold by Microsoftthat provides project management tools to manage projects. The program, which has many different versions, allows users to: Understand and control project schedules and finances. Communicate

and present project information. Organize work and people to make sure that projects are completed on schedule. Proper planning and scheduling is very important in construction projects for reducing and controlling delays of the project. Substantial amounts of time, money, resources are wasted each year in a construction industry due to improper planning and scheduling (Ahmed,A ,2016)

. Providing good planning, proper organization, sufficient flow of resources to a project cannot automatically achieve desired result. A warning mechanism must be present which can alert the organization about its possible success and failures throughout the project. The main objectivesof this study are to plan, schedule a Residential project with help of primavera software, studythe results generated, it is possible to suggest which method is suitable for the selected residential Building project.

6. METHODOLOGY USED IN THE PROJECT

6.1 INTRODUCTION

The methodology which is being used in this project consisting of three stages namely input preparation, data modelling and progress monitoring. The flow diagram of the methodology isbeing shown in the below flowchart.

6.2 STEPS INVOLVED IN THE METHODOLOGY

6.2.1 Input Preparation

The input preparations include the AutoCAD drawing and Primavera scheduling preparations. In the AutoCAD preparation, the drawings of each layer (activities) are drawn. Two project located at different spatial locations are considered hence separately each layer of both buildings should be prepared. The Primavera scheduling of both plan and progress for

both project is also prepared in Primavera P6 software.

(i) Auto CAD Drawing Of Excavation Plan

The excavation with 75 cm depth and 80 cm width

plan is drawn in Auto CAD 2017software.

Fig.6.1 AutoCAD drawing of the excavation plan

(Auto CAD 2017)

(ii) Auto CAD Drawing Of The Plain Cement Concrete Layer Plan
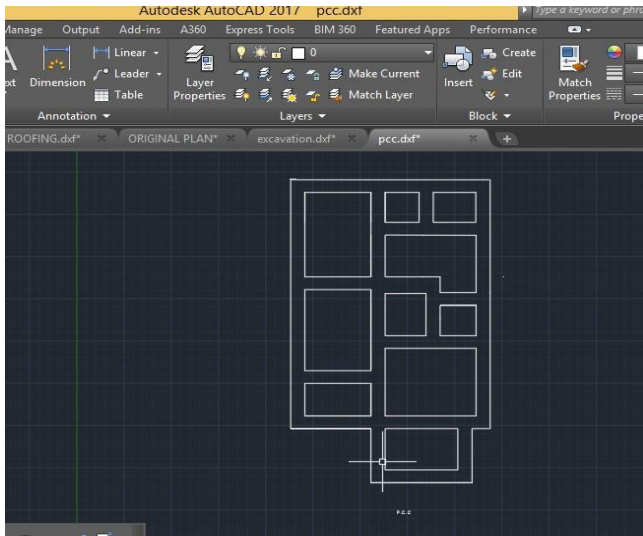
Figure 6.2 shows the plan of the Plain Cement Concrete with 75 cm width and at a depth of 10cm.
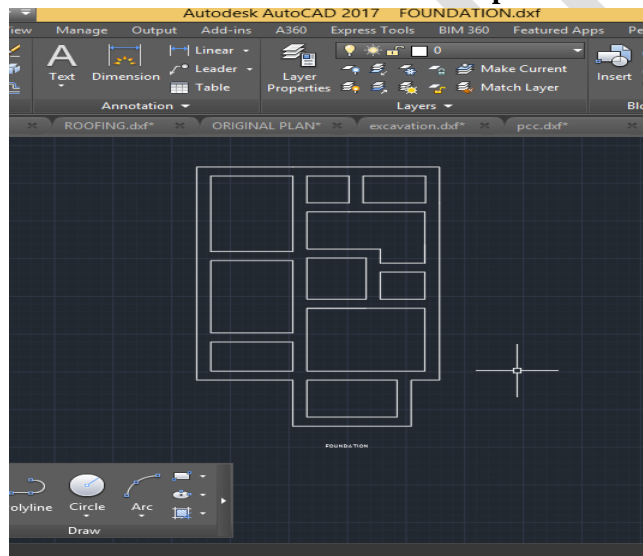
Fig.6.2 Auto CAD drawing of the P.C.C plan (Auto CAD 2017)

(iii) AutoCAD Drawing Of The Foundation Layer Plan
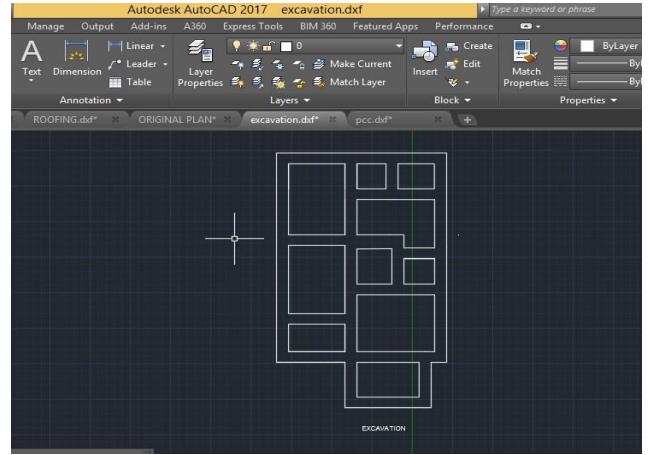
Figure 6.3 shows the AutoCAD drawing of the foundation layer with a width of 60 cm and ata depth of 45 cm.
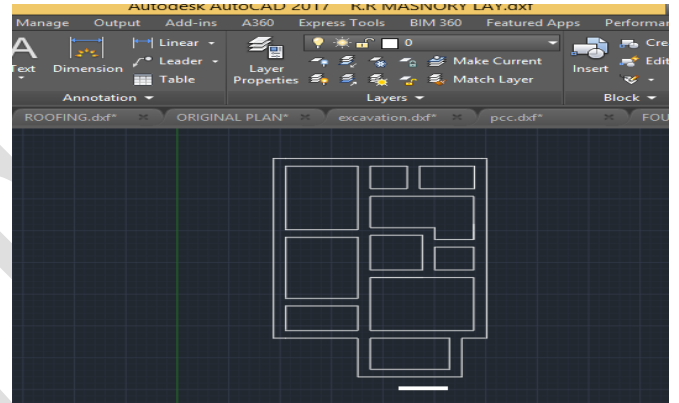
Fig.6.3 Auto CAD drawing of the Foundation plan (Auto CAD 2017)

(iv) Auto Cad Drawing Of The R.R Masonry Layer

The figure 6.4 shows the AutoCAD drawing of the random rubble masonry layer plan with45 cm width and 45 cm depth.
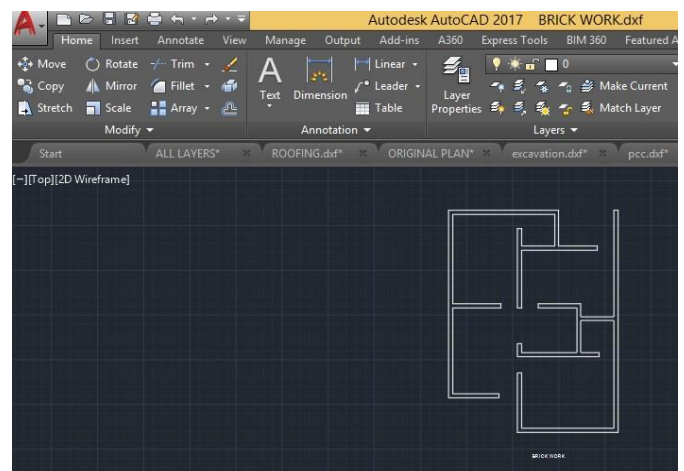
Fig.6.4 Auto CAD drawing of the R.R Masonry plan (Auto CAD 2017)

(v) Auto CAD Drawing Of The Brick Work Layer Plan

Figure 6.5 shows the plan of the brick work at a thickness of 23 cm at a height of 300 cm.
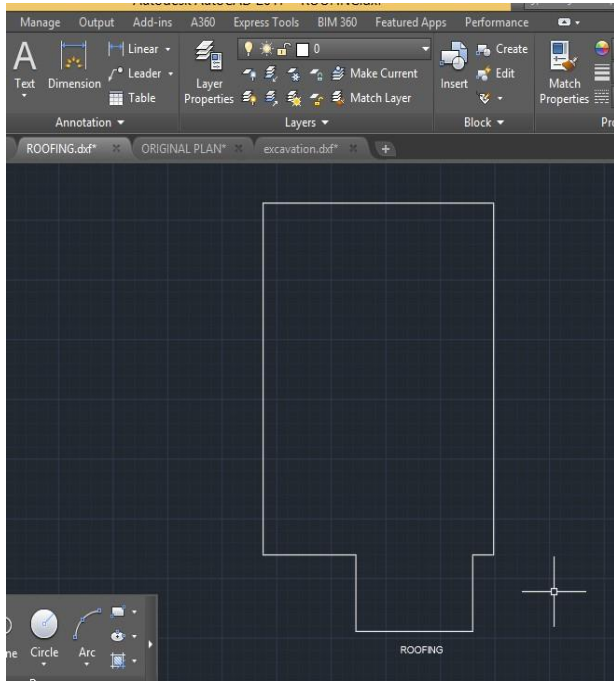
Fig.6.5 Auto CAD drawing of the Brick Work plan (Auto CAD 2017)

(vi) Auto Cad Drawing Of The Roofing Layer Plan

Figure 6.6 shows the plan of roofing in Auto CAD drawing.Fig.6.6 Auto CAD drawing of the Roofing plan (Auto CAD 2017)

(vii) Primavera Scheduling Preparations

By using Primavera P6 software the scheduling of the project is being done. This is then integrated with the Arc-GIS software , so that all the parties involved in the construction project(especially for decision making) would be able to see all the spatial aspects of project in one system. Figure 6.7 shows the Primavera Project Schedule of the project. The schedules are prepared for both plan and progress for both buildings located at different spatial locations.
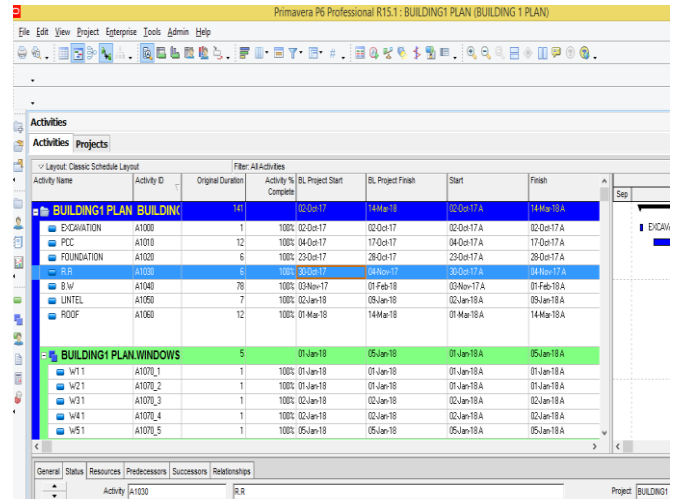
Fig.6.7 Plan data schedule of project 1 (Primavera P6)

The progress data of the project 1 is also prepared in P6 software is being shown in the belowfigure 6.8.
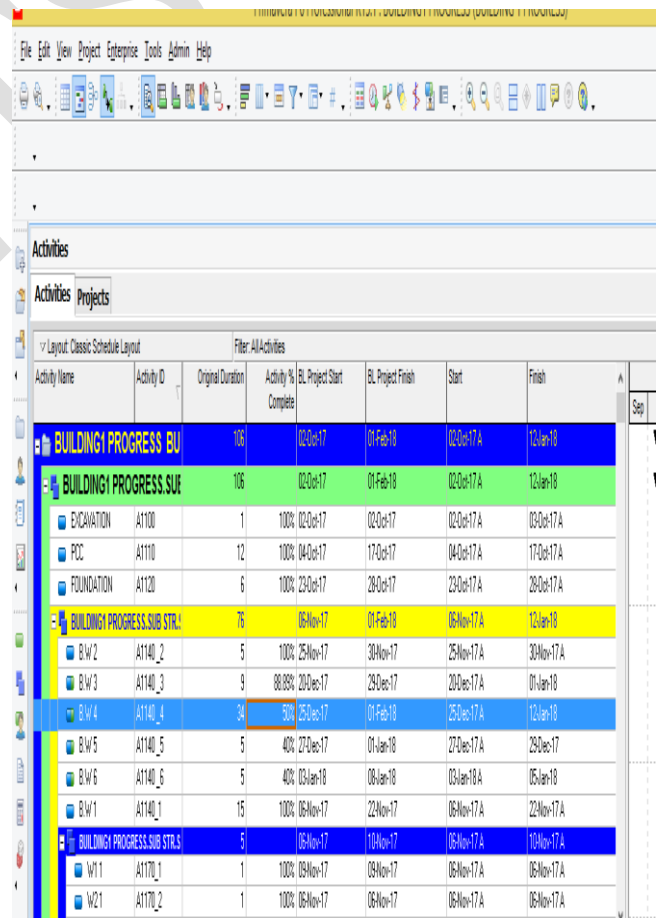
Fig.6.8 Progress data schedule of project 1 (Primavera P6)

Similarly the plan and progress data of project 2 is also prepared . Figure 6.9 and figure 6.10shows the plan and progress of project 2 .

Fig.6.9 Plan data schedule of project 2
(Primavera P6)

Fig.6.10 Progress data schedule of project 2
(Primavera P6)

6.2.2 DATA MODELING

Data modeling is a process of migrating the input collected from Auto-cad files and primavera to GIS platform**.**

(i) Creation Of Geodatabase In ArcCatalog

The geodatabase is created in the Arc catalog, a module of Arc GIS. The feature dataset andfeature classes are then created inside the geodatabase. The geodatabase is

saved as gdb fileformat. The geodatabase creation is shown in the figure 6.11.
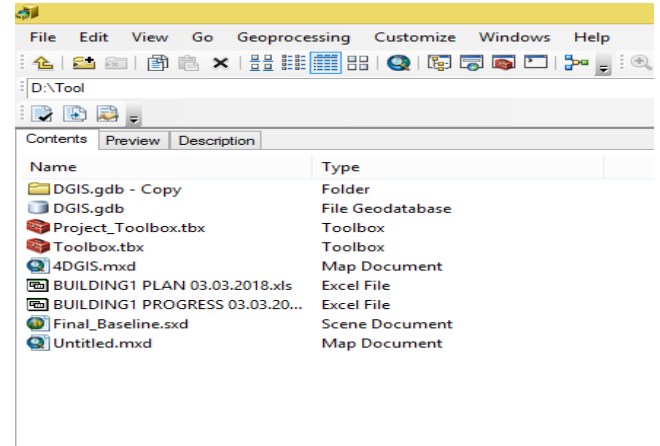
Fig. 6.11 Creation of Geo-database (ArcCatalog 10.3.1)

(ii) Feature Extrusion

In Arc-map open geo-database and feature classes (layers) is added .The feature classes under the construction and construction progress feature data set is added and these are grouped according to their data set. Then the input cad files is added to arc map Using the geo- referencing the added cad files is projected to the desired location.
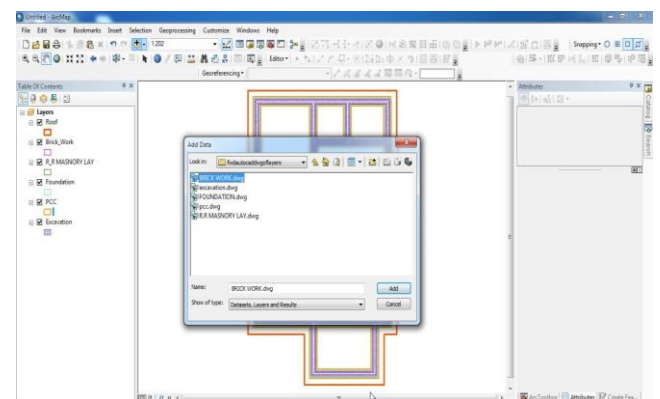
Fig.6.12 Adding layers (Arc map 10.3.1)

By choosing the add data option in the menu bar the feature classes (layers) under the construction and construction progress feature dataset are added and grouped. The groupedlayers are shown the figure 6.13.
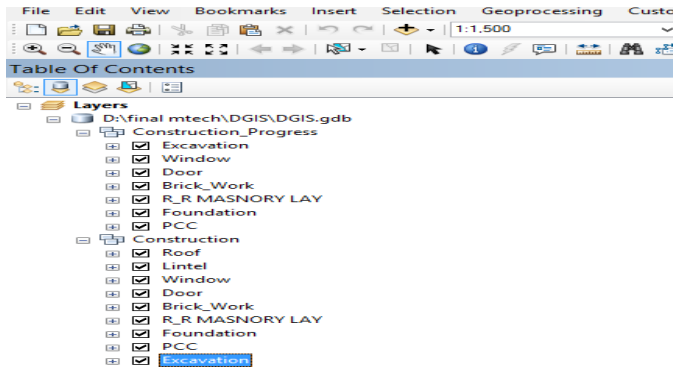
Fig.6.13 Groupe Layers (ArcMap 10.3.1)

(iii) Georeferencing

Georeferencing is the process of assigning real-world coordinates to each pixel of the raster. Many times these coordinates are obtained by doing field surveys - collecting coordinates with a GPS device for few easily identifiable features in the image or map. The purpose of georeferencing is to turn nonspatial imagery, such as historical air photos or maps, into spatial raster data for use in a variety of circumstances. Spatialized air photos, for example, can be used for GIS land cover analysis or to use as a baselayer on a mobile device while in the field. Here after importing all the layers it is then georeferenced. The georeferencing image is being shown in the figure 6.14.

Fig.6.14 Georeferencing Window (Arc-map

10.3.1)

The georeferencing stages are being shown in the below figures 6.15, figure 6.16, figure 6.17.
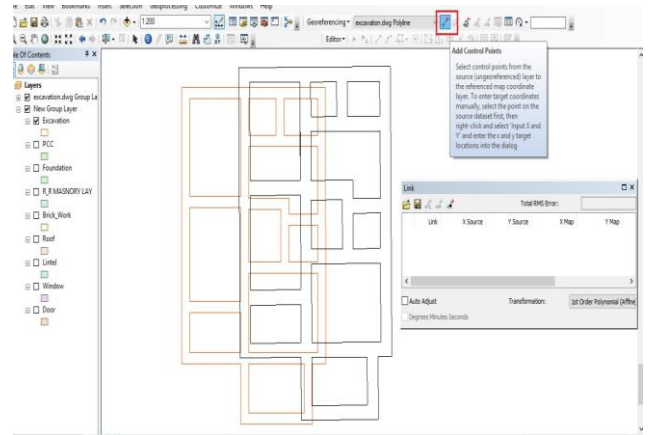
Fig. 6.15 Georeferencing stage 1 (Arc Map)
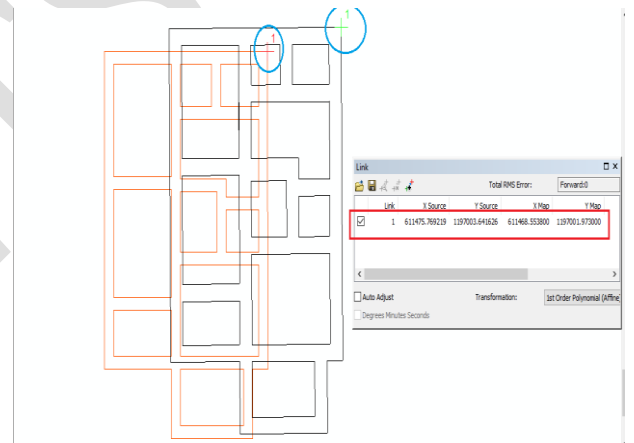
Fig. 6.16 Georeferencing stage 2 (ArcMap 10.3.1)
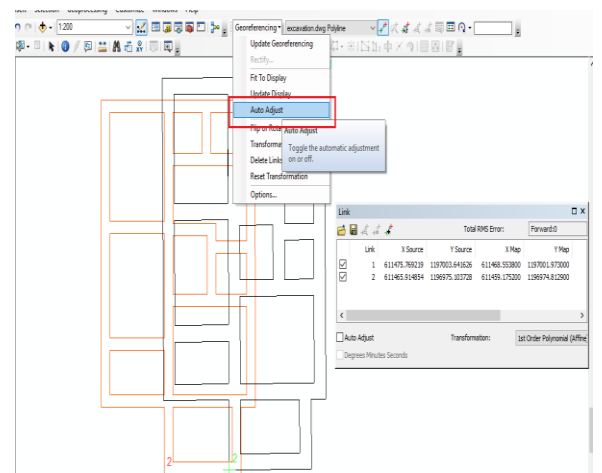
Fig. 6.17 Georeferencing stage 3 (ArcMap 10.3.1)
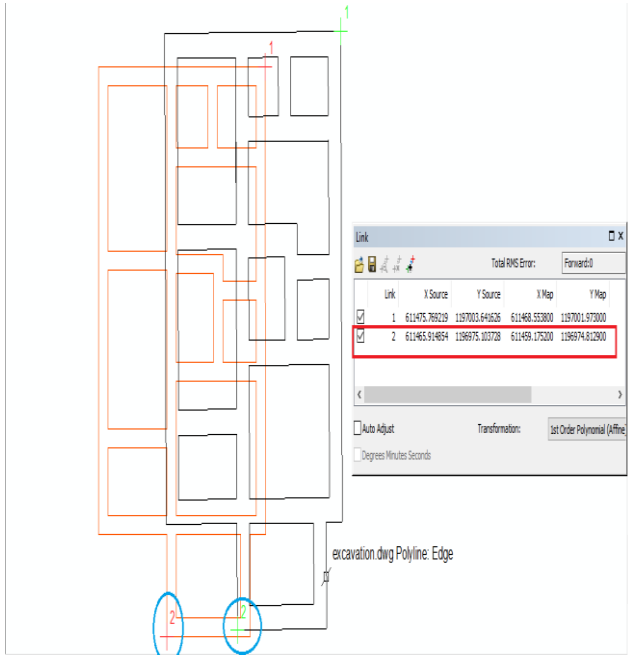
Fig. 6.18 Georeferencing stage 3 (Arc Map 10.3.1)

Fig.6.18 Final Data view (ArcMap 10.3.1)

Both plan and progress of both projects are geo referenced. Th plan and progreess view ofproject 1 is being shown in figure 6.19.

Fig.6.19 Arc map view of plan and progress of project 1 (ArcMap 10.3.1)

The arc map view of both plan and progress of both buildings is shown inn below figure 6.20.
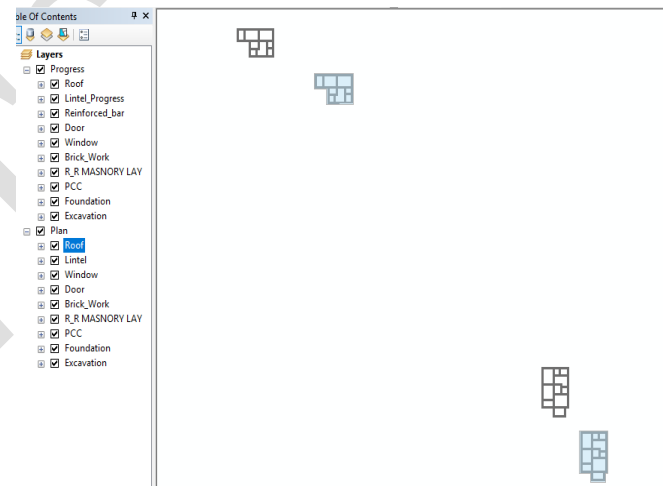
Fig.6.20 Arc map view of plan and progress of both projects (ArcMap 10.3.1)

(iv) Integrating Primavera with GIS

A python script tool is used to read relevant data from primavera. The parameters are created with in the script tool and the data are then updated in to the features based on their activity Id. With the help of different editing and geo-processing tools the features are extracted to differentlayers based on the input cad files . The features are modified and each features is assigned itsunique activity Id as given in primavera . The Python script tool coding is being shown in the below figure 6.21.

Fig.6.21 Python script tool coding (Python IDLE)

This python file is then saved in Arc catalog as script

tool . The scsript tool inside the projecttoolbox of Arc

catalog is shown in the figure 6.22
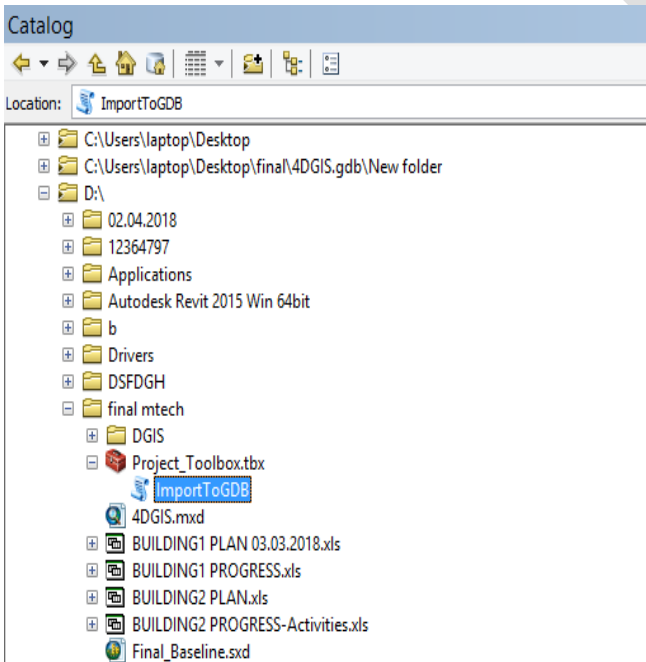
Fig.6.22 Script tool (ArcToolbox)

The script tool (Import To GDB) is then should be

runned and the attribute fields of both plan and

progress of both projects must be done. The running

of the python script tool is being shown n the figure

6.23.
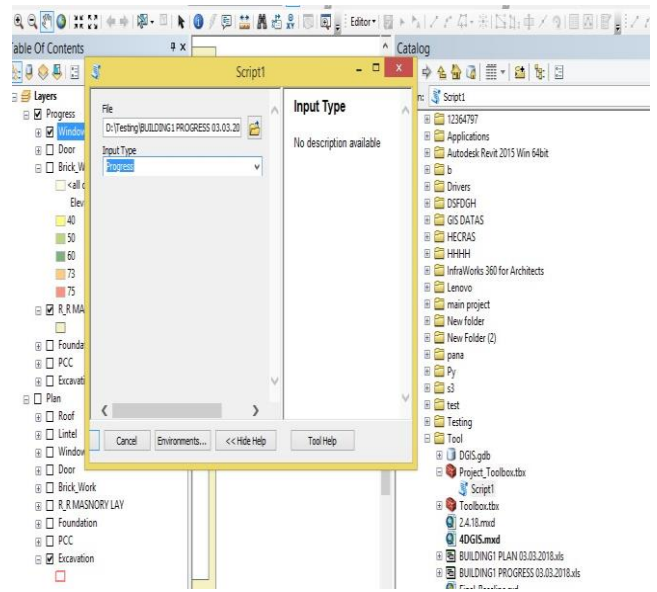
Fig.6.23 Running of a Python Script tool (ArcMap 10.3.1)
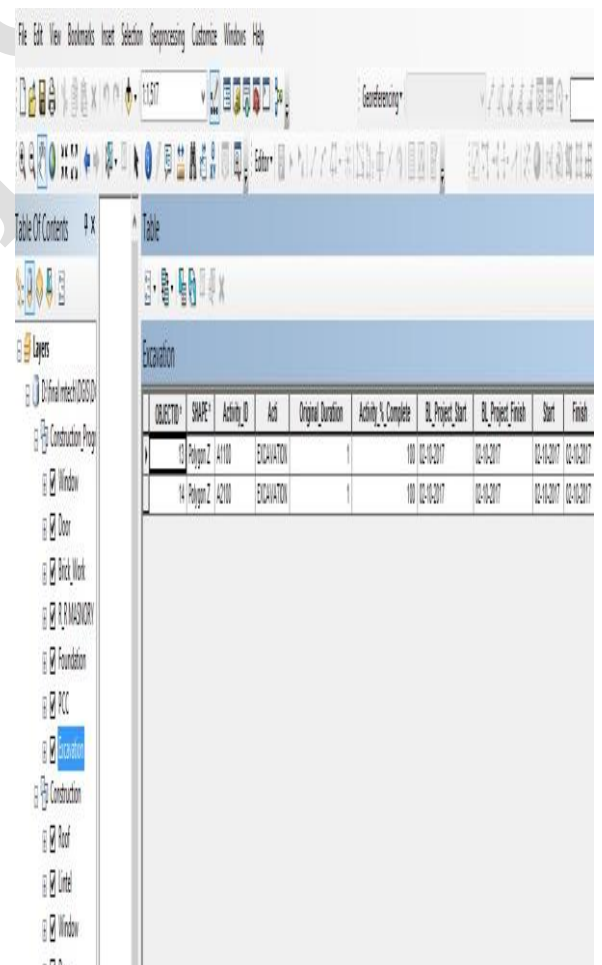
Fig.6.24 successful running of python import tool (ArcMap 10.3.1)

Fig.6.25 Attribute table of excavation after running tool (ArcMap 10.3.1)

Fig.6.25 Attribute table of brick work after running tool (ArcMap 10.3.1)

Fig.6.25 Attribute table of R.R masonryafter running tool (ArcMap 10.3.1)

6.2.3 Progress Monitoring

The progress monitoring is done by Opening ArcScene then the feature classes under the construction and construction progress feature data set is added.The adding of these featureclasses is shown in figure 6.26.
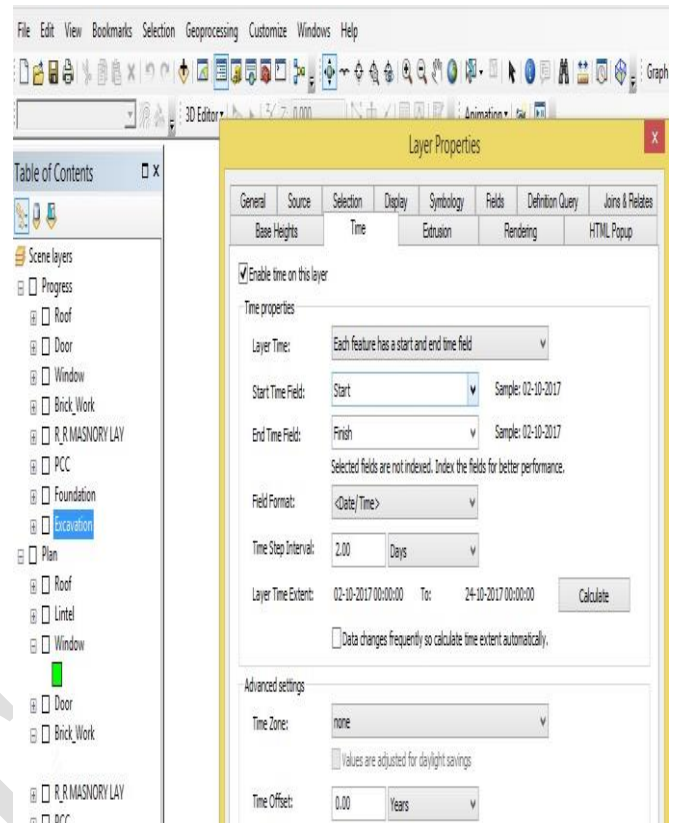

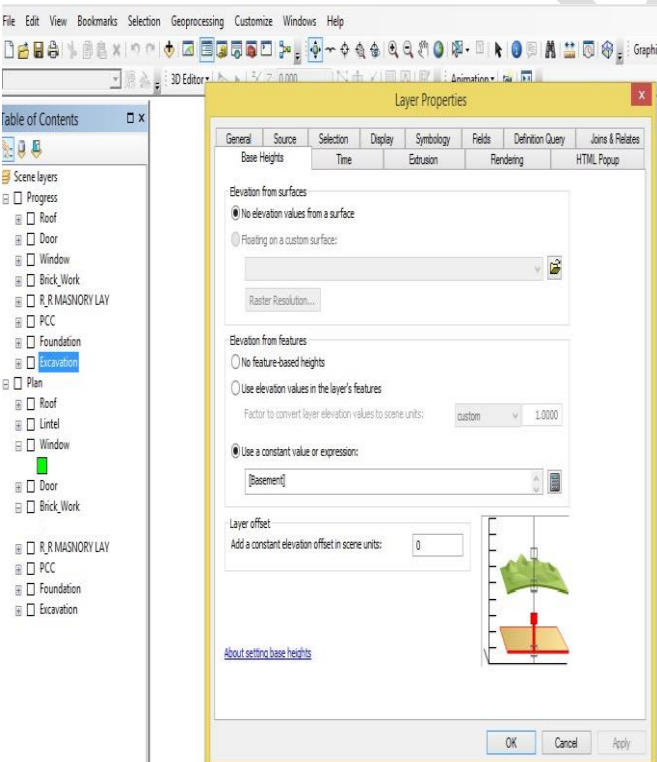**Fig.6.26 Adding feature class in ArcScene (ArcScene 10.3.1)**

These are grouped according to their data set and different symbologies are assigned to each features classes (layers) and the properties like extrusion, base-height and time are enabled foreach feature classes.
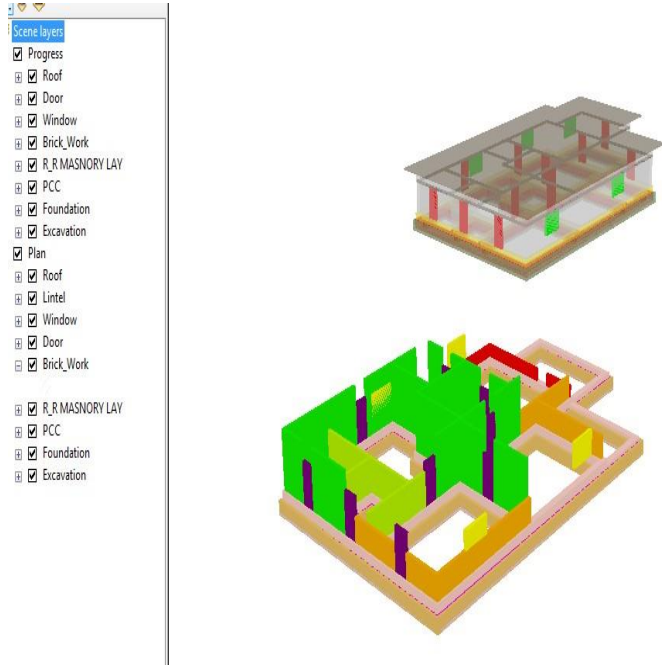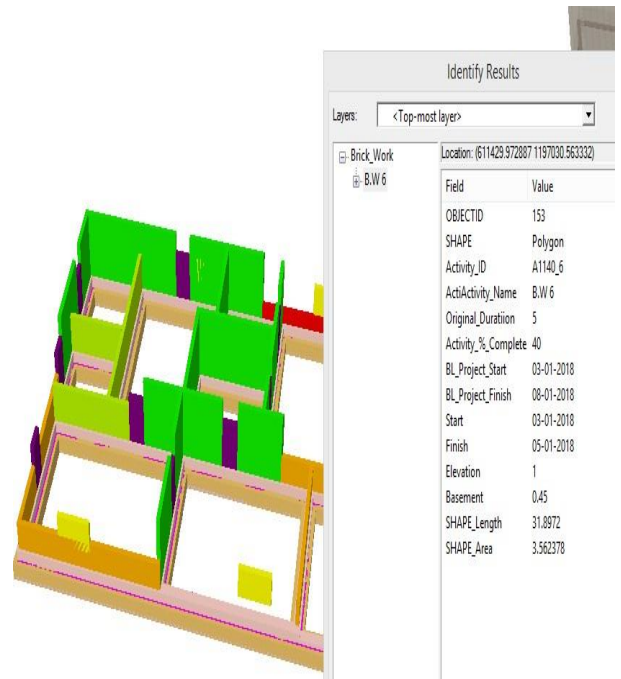
Fig.6.27 Enabling extrusion (ArcScene 10.3.1)
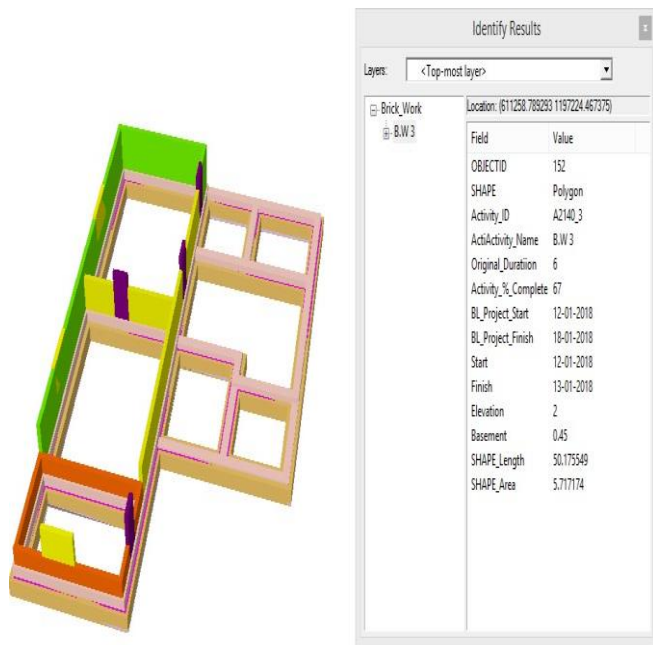
Fig.6.27 Enabling time component (ArcScene 10.3.1)

FINAL OUTPUT

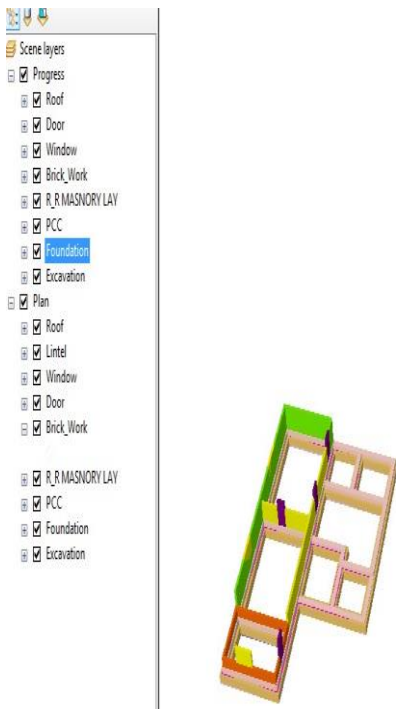**Fig.6.27 Enabling baseheight (ArcScene 10.3.1)**

Fig.7.1 4D view of project 1

Fig.7.2 Updated progress view of project 1
(ArcScene 10.3.1)

Views obtained in google earth while integrating ArcScene with google earth hence to showthe exact spatial location is shown in below figures.
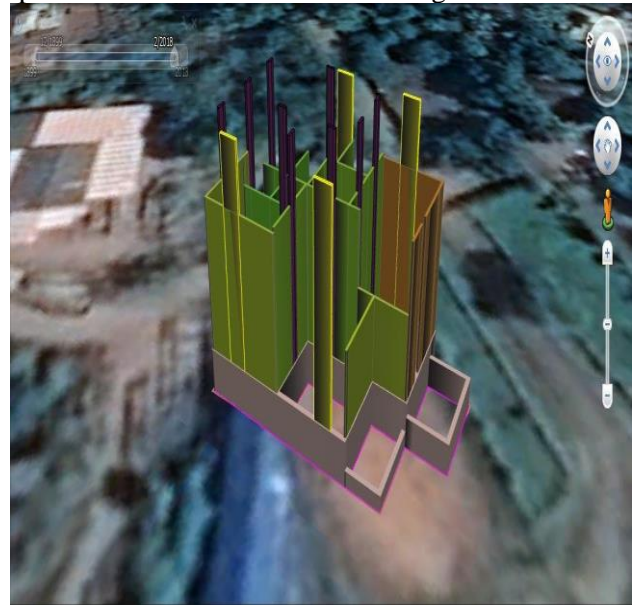
Fig.7.5 Google earth image of project 1
(Google Earth Pro)

Fig.7.3 4D view of project 2
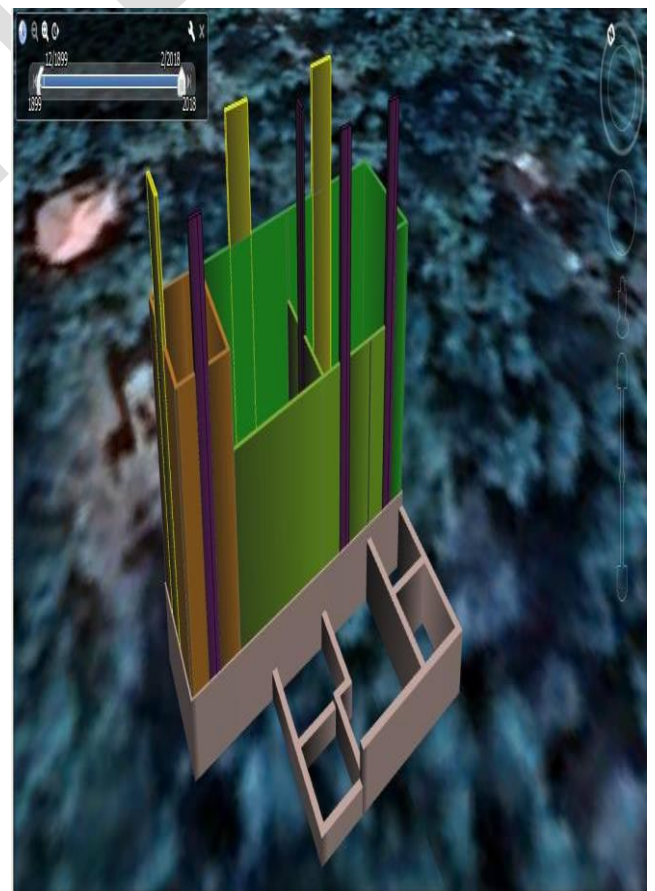
Fig.7.6 Google earth image of project 2
(Google Earth Pro)

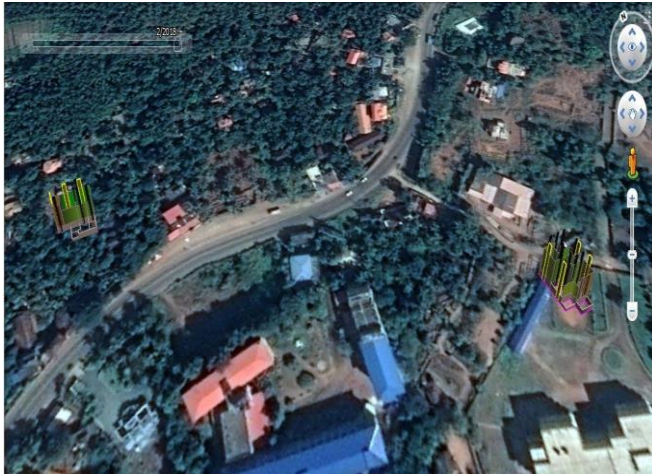**Fig.7.4 Updated progress view of project 2**
(ArcScene 10.3.1)

**Fig.7.7 Google earth image of both projects
(Google Earth Pro)**

CONCLUSIONS

Using GIS technology we can easily interpret the progress of construction activities. The different stages of the construction activities can be easily analyzed from the final view. Hence the integration of GIS with project management helps all the members including in the projectcould able to visualize the construction activities and also helps in proper decision making.

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