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# Improve the Productivity of Building Construction Project using Clash detection Application in Building Information Modeling

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**Abstract:-** *In the 21st century, BIM has brought a revolutionary concept in the Architecture, Engineering and Construction (AEC) industry, which is allows constructing building virtually before it is built on construction field. The starting to implement of BIM at different levels in various developed countries like USA, Australia and UK are implementing BIM to a greater level where in India is in total contrast to status in developed countries. The Clash Detection tool is one of the most useful application of BIM, which is useful for the coordination of systems to make the projects time efficient and economical. In this paper we focus the methodology involved conducting clash detection analysis using building information modeling software. This research also involves the concept of BIM, status of BIM in India. As such, it is case study of a residential building which consisting of an architectural, structural and Mechanical, Electrical and Plumbing (MEP) BIM models and their consequent clash detection. In this case study, commercial software such as Autodesk Revit 2016, Autodesk Navisworks Manage 2016 are used and also focuses on simplifying and standardizing the process of BIM coordination using Autodesk Navisworks software*.

***Keywords:*** Building Information Modeling, BIM software, AEC Industry, Clash Detection.

## 1. INTRODUCTION

In the last few years the construction industry, the complexity of modern day construction projects has increased and there will be no significant improvement in the productivity of the construction industry has been observed. The productivity of the construction industry has traditionally been much lower than that of other industries because the main reason for this shows to be the incapability of new technologies. As other industries have improved their productivity by using new modify methods and techniques, the construction industry is also applying new technology such as building information modeling (BIM) to assist better the productivity of construction Project Management.

A building information model is consisting of the 3D models of the project with links to all the required information connected with the projects planning and construction or operation. BIM is a 3D modeling which may involve 4th dimension as time (4D), 5$^{th}$dimension of cost (5D) and information database of the project , 6D dimension is related to Facilities Management (FM) & 7D dimension is related Sustainability.

The National Building Information Modeling Standards (NBIMS) committee of US defines BIM as, "a digital representation of physical and functional characteristics of facility. BIM is a shared knowledge resource for information about a facility forming are liable basis for decisions during its life cycle i.e. from earliest conception to demolition. A basic premise of BIM is the collaboration by different stakeholders at different phases of the life cycle of a facility to insert extract, update or modify information in BIM to support and reflect the roles of that stakeholder" .

### 1.1 Need of BIM

Building Information Modeling (BIM)is an integrated the process of development and utilizes of a computer generated model to simulate the design, planning, construction schedule, cost information and clash detection such as physical and functional characteristics digitally before it is built. In Indian construction industry is not applying the true potential of BIM tools. Lots of the architectural and engineering firms in India still depend on upon two-dimensional Computer-Aided Design i.e. CAD drawings. This usage of traditional methods neither expresses that the Indian designers are uninformed about BIM technology and its capacity, because of unskilled BIM users in the Indian AEC industry.

In traditional method of clash detection when BIM wasn't around, AEC professionals used to burn mid-night oil for

identifying mistakes in the 2D drawings. But even after doing a lot of hard work in detection of clashes before the starting of construction, architects and engineers used to find out design problems of high magnitude during final building procedure. Finding of clashes quickly used to result in rework on jobsite which used to show quite costly for owners. Budget overruns are instant consequences of rework carried out by architects and engineers during onsite construction. Due to the failure of traditional method it is necessary to bring about a new way of working and thinking within the construction industry So that it requires implanting modern technology like BIM to improving in clash detection instead of traditional method.

## 2. STATUS OF BIM IN INDIA

The Indian Architecture, Engineering and Construction (AEC) industry is one of the vital pillars of the Indian economy. Indian AEC has vast employment opportunity. While, real estate sector in India was the domain area of only handful players in the 90s, now it's changing day by day the growth has reached to investors, developers and global stakeholders in the growing Architecture, Engineering and Construction (AEC) industry in the country. Real estate is second largest employment sector in India, after agriculture. In contrast, the India Architecture, Engineering and Construction (AEC) industry is not using the true potential of BIM technology .According to a recent McGraw-Hill Construction Report, BIM implementation in the USA extended from 55 Percentage in 2013 to over 79 Percentage in 2015 .A Survey done by Indian RICS School of built environment and KPMG in 2014 found that 22percentage of respondent currently use BIM, 27percentage respondent reported that they are cognizant and actively considering BIM utilization in India. The major reason for not using BIM here is the lack of technical expertise, the professional who has heard about this technology but doesn't know how to use it, and most of them are not even aware of this technology, high cost of software, No mandate from the government for BIM implementation ,low demand from clients and lack of skilled or trained employees.

## 3. CLASH DETECTION

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.

There are 3 main types of clashes

1. Hard clash:

This type of clash occurs with two objects are taking up the same space. Such like pipes passing through walls, lower ceiling light. This type of information is entered in the BIM modeling objects and hard clash provides the detection based on the geometrical as well as on semantic and rule-based algorithms.

2. Soft Clash/Clearance Clash

Soft clash detects clashes which occur when the object needs more positive spatial or geometric tolerances, spaces and buffers within their buffer zone for improved accessibility, insulation, maintenance and safety. For example, an air conditioning component may require certain clearances to allow for maintenance, access or safety that steel beam would negate.

3. 4D/Workflow Clash:

This type of clash might involve the scheduling of contractors, the delivery of equipment i.e. cranes, bulldozers and materials, and general timeline conflicts. For example, work crews arriving when there is no equipment on site[4]. Since these objects are frequently scheduled as temporary, demolished, or other schedule so link them for clash detection to make sure they do not affect to project.

### 3.1 Need Of Clash Detection

In traditional method organizations are the 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 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 to see that the detailing of structural elements, plumbing, electrical lines, attachment 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.

## 4. SOFTWARE USE FOR CLASH DETECTION

There are several companies who offer clash detection software for the AEC industry. Following are some software's which is use for clash detection in BIM

1. Revit

Revit is database structure and object definition modeling, is a effective modeling software the preferable work practice is of course when all the modeling is performed internally within Revit .In order to satisfy the specific needs of the diverse types of specialist for Revit, Autodesk distributed the product into three types – Revit Architecture, Revit Structure and Revit MEP. Revit software gives clash detection abilities where objects clashes with each other are highlighted for improvement. This capability is however, limited in that it does not develop reports, trace Clashes, Status Clashes ,Set Rules, Custom Clash Test, Clearance Tests, Time Based Clashing or track changes[5]

2. Bentley Navigator

Bentley Clash Resolution allows user to identify sets of business or graphical elements and to detect geometrical clashes between these object element sets. The user can after that interactively and graphically review these clashes, mark up particular clashes, and allocate them for action. Clash results can be grouped, marked up and exported to a GPS system or Excel spread sheet. [7]

3. Solibri Model Checker

Solibri Model Checker (SMC) software finds potential faults before actual work start on site . It is advanced clash detection tool which is consisting BIM and accessibility compliance, deficiency detection, model comparisons and full information take off. The checking of Solibri Model Checker is done on the basis of rules grouped into related “rule sets”. This can be viewed as “design spell checking”. One of most noticeable advantages of Solibri Model Checker is to be viewed in the original BIM authoring application, permitting them to be fixed more easily and quickly [1]. By using Solibri Model Checker BIM stakeholders can manage costs, delivery timings and maintenance work.[7]

4. Autodesk Navisworks

The Autodesk Navisworks products helps architecture, engineering, and construction teams to develop better control over the outcome of their projects. With Navisworks solutions, detailed design models can be combined and reviewed by all project stakeholders, serving users to benefit from the competitive advantages of building information modeling (BIM) workflows. The Autodesk Navisworks software provides a Clash Detection module that checks BIM model and shows any areas where items interfere, or “clash”, with each other. This BIM tool allow to set up the rules, Identify clashes ,Generate Reports, Trace Clashes, Status Clashes, Manage Clashes, Set Rules ,Custom Clash Test, Clearance Tests ,Time Based Clashing. The Autodesk Navisworks software family offers three products(Autodesk Navisworks Manage, Autodesk Navisworks Simulate, Autodesk Navisworks Freedom) to provide project stakeholders with the right tools to help collaborate, coordinate, and communicate more effectively.

## 5. METHODOLOGY

The methodology involved collecting three model files of type “.rvt” (Autodesk Revit 2016) 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, with a tolerance of 0.0 mm. There are many BIM software

available in market which is useful for design and construction professionals to increase the productivity of the project, but in this case study software used for clash detection process is Autodesk Navisworks Manage 2016 etc. 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.

1. The first step in this case study is to import all the Revit 2016 files i.e. MEP, structural and architectural files into Navisworks which is use 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.

2. In the next step in clash detection process converts all the recently imported rvt files into Navisworks file format that is .nwf file format which is shown in Figure no 1

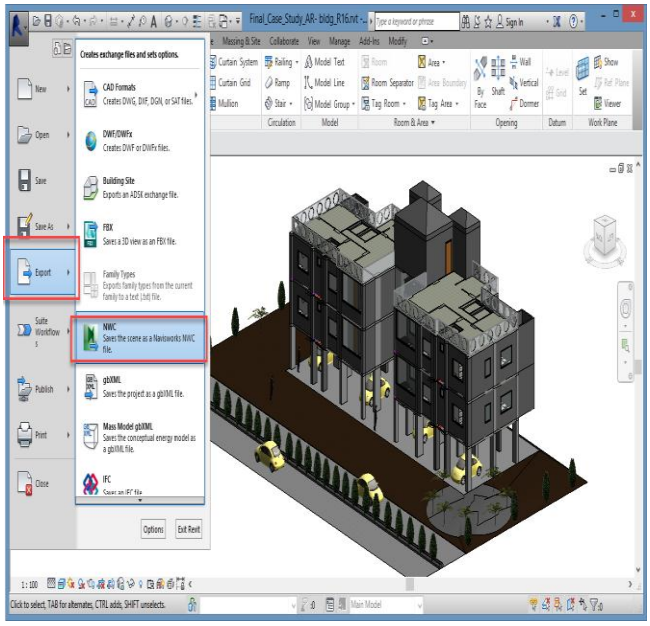


**Fig.1** Converting Revit file into NWC format

3. Once all rvt files are transformed into nwf file format we can be simply opened in Navisworks software and then clash tests carry out by using rvt files.

4. For performing clash tests in Navisworks software press the 'Clash Detective' tool.

5. After that we can simply click on to 'Select' tab that is located within clash detective tool in Navisworks software.

6. Next step is click on 'Select' tab then two different columns will appear on computer screen so select different model elements which have the chances of conflicting with each other which is shown in figure no 2. For example structural element can interfere with MEP element, so in one column we should select 'structural element' and in other column we should chose 'MEP element' and then simply click on 'OK' to run clash test.

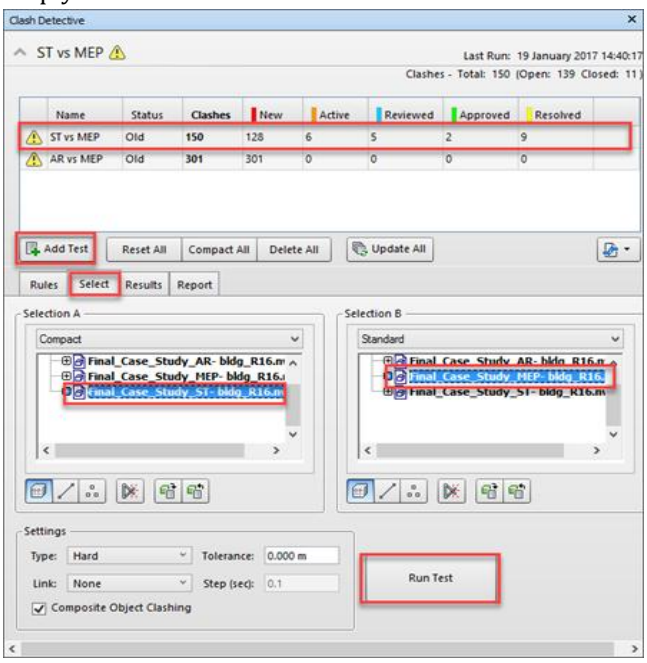


**Fig 2**. Clash detection process by Navisworks

7. After the clashes between structural element and MEP element can be easily recognized. After that for inspection its results, we must go to Results tab.

8. Autodesk Navisworks automatically gives a status to each clash for future use .So after that 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 fig 3

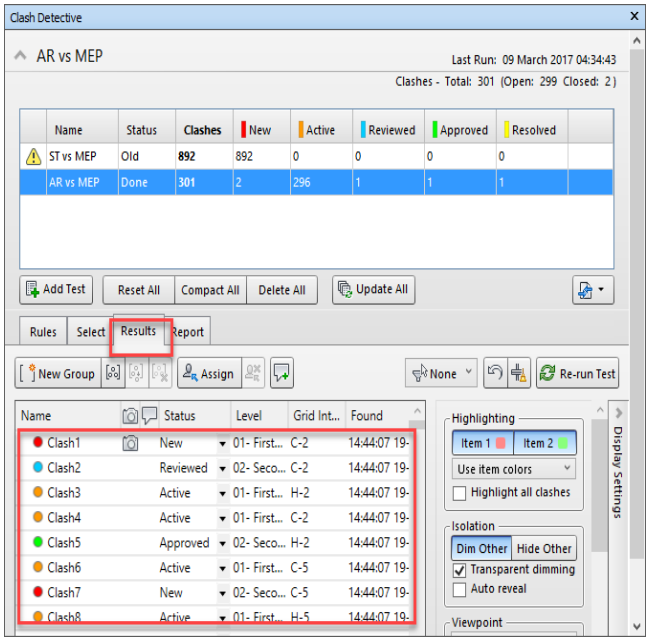


**Fig 3** Clash Detective showing the results tab

9. Further, for creating report of clash test click on Report tab and creating report on .XML file format which is shown in fig 4 and fig 5

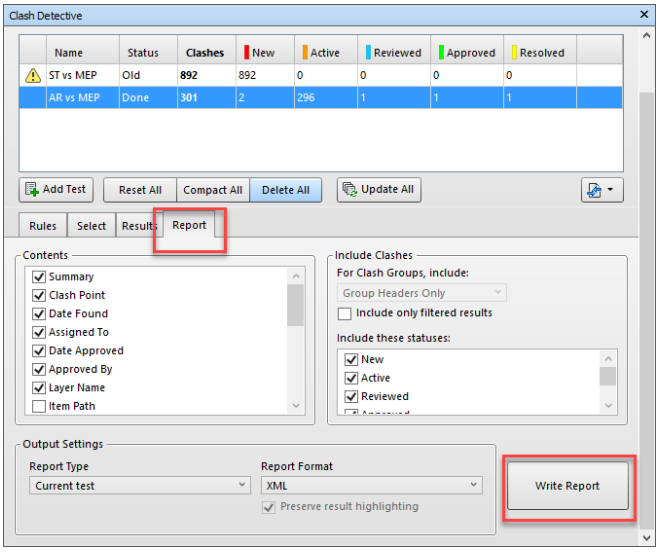


**Fig 4** Clash Detective showing the report tab


**Fig 5 :** Clash report generated by Navisworks

10. Clashes can be resolved by changing position of particular element i.e. figure no 8 shown that clash can be resolved by changing slope of pipe.

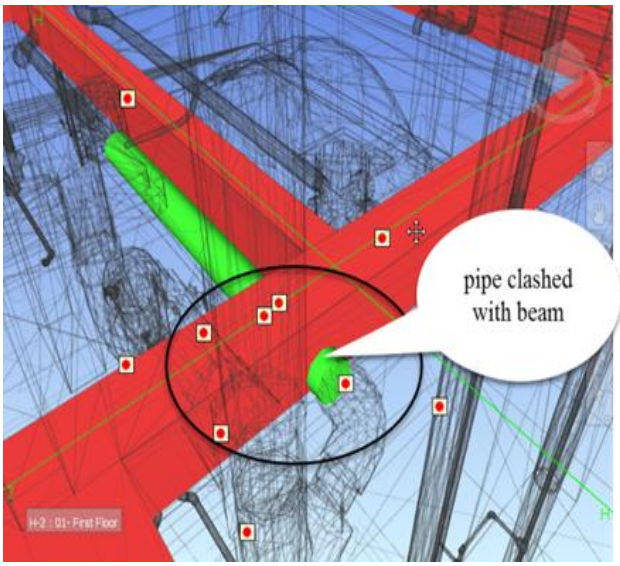


**Fig.6** Clash between pipe (Green) and Structural Beam (Red)

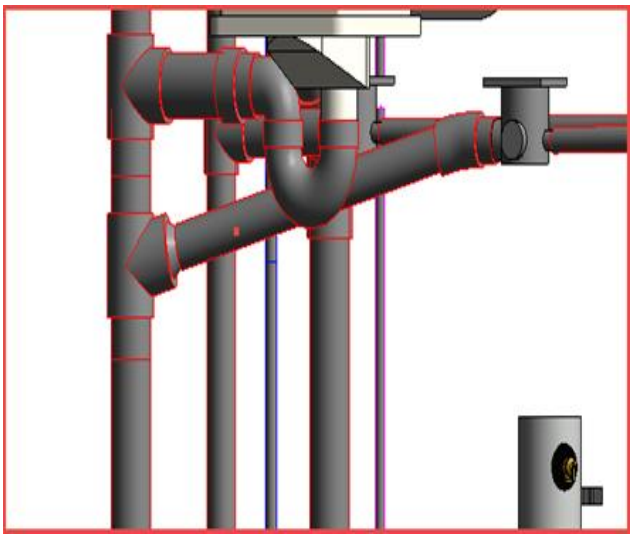

**Fig 7.**pipe position before clash resolving

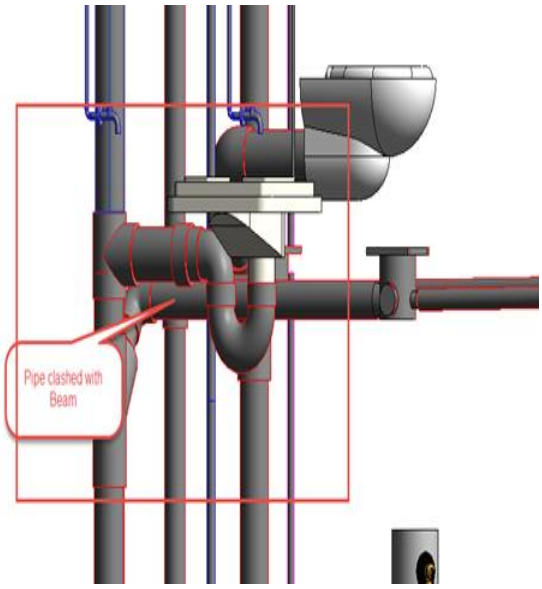


**Fig 8** .Resolving clash between pipe and beam by Changing slope of pipe

## 6. CONCLUSION

1. Building Information Modeling (BIM) is rapidly growing within the AEC industry where its current implementation shows great effects on projects in terms of performance, time and cost.

2. In Indian construction industry is not applying the true potential of BIM tools. Indian AEC industry is not aware about BIM technology and its capacity and they are unskilled BIM users.

3.Using Clash detection in this case study instead of traditional method detects the conflicts in 3D Model before actually construction starts of building so that it is useful for to decrease coordination errors, human errors so that results in high level of accuracy of models. So this will be avoiding re-work on jobsite.

4. 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.

5. Hence, implementation of clash detection tool is very important for error-free construction project helps to optimize time in the construction schedule and minimize the overall cost of project at the construction stage

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**BIOGRAPHIES**

Swapnesh. P. Raut received his BE degree in civil engineering from shivaji University (Maharashtra) in 2015, pursuing the M.Tech degree in Construction Management from Government College of Engineering, Karad, Maharashtra. His research interest is Building Information Modeling.

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