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Project Management using BIM

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***Abstract* – Planning and scheduling are important task in construction projects. In this project, 3D model was made using Revit, AutoCAD was used for 2D drawing, scheduling was done using Microsoft project, detection and elimination of clashes was done using Navisworks. For planning and scheduling work huge amount of paperwork is required, which makes the management very burdensome. These problems can be solved using project management software's which helps to give a planned approach to planning. This analysis was done because of their comparable technical features and to evaluate on the basis of the function to manage the project. Each software had many benefits; in this project we have used software's such as Revit, Navisworks, Primavera, AutoCAD, Microsoft project. In this study, a case of a railway wagon repair work shop has been taken to display how proper planning and scheduling is done.**

***Keywords* – BIM, Revit, AutoCAD, Navisworks Manage, MS Project .**

I. INTRODUCTION

The project "Project Management using BIM" aims at the use of 4D simulation to support construction planning and assess the viability of construction schedule and workflow. This has been done by the use of computer aided software's, wherein we prepared 3D BIM model of the proposed construction and detected and resolved clashes beforehand its actual occurrence on site.
This project aims to study different aspects of 4D technology and to find out its impact on the construction planning process, and how to benefit most from this technology. A thorough literature review was conducted and the project performance was analyzed to determine the benefits and limitations of 4D modeling on the construction planning process. 4D modeling allows the simulation and evaluation of the planned construction schedule. This BIM-centric 4D modeling approach towards project management technique has a very high potential to improve the project management and delivery of construction project, of any size or complexity.
The Indian construction industry has experienced a relatively slow progress and gradual decrease in productivity in relation to complex projects. Hence it always faces the problem of not being able to complete projects on time. The main causes of the lack of progress of the construction industry are related to its conventional construction project management approach, use of 2D Computer Aided Design (CAD) technology.
Current planning processes in the construction industry in India are still mainly based on two dimensional (2D) drawings. The use of these traditional two-dimensional CAD drawings lacks a collaborative approach. These drawings are not integrated and usually pose conflicts of information which result in errors, complexities and delays.
Moreover, the 2D CAD approach does not promote the integration of the drawings with schedule and cost. This indicates that construction industry is lacking in adopting the right kind of technology which will be responsible for increased productivity as well as reduced project time line.
Construction industry has come to a point to realize the true benefits of technological advancement; Adoption of BIM is one such example.

A typical construction schedule is a complicated chart or network which consists of activities and the time needed to deliver those activities. Traditional procedures are time consuming and would lead to a high potential of errors due to the manual data collection. For field person while executing or communicating construction sequence he must mentally link this schedule information with physical building and it may be difficult when there is any change which affects the overall sequence of construction of project. CPM schedule is confusing and not easy to understand when there is complex project and more efforts consumed to replan and redraw network each time when it gets updated. Need for better visualization of construction work, better communication among project teams and increased planning efficiency.

Project is an activity to meet the creation of unique product or service and thus activities are undertaken to accomplish routine activities cannot be considered as project. The completion time for a unique endeavor can vary from a few hours to many years, and the cost can change from low to very high. Each project has a specified mission or a purpose to be achieved. It ceases

after the mission is accomplished. A construction project mission is to create desired facilities like a housing complex or a fertilizer plant with predetermined performance objectives defined in terms of quality specification, completion time, budgeted costs and other specified constraints. Project management is the discipline of initiating, planning, executing, controlling, and closing the work of a team to achieve specific goals and meet specific success criteria. A project is a temporary endeavor designed to produce a unique product, service or result with a defined beginning and end undertaken to meet unique goals and objectives, typically to bring about beneficial change or added value. Construction planning is a fundamental and challenging activity in management and execution of construction projects. It includes the selection of technology, the definition of work task, the estimation of required duration and resources of individual task, and identify the interactions between different work tasks. A good construction plan is the base for developing the schedule and the budget for work.

II. PROPOSED METHODOLOGY

The methodology used in this project is divided into 3 main phases. First the 2D drawings of the railway wagon repair workshop were converted into 3D model. Then from the 3D models roadwork, drainage, water supply pipelines were analyzed with all their details, and finally clashes that were present in these three components were resolved.

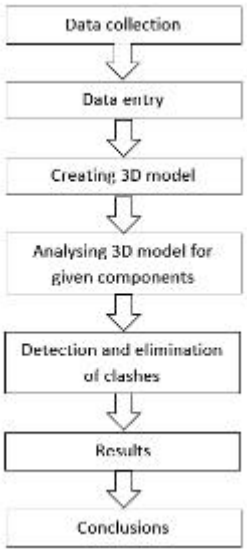

Fig.1. Research Methodology Chart.

III. LITERATURE REVIEW

Construction industry is the vital industry in the developing countries like India, as it contributes to the socio-economic development of country. Project cost and time is the critical factor in construction industry as its overrun /under run impact the total project duration and cost. So, main preference wants to give for cost & schedule. As a developing country so much competition is there in market, for a construction sector in order to sustain in the market we have to follow the promise was given to the client & customers of the completion of the project on the time and within the budget. We have to think and do our work in a more sustainable way. From this software package we will get know the performance of project better. As a construction industry is vulnerable to uncertainties, we have to manage a project in good aspects. This project report indicates significance, execution and particular components of clash detection and elimination & eventually brings about efficiency in the project execution.

Current techniques used to manage the design, planning and construction processes of a facility employ software tools that abstract the processes and reduce a complex building cycle to a Gantt chart or CPM schedule. This abstraction represents a best effort to communicate a progression of linked activities over time. The hurdles of transforming two-dimensional drawings to reality are cleared by a separate exercise featuring scale models and successive levels of detailed drawings.

A strong need still exists for a comprehensive tool which allows architects, engineers and contractors to simulate and visualize construction sequences as part of an interactive experience. The 4D model provides the basis for a common language between all parties and a representation of the schedule itself. Design and construction planning alternatives can be assessed realistically within the context of space and time. Simultaneously modeling both the temporal and spatial aspects of construction intent can optimize and justify the decisions involved in the planning and design of projects.

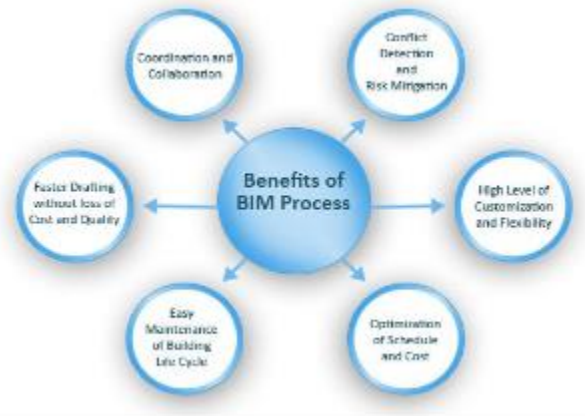

Fig.2. Benefits of BIM Process.

Five-dimensional computer-aided drawings (4D-CAD) are breakthrough advancements in the way scheduling and budgeting is now done. 4D-CAD models are 3D Models of a project linked with schedule and budget. To create 4D-CAD models a 3D model is created first. Many

software applications are available to create 3D model of a project such as AutoCAD, Autodesk Revit, Google SketchUp. The model and the schedule are then linked using a third-party application which provides a visual simulation of the building construction process. Some of the software applications available for 4D Simulation are Autodesk Navisworks, Synchro 4D, Autodesk BIM 360. But these software applications require a schedule for visualization of the project and do not reduce the tedious time-consuming manual work of entering data.

Using the Autodesk Revit platform in combination with Autodesk Navisworks Manage creates a workflow that enables project teams to effectively plan construction operations, identify potential problems, and explore and evaluate alternatives. Using these tools, construction planners can simulate planned sequences of construction activities, identify clashes and interference problems, find opportunities for improving construction schedules, track materials and manage the supply chain, and much more.

Some suggested application of BIM for construction planninginclude: .

4D Modeling-simulating the planning sequence of construction activities and space requirements on a building site. 4D modeling provides a powerful visualization and communication tool that gives project teams (including owners and building users) a better understanding of project milestones and construction plans. 4D simulation can help teams identify problems well in advance of construction activities, when they are much easier and less costly to resolve.

4D models can also use to plan the phased occupancy in a renovation, retrofit, addition. Creating dynamic phasing plans of occupancy enables multiple options and solutions to space conflicts to be considered and evaluated.

Site Utilization Planning-using BIM models to evaluate the locations of both permanent and temporary facilities on site during multiple phases of the construction process. BIM models can be linked with construction activity schedules to explore space and sequencing requirements. Additional information describing equipment locations and materials staging areas can be integrated into the project model to facilitate and support site management decisions, enabling project teams to effectively generate and evaluate layouts for temporary facilities, assembly areas, and material deliveries for all phases of construction

3D Coordination and Clash Detection-identifying potential conflicts by comparing 3D models of all building systems. The goal of clash detection is to reduce and eliminate field conflicts, which in turn reduces RFI's, reduces construction cost, and increases productivity on site. Identifying Time-Based Clashes-verifying the planned sequence of construction operations on constrained sites to confirm that the demolition, permanent construction, and temporary construction activities can occur without creating conflicts.

Time-based clash testing provides valuable insights for construction planners as they coordinate the trades, materials, and equipment that must coexist in the limited space available. Construction planning models can be integrated with the composite project model and linked to the project timeline to consider the impact of temporary items (such as work packages, formwork, cranes, installations, and so on) and check for potential time-based clashes.

Construction System Design (Virtual Mockups) - creating a model to design and analyze the construction of a complex building system (for example, formwork, glazing, tie-backs, and so on) to support detailed construction planning. Creating virtual mockups of a construction system design can increase the constructability of a complex building system and construction productivity on site by effectively planning and communicating the complexities of the process to all participants.

Materials Planning and Management-using 4D modeling and links between the building elements in the project model and the associated task schedule to forecast the dates when elements are needed on site for installation. Parameters can be added to the elements in the project model to track their ordering and delivery status and manage the supply chain for materials needed on site.

Advantages of 4D simulation:

The ability to forecast and anticipate problems before they occur is essential for effective project management. When the cost of schedule delays or construction rework because of errors is considered, it is clear that project managers need to carefully plan and orchestrate construction operations down to the last detail, both in space and time. Traditional scheduling methods do not address the spatial aspect to the construction activities nor are they directly linked to a design or building model. Traditional bar charts or Critical Path Method network diagrams can be difficult to understand or interpret. Having the ability to watch the elements of a design come together onscreen gives the design and construction team improved accuracy in construction sequencing.

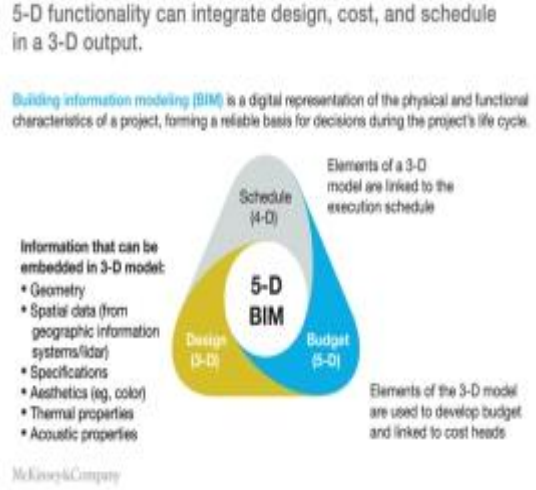

Fig.3. 5D BIM functionality.

IV. SYSTEM DEVELOPMENT

This chapter covers the following aspects which are enlisted below-

1. Selection of appropriate Software's
2. Data Procurement and Study
3. Microsoft Scheduling
4. Microsoft Budgeting
5. Model Development Using Revit
6. Model merging in Navisworks

1. Selection of appropriate Software's

After a brief study of the above listed software's, we observed and noticed that for the help of cause of our project, the necessary software's that were utilized are as follows:

Microsoft Project for scheduling and budgeting of the entire construction Autodesk Revit for 3D modelling of the given 2D drawings which comprised of – Roadworks, Drainage system and water conduits (pipeline). After Detecting clashes, Revit was used to prepare a clash-free plan with zero clashes. Autodesk Navisworks Manage for better visualization of the model. This model was later analyzed for detection of clashes.

2. Data Procurement and Study

The proposed site for the repair work of railway wagons is situated at the outskirts of Amravati city at Badnera. Workshop site is adjacent to Badnera railway station. The capacity of the workshop being 180 wagons POH per month.

The main purpose in selecting this site was the possibility of high number of clashes that could have occurred due to various construction process colliding in the proposed schedule. Clash Detection Using BIM techniques and BIM equipped software's was the main ideology.

2. Microsoft Scheduling

A proper Work-Breakdown Structure was first prepared for the entire project taken into consideration for study. According to the chainages marked on drawings the various activities were divided. The sequence of various activities was decided accordingly. Resource sheet was then prepared followed by allocation of various resources to the prescribed activities. Gantt chart was prepared by MSP as we add predecessors to the activities.

3. Microsoft Budgeting

In Microsoft Project there is a provision of allocating resources to each activity which was utilized to a good extent in this project. This was done keeping in mind the calculation of actual sum to be spent i.e. budget of the project. Under resource column the quantities of all the materials required for construction were added. Under Resource Sheet addition of rates of different resources was done. This allows Microsoft Project to automatically calculate the cost of each of the activities under construction project. Hence total cost of project is calculated by Microsoft Project

4. Model Development Using Revit

Model development as a step in this project aimed at developing three dimensional models from basic two-dimensional drawings. This is done keeping in view clash detection which is the ultimate aim of this project. This is done by the help of various software's, but here Autodesk Revit 2017 has been used. Basically, three models have been developed – Roadworks, Water supply pipelines and drainage system. The procedure followed for developing 3D models in Revit is explained below:

Selection of new file

Selecting appropriate template file. In this project construction template was used

5. Model merging in Navisworks

a) Road network model

Two types of roads were clearly identified and modelled. These were PWD road and roads joining the different workshops respectively. Following data regarding roads is provided to know the model better:

- Total length of the road = 10,721 metre
- Thickness of PWD road (Cement Concrete road) = 400 mm
- Thickness of other roads linking various workshops (bituminous) = 120 mm
- Total area of roads = 69,886.052 square metres
- Width of PWD road = 24 metre
- Width of other road = 3.5 metre or 3 metre

Fig.4. 3D Road Revit Model.

b) Drainage system model

All the side drains surrounding the wagon repair workshop are modelled as well. The drainage is made up of concrete.

Information regarding the side drain model is as follows:

- Thickness = 1 metre
- Area of drains = 370490865 square metres

- Width of drains = 2 metre

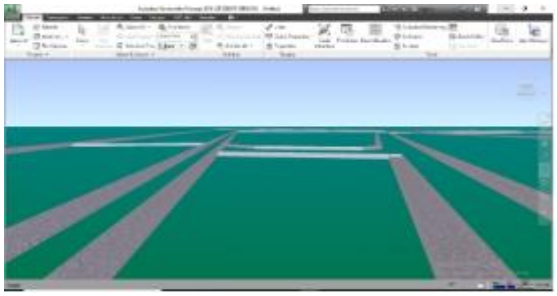

Fig.5. Aerial view of side drains.

c) Water supply pipeline

The material used in water supply pipeline is cast iron.

- Overall Size of the pipeline = (300 mm diameter)
- Inside diameter of pipes = 303.2 mm
- Outside diameter of pipes = 323.9 mm

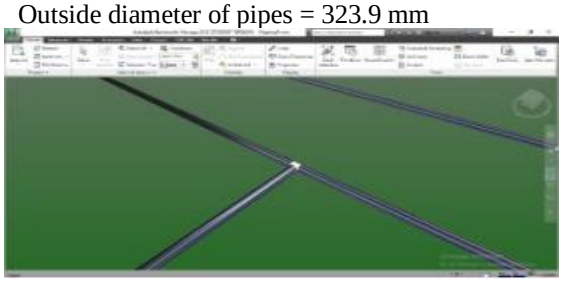

Fig.6. Water pipeline model.

V. PERFORMANCE ANALYSIS SOFTWARES USED FOR 4D SIMULATION

5.1 Autodesk Autocad

Autodesk AutoCAD is building information modeling software for architects, structural engineers, MEP engineers, designers and contractors. It allows users to design a building and structure and its components in 3D, annotate the model with 2D drafting elements, and access building information from the building model's database. Out of the many units planned for the construction of the wagon repair workshop, the ones selected for carrying out our testing for clashes were –Roadworks, water supply pipeline and drainage system. The 2D drawings of the above-mentioned units were then through proper legal methods procured for further proceedings to be completed. The drawings were then studied deeply and understood properly to locate the various roads, pipelines and drainages according to the need of the project.

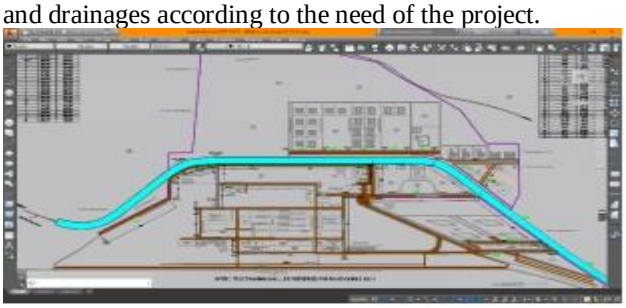

Fig.7. Road Works 2D Drawing.

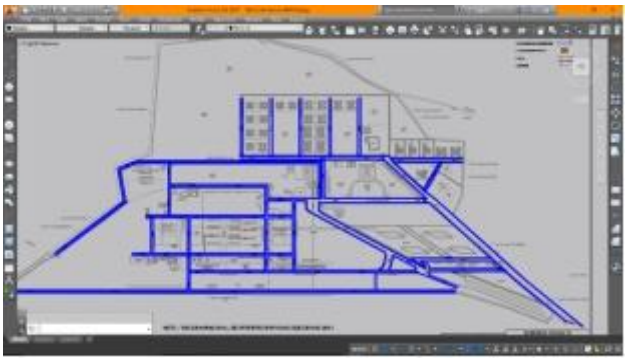

Fig.8. Road works 2D Diagram.

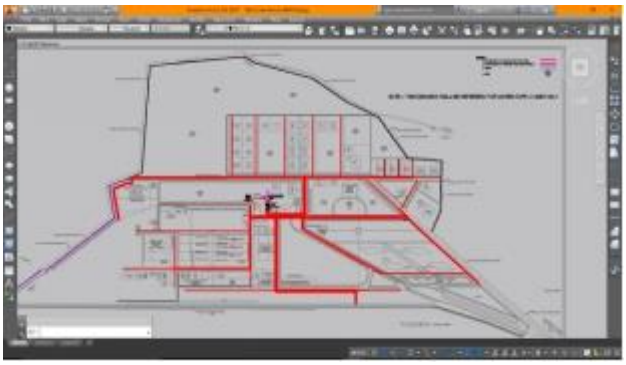

Fig.9. Road Works 2D Drawing.

5.2 Autodesk Revit

1. **Modelling:**

The Revit work environment allows users to manipulate whole buildings or assemblies (in the project environment) or individual 3D shapes (in the family editor environment. There are many categories of objects ('families' in Revit terminology), which divide into three groups

- System Families, such as walls, floors, roofs and ceilings which are built inside a project
- Loadable Families / Components, which are built with primitives (extrusions, sweeps, etc.) separately from the project and loaded into a project for use
- In-Place Families, which are built in-situ within a project with the same toolset as loadable components

2. Rendering

With this, the user can set the rotation, size, brightness, and intensity of textures, gloss maps (also known as shinemaps), transparency maps, reflection maps, oblique reflection maps, hole maps and bump maps, as well as leaving the map part out and just using the sliders for any one (or all or none) of the aforementioned features of textures. Cloud-based rendering with the experimental plug-in dubbed Project Neon, located on Autodesk Labs is in the beta phases and allows for the user to render their images through their Autodesk account instead of locally through an add-in available for Revit called Enscape3D allows live 3D rendering walkthroughs and flyarounds. It permits live updates and also allows for sound sources to be added so that acoustics may be tested.

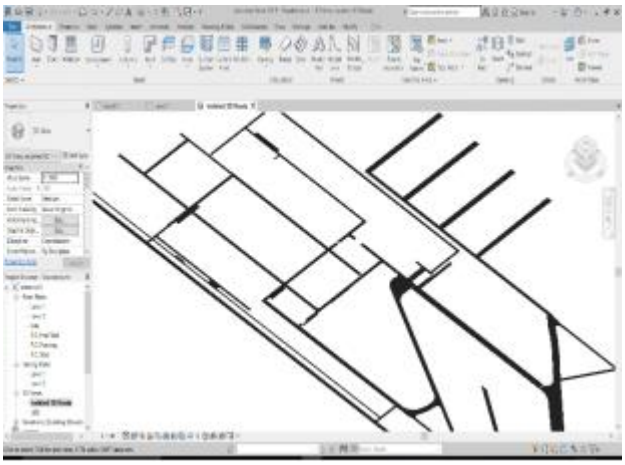

Fig.10. 3D model of roadworks.

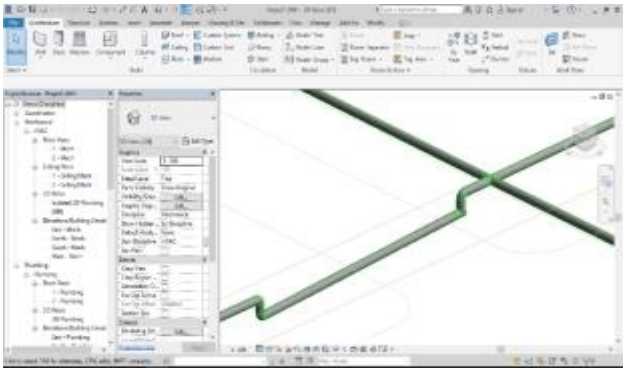

Fig.11. Modified element of plumbing model.

5.3 Navisworks Manage

Navisworks is a 3D design review package for Microsoft Windows. Used primarily in construction industries to complement 3D design packages (such as Autodesk Revit, AutoCAD, and MicroStation) Navisworks allows users to open and combine 3D models, navigate around them in real-time and review the model using a set of tools including comments, redlining, viewpoint, and measurements. A selection of plug-ins enhances the package adding interference detection, 4D time simulation, photorealistic rendering and PDF-like publishing.

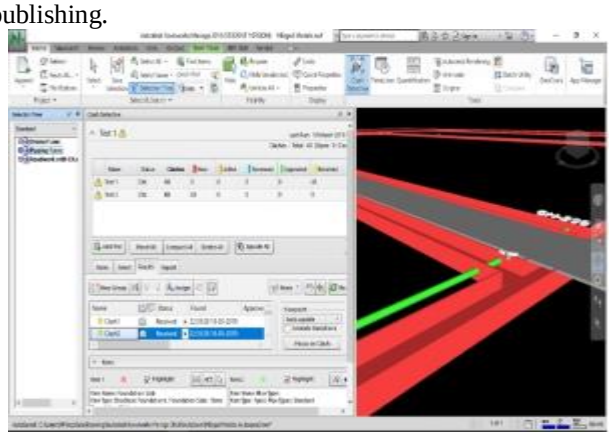

Fig.12. Clash Identification after successful run of the test.

Fig.13. Zoomed view of a typical clash between drainage and pipeline.

Fig.14. Clash detective test with zero clash.

5.4 Microsoft Project

Various functions performed in Microsoft Project:

- **Roamer** - The core part allows users to open models from a range of 3D design and laser scan formats and combine them into a single 3D model. Users can then navigate around the model in real-time and add review the model with a range of mark-up tools.
- **Publisher** - This plug-in allows users to publish the complete 3D model into a single nwd file that can be freely opened by anyone using Freedom, a free viewer.
- **Clash Detective** - A plug-in to enable interference detection. This means users can select parts of the model and look for places where the geometry conflicts. This is for finding faults in the design.
- **Presenter** - With Presenter users can apply materials and lighting to the model and produce photorealistic images and animations
- **Timeliner** - Adds 4D simulation so the user can link geometry to times and dates and to simulate the construction or demolition of the model over time. Also links with project scheduling software (Such as Microsoft Project or Primavera products) to import task data.

- **RVM Reader** - Adds the ability to load rvm and associated .rvs files generated by AVEVA Plant Design Management System (PDMS).

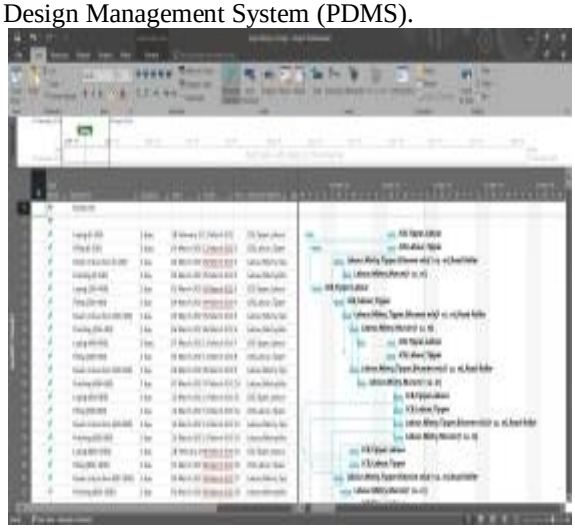

Fig.15. M.S Project Gantt chart.

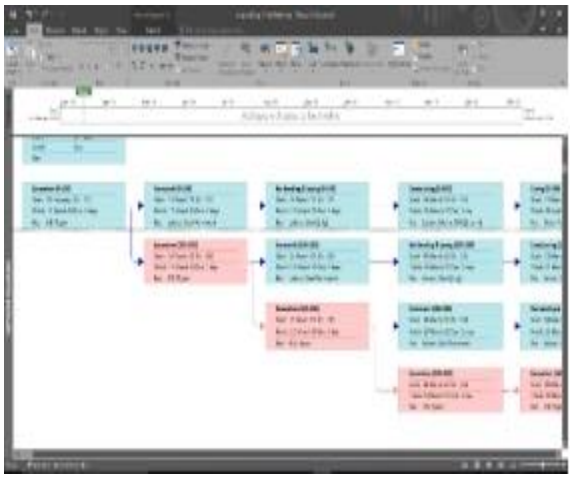

Fig.16. MS Project Network Diagram.

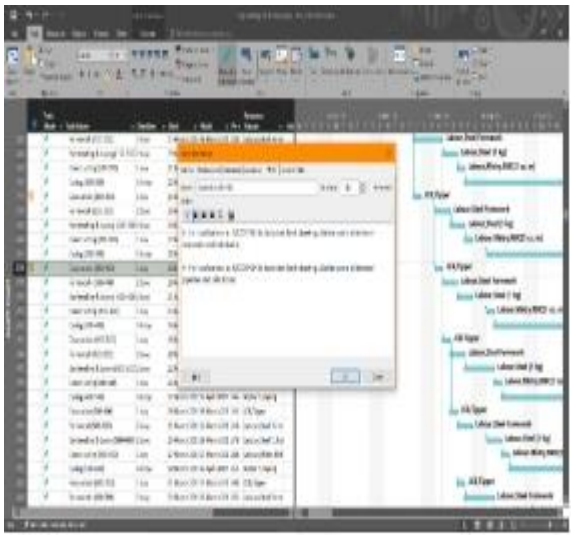

Fig.17. Screenshot showing addition of notes for multiple clashes on a single activity.

Fig.18. Cash flow report.

VI. CONCLUSION

- 4D simulation improved ability to monitor actual progress vs. planned progress and to thereby identify and resolve issues more quickly, thereby reducing claims.
- Improved site planning and coordination with ongoing operations.
- 4D models helped create reliable sequences of work that optimize use of resources.
- This method can improve communication among project stakeholders and help to avoid planning failures.
- This construction project 4D visualization model requires the integration of a 3D geometrical model with associated schedule of activities.
- By using the traditional methods of planning like Gantt charts and CPM scheduling, it is very easy to miss some activities in the construction plan due to lack of visualization. Whereas, 4D modelling provide a very effective tool to visualize the building project and identify all the possible construction activities leading to an accurate and detailed work plan.
- As we achieved 100 percent efficiency we can say that our system is perfect for practical application on a bigger cons Microsoft project also proves helpful in scheduling compared to traditional means but Navisworks proves more helpful than MSP as results are in more detailed manner along with video generated which is not possible in MSP.
- It adds the time factor to basic 3D model so it can simulate the project dynamically.

- We can visualize the work in 3D with respective to time, cost and labour which can prove helpful in taking management decisions.

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