3D Visualization of Underground Pipelines By Using BIM

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Abstract : Management and visualization of underground utilities have been always of a great concern in many countries. Insufficient, inaccurate and unclear information about location and depth of cables and pipelines may cause various problems and may even result in tragic accidents In this paper we argue that 3D visualization of pipelines is of a critical importance for efficient maintenance ,providing a better perception and understanding of the complexity of the underground networks. visualization of pipelines organized as 3D lines in a RIVET and NEVISWORK. Parameter, such as diameter, heights, radius etc. are organized together with the pipe geometry as well. various tests are performed on a case study of karad area.

***IndexTerms* – BIM, Undergrond Pipeline Information System.**

I. INTRODUCTION

In traditional method organizations prepares activities for the execution stage as establishing contracts with contractors, buying materials, ensuring a good coordination and assembly order of the different systems of a project. The most clashes are recognized when the contractor receives the design drawings and everyone is on-site and working. It is compare with 2D designs to each other to find conflict clashes between the specialty designs. Because the specialty contributors i.e. structural engineers, MEP engineers etc. develop their designs separately, so when comparing these designs on different drawings is a process easily overlook clashes. The contractors require seeing that the detailing of structural elements, plumbing, electrical lines and other component is done well. If there is some mistake in of these clashes result change orders then these effects on cause delay in project, design modifications, materials costs and budget overruns. Using BIM and the Clash Detection application enables potential problems to be identified early in the design phase and resolved before construction begins with more effective.

II. OBJECTIVES

Following are the objectives of the study

1. To visualize underground features and their relation to the 3D space.
2. To Prepare set of data which satisfy the demand of underground BIM of pipe network.
3. To develop a 3D model of underground environment.
4. Clash Detection and Elimination using BIM.

III. METHODOLOGY

The first phase of the research thesis proposal included identifying and defining the problems, establishing the objectives of the study and developing the research plan. The second phase included a summary of the comprehensive literature review. The third phase included a development of 3D visualization model from actual site data.The fourth phase focused on clash detection and elimination of clashesh. The fifth phase included analysis and discussion. The sixth phase included the conclusion and recommendations.

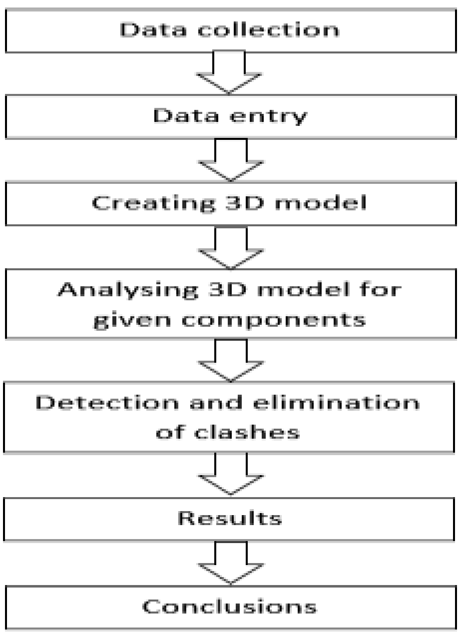


Figure 3.1 METHODOLOGY

IV. CASE STUDY

These case study were VIRAVADE WATER SUPPLY SCHEME tal karad dist satara the work has been executed by a contractor pratik sawant under MAHARASHTRA JEEVAN PRADHIKARAN. The contractor reasoned that this project is suitable with my study because its duration fits the study period, which took place from Jan 2018 and is still in progress. And more importantly, the project was planned to employ 3D Visualization. The 3D model in this case study was created by combining 2D models and the project schedule. The 3D models were created separately by using Revit. Then those models and the project schedule were put together by Rivet to form models. In this project, these models have served as a tool for workers to visualize the construction sequences on site, as a common model for related actors to discuss about errors and conflicts in project meetings and as a simulation of the project schedule.

Table no.4.1 Site Details

Sr no	Requirements	Details
1	Name of village/GP/District	Viravade Dist. Satara
2	Name of Muncipal Council/MC which village included in PU	Karad Municipal.
3	Source Proposed	Krishsna River
	Population	
4	As per Census 2011	3770
5	As per Consumer survey	4676
6	Design stage(2032)	5856
7	No. of Households as per consumer survey	722 No
8	No. of Metered connections proposed	785 No
	Cost of Scheme (Rs. In lakhs)	
	Net Rs	561.34 Lakh
	Gross Rs	611.86 Lakh

4.1 Data collection

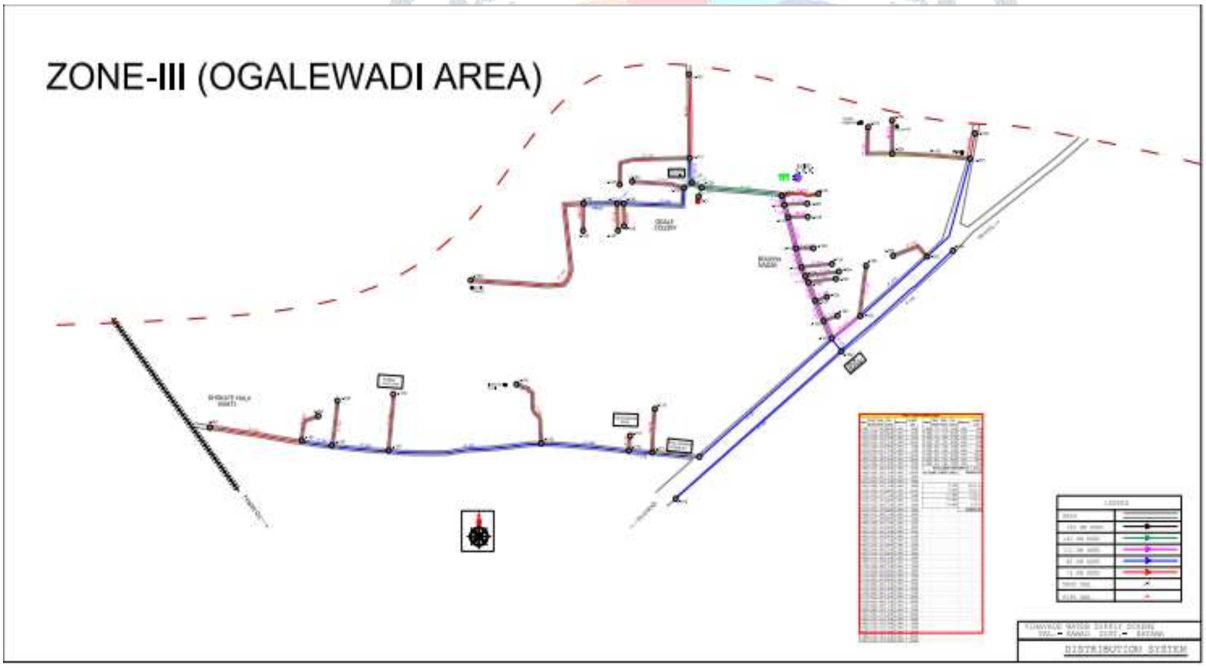


Figure 4.1 Plan of water supply scheme

4.2 Photographs

Figure 4.2 Actual photographs of site

V RESULT AND ANALYSIS

5.1 CLASH DETECTION

A clash is the result of two elements in design taking up the same space. BIM clash detection is the technique identifying if and where or how two parts of the system(pipelines, telephone cables etc) are interfering with one another.
Clash detection process identifies where the independent models clash with each other finding where elements from one model overlap the elements of model from other architect-engineering design desciplines.

Clash detection remains the primary requirement of any multidisciplinary project wherein composite design needs to be inspected for the identification of clashes. Clash Detection is the method of inspecting and identifying the various interferences which frequently occurs in coordinating process of 3D models created in different modern software‟s like Revit Architectural, Revit Structural & Revit MEP .In BIM, 3D models for different types such like Structural, Civil, and Architectural &MEP(Mechanical, Electrical and Plumbing). When combination of all these different types of models to create a complete BIM model there will be chances of clash between these elements. In clash detection test it detects the conflicts between different elements within 3D Building Information Model before actually construction starts, and therefore time optimization in the construction schedule, reduce costs and change orders. By using clash detection application in AEC industry increase the productivity of design and construction project.

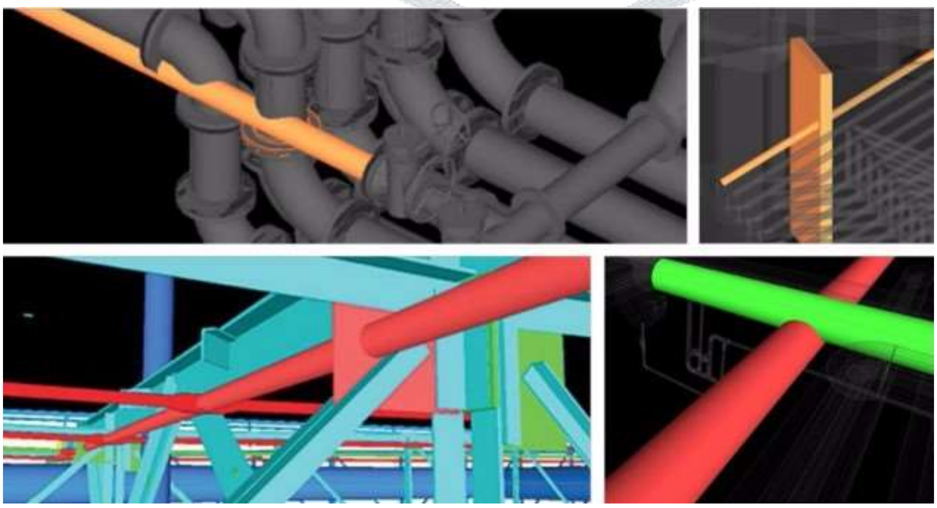


Figure 5.1.1 example of clash

5.1.2 DIFFICULTIES ANALYSIS

1. The first difficulty in underground transportation construction is the fact that the surrounding working environment of the construction is complicated. our project is built under areas with a lot of complex underground pipe-line systems of an urban area. which involve numerous safety risks during the construction stage. Construction in a crowded urban environment can

always cause ground deformation and surface subsidence. Furthermore, poor geological conditions, shallow buried structures and the stability of the surrounding rock can also be elements that influence the quality of underground transportation construction.

2. The second difficulty in underground transportation construction is the complicated organizational structure of construction. As a part of a public transportation system constructed in an underground environment, the underground pipeline scheme usually involves multiple disciplines, which means that our study area is located at place where lots of conflicts arises such as railway crossing, drainage line, transmission tower .telephone cables etc. these conflicts can be scheduled in clash detection by using BIM. There are many embedded parts and reserved holes in the design. A BIM model of the construction phase of an underground transportation project. Construction deficiencies such as omissions and embedding mistakes cannot be avoided when using the traditional construction method, mainly based on two-dimensional drawings.

3. In traditional method organizations prepares activities for the execution stage as establishing contracts with contractors, buying materials, ensuring a good coordination and assembly order of the different systems of a project. The most clashes are recognized when the contractor receives the design drawings and everyone is on-site and working. It is compare with 2D designs to each other to find conflict clashes between the specialty designs. Because the specialty contributors i.e. structural engineers, MEP engineers etc. develop their designs separately, so when comparing these designs on different drawings is a process easily overlook clashes. The contractors require seeing that the detailing of structural elements, plumbing, electrical lines and other component is done well. If there is some mistake in of these clashes result change orders then these effects on cause delay in project, design modifications, materials costs and budget overruns. Using BIM and the Clash Detection application enables potential problems to be identified early in the design phase and resolved before construction begins with more effective.

The potential difficulties discussed above can be avoided with the use of BIM technology in underground transportation engineering. The measurement images, calculation numbers, and construction information can be converted into 3D or 4D models for the de-signer and constructor. In addition, BIM can also provide a collaborative platform for each profession so that the management of the construction can be done easily. In addition,

BIM technology can provide better solutions for the management of collision coordination with other buildings and pipelines, quantity control and performance analysis. In that way, the workload can be simplified, and the efficiency can be improved. Thus, the construction costs can be reduced.

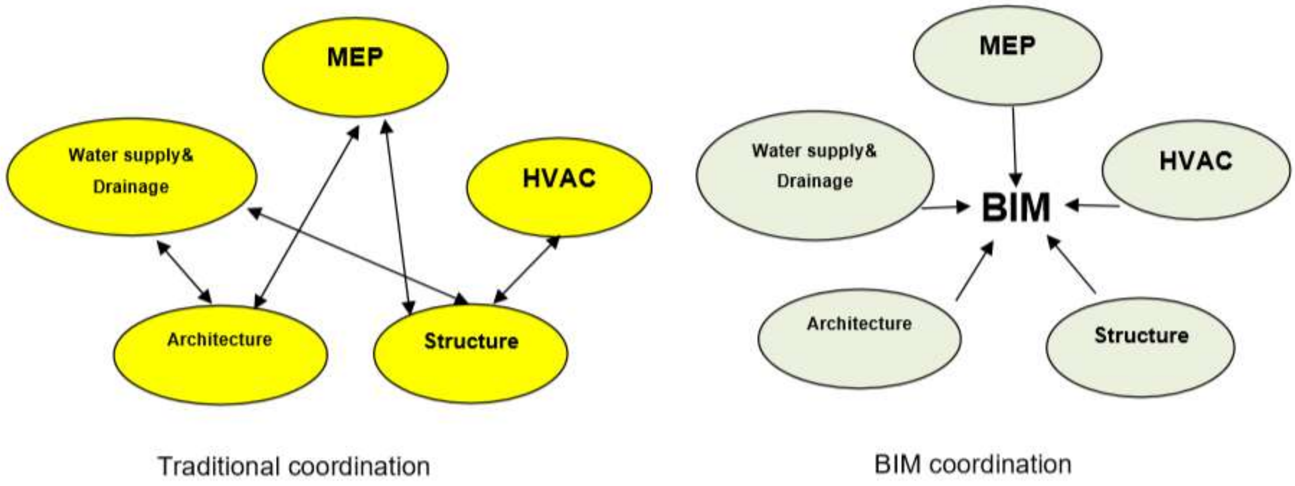
5.1.3 NEED OF CLASH DETECTION

In traditional method organizations prepares activities for the execution stage as establishing contracts with contractors, buying materials, ensuring a good coordination and assembly order of the different systems of a project. The most clashes are recognized when the contractor receives the design drawings and everyone is on-site and working. It is compare with 2D designs to each other to find conflict clashes between the specialty designs. Because the specialty contributors i.e. structural engineers, MEP engineers etc. develop their designs separately, so when comparing these designs on different drawings is a process easily overlook clashes. The contractors require seeing that the detailing of structural elements, plumbing, electrical lines and other component is done well. If there is some mistake in of these clashes result change orders then these effects on cause delay in project, design modifications, materials costs and budget overruns. Using BIM and the Clash Detection application enables potential problems to be identified early in the design phase and resolved before construction begins with more effective.

5.1.4 BIM APPLICATION ANALYSIS

The design of a water supply scheme always comprises more than 20 professions, not only the traditional construction professions like architects, structural engineers, and plumbers, also special disciplines like a mechanical and railway engineering are included. Unified decisions are hard to make when engineers from communication and coordination, the contradiction between the drawings of different units will appear, which may cause re-work, thus decreasing the quality and efficiency of the project.

Unlike the traditional coordination design mode, in which the coordination is separated and restricted into two sectors, BIM technology provides a collaborative design stage for underground transportation construction. With the help of BIM technology, the coordination can be executed simultaneously by all sectors involved, as shown in figure below.



5.1.2 Integrated coordination comparison between traditional mode and BIM coordination mode.

BIM can collect and integrate all data and resources so that engineers from different sectors can get all the information they need through information sharing. In addition, the details of the structure can be observed directly during the design phase with the visualized characteristics of the BIM 3D model. Different construction options can be compared, the sequence of the construction order can be arranged at the design phase, and the best solution can be found. In addition, at the construction drawing design phase, the collision detection of BIM can find the problems in design drawings and construction scheme, effectively avoiding the design flaws and mistakes and any delays in the schedule.

5.2 SYSTEM DEVELOPMENT

The following systematic approach was undertaken during the whole process –

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

5.2.1 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: Autodesk Revit for 3D modelling of the given 2D drawings which comprised of – water supply scheme. 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.

5.2.2 Data Procurement and Study.

The proposed site "VIRAWADE WATER SUPPLY SCHEME" located at viravade, tal karad ,dist satara. 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.

5.3 PERFORMANCE ANALYSIS

Softwares used for 3D modelling

5.3.1 AUTODESK AUTOCAD

Initial drawings were obtained from legal sources which were in 2D as shown in figures in AutoCAD and then the three components namely Railway crossing, Drainage works and water supply pipelines were chosen for conflict detection.

5.3.2 AUTODESK 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.

In Autodesk Revit, Revit Architecture, Revit Structure and Revit MEP (Mechanical, Electrical & Plumbing Design) are to be created separately and finally it is to be coordinated with each other. Each discipline have separate template file for making model.

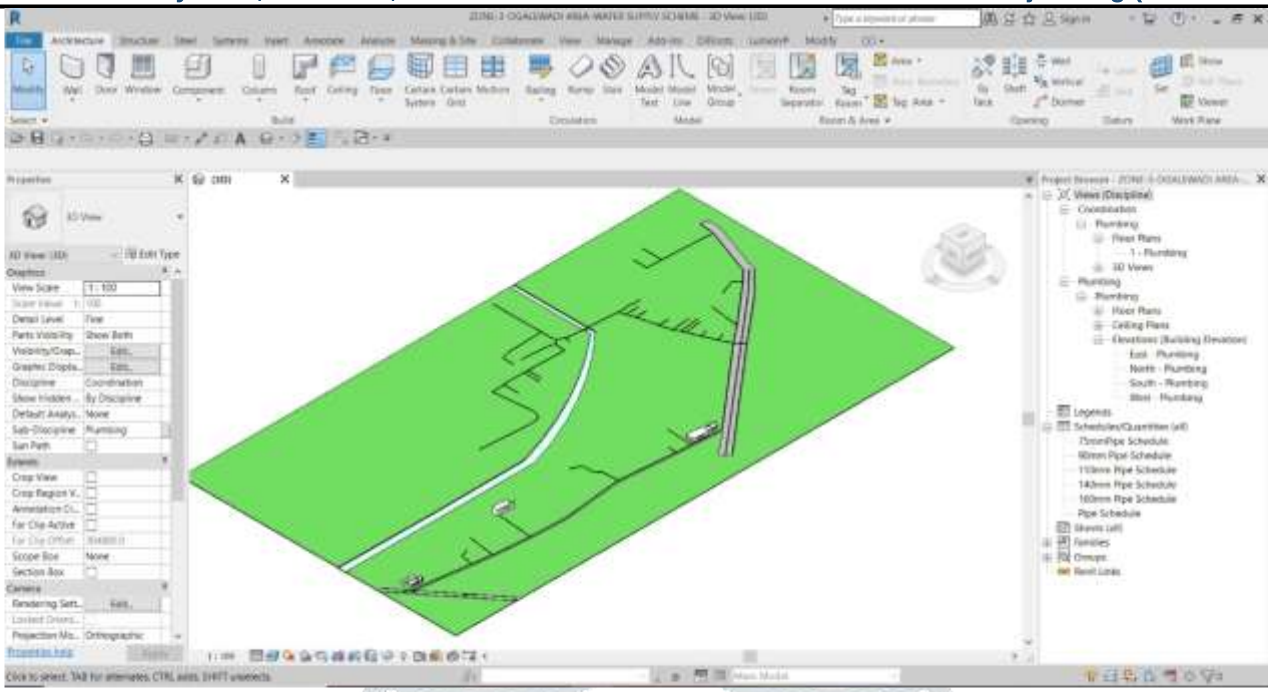


Figure 5.3.1 3D model of pipeline scheme

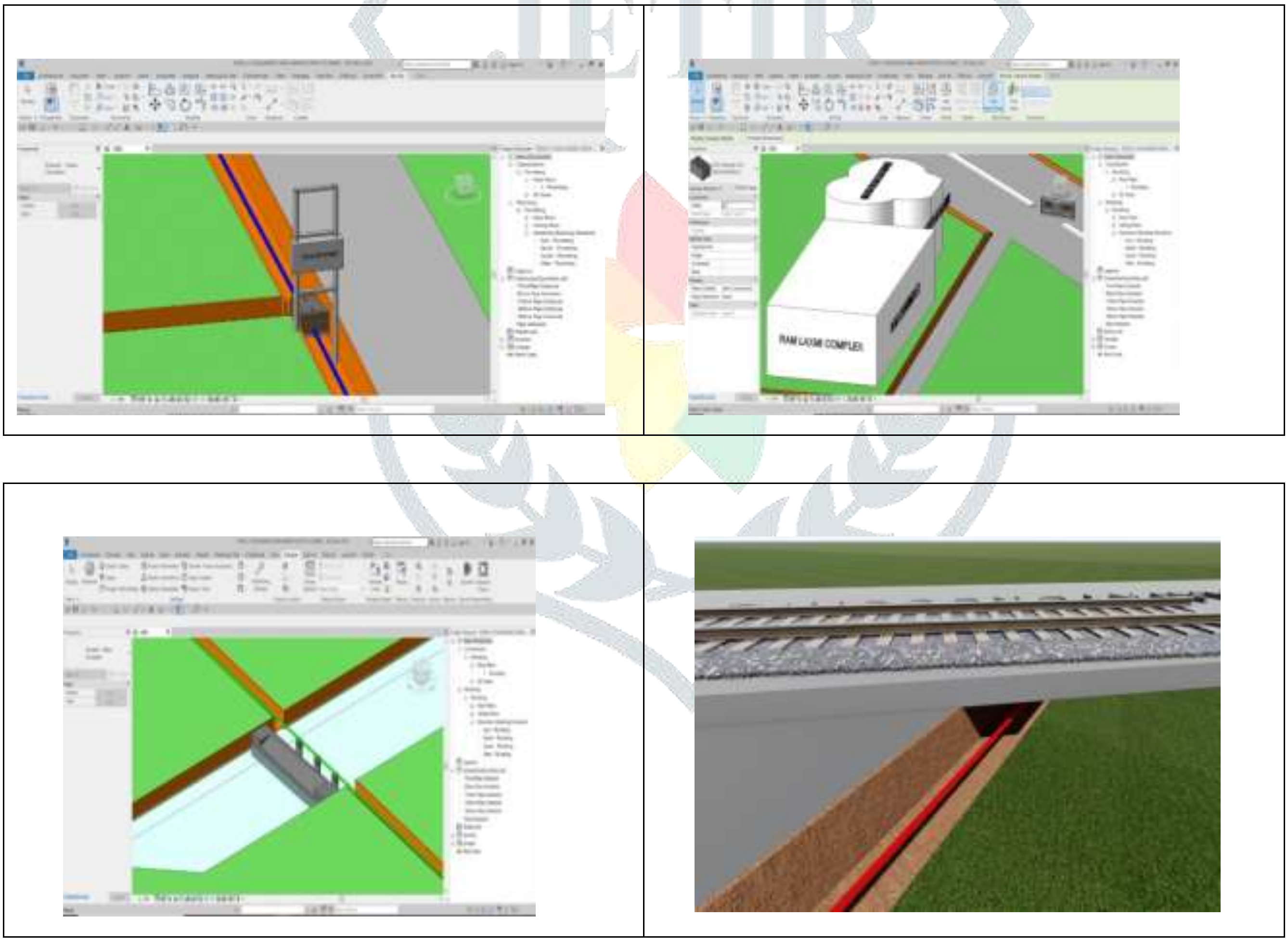


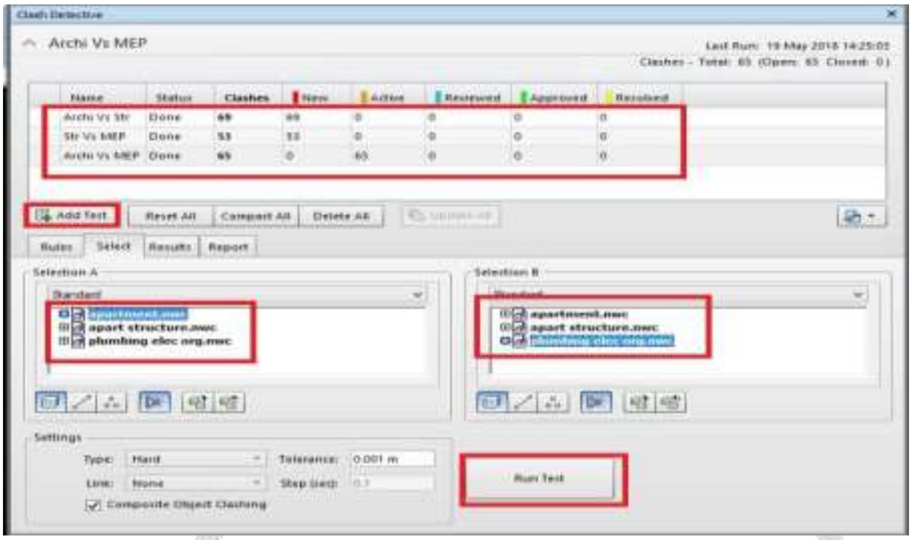
Figure 5.3.2 zoomed view of construction stages

5.4 PROCESS OF CLASH DETECTION

The procedure involved collecting three model files of type ".rvt" (Autodesk Revit 2017) for the three models, i.e. architectural and structural and MEP model. Three separate clash tests were conducted: 1) Architectural Model versus Structural Model (AR Vs ST), 2) Architectural Model versus MEP Model, (AR Vs MEP) 3) Structural Model versus MEP (ST Vs MEP).

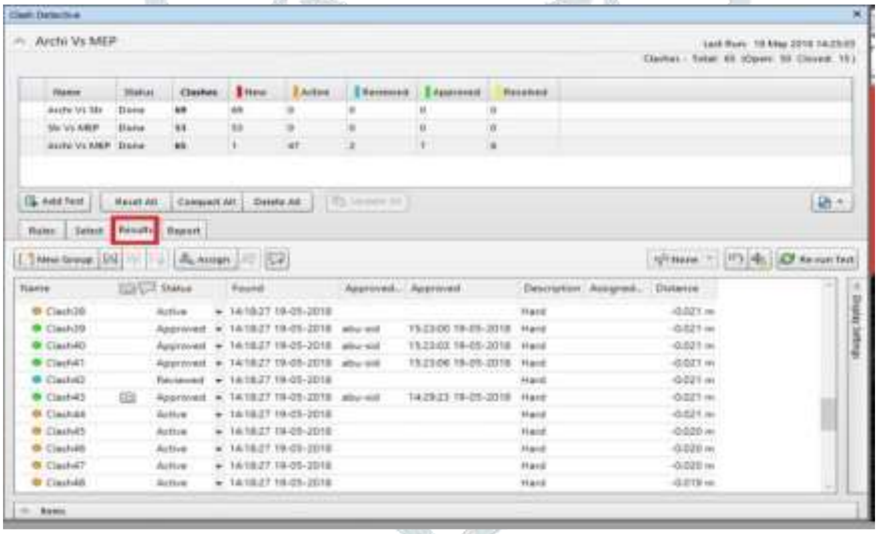
The software was set to detect only hard clashes, There is much BIM software available in market which is useful for design and construction professionals to increase the productivity of the project, but in this study software used for clash detection process is Autodesk Navisworks Manage 2017. Autodesk Navisworks Manage greatest strength is clash detection. Due to this software detecting collisions during design, in real time, gives the BIM stakeholder a very efficient method to improve coordination among multiple building systems and ultimately avoid costly remedies after drawing completion and during Construction phase. Following are the steps for clash detection process

- The first step in this study is to import all the Revit 2017 files i.e. MEP, structural and architectural files into Navisworks which is used in clash detection process. For clash detection process in Navisworks, it is required to import 3D Revit files into Navisworks or export files from Revit to Navisworks.
- In the next step the clash detection process converts all the recently imported „.rvt" files into Navisworks file format that is „.nwf" file format which is shown in Figure below.



5.4.1 clash detection process by neviswork

- After the clashes between structural element and MEP element are being easily recognized. Result inspection is done using Results tab.
- Autodesk Navisworks automatically gives a status to each clash for future use .The Clash Detective tool that keeps on updating the status of the clashes after they are identified and are listed within Results tab which is shown figure below



5.4.2 clash detective showing result tab

Further, for creating report of clash test Report tab is made click on and report created in.HTML" file format which is shown in fig below

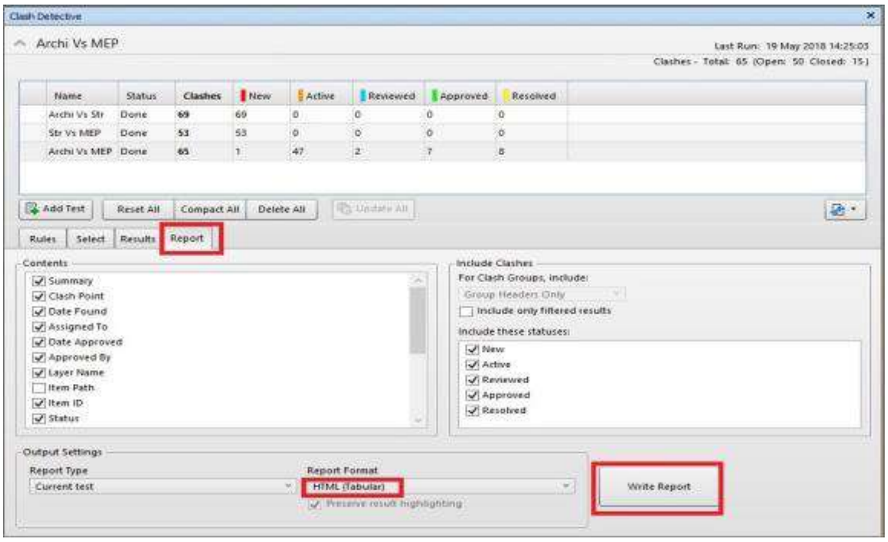


Figure 5.4.3 clash detective showing report tab

Autodesk Navisworks Clash Report

Archi Vs MEP	Tolerance	Clashes	New	Active	Reviewed	Approved	Resolved	Type	Status
	0.001m	65	65	0	0	0	0	Hard	OK

							Item 1				Item 2			
Image	Clash Name	Status	Distance	Description	Date Found	Clash Point	Item ID	Layer	Item Name	Item Type	Item ID	Layer	Item Name	Item Type
	Clash1	New	-0.089	Hard	2018/5/19 08:48.27	x:9.252, y:11.648, z:3.578	Element ID: 1323068	Level 1	Copper	Solid	Element ID: 360278	Level 2	Concrete, Sand/Cement Screed	Solid
	Clash2	New	-0.089	Hard	2018/5/19 08:48.27	x:-14.128, y:11.680, z:9.978	Element ID: 1323566	Level 3	Copper	Solid	Element ID: 359764	Level 4	Concrete, Sand/Cement Screed	Solid
	Clash3	New	-0.089	Hard	2018/5/19 08:48.27	x:9.252, y:11.648, z:9.978	Element ID: 1323583	Level 3	Copper	Solid	Element ID: 361193	Level 4	Concrete, Sand/Cement Screed	Solid
	Clash4	New	-0.075	Hard	2018/5/19 08:48.27	x:9.252, y:6.519, z:10.048	Element ID: 1323540	Level 3	Copper	Solid	Element ID: 361199	Level 4	Default Wall	Solid

Figure 5.4.4 clash report generated by neviswoks

5.5 ANALYSIS

Before conducting clash test the manual quantities of whole scheme was taken from MJP. The quantity report has been exported in Microsoft Excel format. After resolving all clashesh again quantities of clash points are taken from autodesk Nevisworks and exported in excel format .both the quantities are compared. following changes are observed

- After resolving clashesh you may be able to avoid some extra material cost and redoing of work.
- Savings from safety- clashesh in construction projects impact completion time and workers safety and time spent on rework is more where injuries could occure.according to the national safety council,workplace injuries cost $41,000 per incident on average.
  After resolving clashesh we are able to avoid all those things and save money and time also.and able to complete project on time.
- Improves productivity-
  A major advantage of BIM is that it requires *earlier and better building design* which *increases productivity rates*, which causes compression of the overall project schedule. Figure below shows that the BIM process forces more design decisions to occur earlier in the project when impacts on cost are lower. Because construction components are detailed in 3-D, there are fewer conflicts in plans and greater understanding of what is to be built prior to the actual construction process. BIM is used to coordinate complex building components and reduce the number of errors. This reduces the amount of delays and rework resulting in cost overruns. Case studies have shown that resources spent on the models before construction decrease the amount of changes and delays.

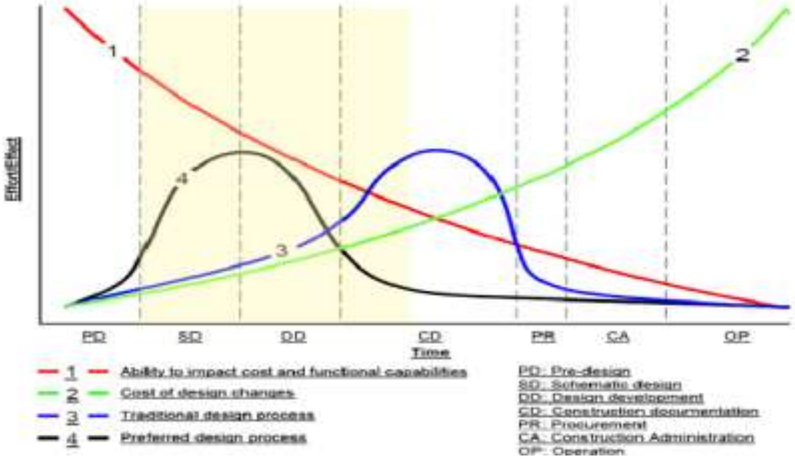


Figure 5.5.1 BIM process and their impact on cost

- Better co-ordination and collaboration between teams-
  Digitized clash detection workflow makes it easier for teams to share and collaborate on the same project. BIM and nevisworks. ensures coordination between members of different design, construction, electrical and engineering disciplines.
- Saving from efficiency
  The first and most obvious area of saving with BIM clash detection is efficiency. these tools save you time that you would otherwise spend fixing issues after they occure. Construction projects typically take 20% longer to complete than originally scheduled. As a result, employee wages, equipment rental and other time related costs end up being correspondingly 20% higher. since clash detection enables project stakholders to prevent clashesh instead of addressing them when they come up. it helps avoid these costs.

- Improve Procurement – BIM model helps to procure the materials in perfect time and perfect quantity (i.e., even the pipe fitting accessories like elbow, couplings count). So the wastage of materials will decrease.
- Achieved construction waste minimization.

Table 5.5.1 construction waste minimisation by the use of BIM

The use of BIM	Potential impact on construction waste minimisation
BIM for detailing	Better understanding of design by clients through a detailed building model resulting in fewer design changes
	Getting level of detail (LOD) right leading to less on-site waste
	More detail, clash detection and fewer on-site clashes
	Better detailing coordination and specification leading to less re-work
Clash detection through BIM	Better coordinated design resulting in less on-site waste
	Fewer clashes leading to less on-site waste
	Less re-work and re-design resulting in less on-site waste
Visualisation and simulation within BIM	Earlier understanding of the design by the client to avoid subsequent on-site design changes
	Better understanding of the building by contractors and a visualised and simulated construction process to lead to less on-site waste
	Enhanced communication and collaboration design between the design team members to eliminate uncoordinated design resulting in fewer clashes on-site
Improved coordination and communication through BIM	Effective and efficient multi-disciplinary design leading to less on-site waste

- Using Clash detection in this study instead of traditional method detects the conflicts in 3D Model before starting of actual construction so that it is useful to decrease coordination errors, human errors which results in high level of accuracy of models. Hence re-work in jobsite can be avoided.
- Autodesk Navisworks makes the clash detection process faster and easier along with completely reducing the scope of human errors during its execution. Design clashes that occur between building elements are successfully identified by Navisworks and they are timely solved. Hence complete elimination of design errors, optimize time and cost is very important for AEC industry before actual construction starts on jobsite.
- In this study totally clashes are identified and they are resolved. So in the result of water supply scheme nearly 30 % saving of materials is observed in quantity analysis. In this saving is design phase only, when in this model implement in real time construction, it helps to save more time & cost.
- Building Information Modeling (BIM) is rapidly growing within the Architecture, Engineering &Construction (AEC) industry where its current implementation shows great effects on projects in terms of performance, time and cost.

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