STUDY ON BUILDING INFORMATION MODELING AND IMPLEMENTATION OF CLASH DETECTION TOOL IN BUILDING DESIGN

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Abstract

Building Information Modeling (BIM) is recently becoming popular and a extremely economical resolution for information management in Architecture, Engineering and Construction (AEC) industry. In Indian construction state of affairs most of the projects are still using 2D CAD drawing for his or her execution purpose. These 2D CAD drawings have lot of issues during execution like miscommunication, misunderstanding and time consuming process etc., This sort of errors and cost is reduced while using this BIM process Clash detection tool is an application of BIM which is employed for the coordination of building systems within 3D building models. This report gives a short introduction about Clash detection in BIM and it focus the methodology involved conducting clash detection analysis using building information modeling. This work involves searching for, how this clash detection tool helps to optimize of clashes in construction of particular building using BIM Coordination. The methodology involved in this report will be study of a G+3 residential building which consist of an architectural, structural and Mechanical, Electrical and Plumbing (MEP) BIM models and their subsequent clash detection analysis is done in this study, commercial software like as Autodesk Revit 2021, Autodesk Navisworks Manage 2022 are used. It also focuses on the methods of simplifying and standardizing the method of Clash Detection using Autodesk Navisworks. The entire cost of the project won't be increased and completion of the project on time and avoids overruns of budget.

***Key Words*: BIM, Clash detection, Navisworks ,Revit etc**

1.INTRODUCTION

Building Information Modeling (BIM) is process that supports virtual design and construction methodologies putting all platoon members together throughout the entire design and construction process and beyond to the operations in conservation of the structure, during its working life. Generally, BIM is one holistic process using real- time, intellectual modeling software effectively working in 3D, 4D (3D time), and 5D (4D cost), D (5D installations operation) to ameliorate productivity, to save plutocrat and time in the design and construction phases, and to reduce operating costs after construction. Clash resolution is one of the tool helps to optimize the time and cost of the construction. The National Building Information Modeling Norms (NBIMS) commission of US defines BIM as, " a digital representation of physical and functional characteristics of installation. BIM is a participated knowledge resource for information about a installation forming is liable base for opinions during its life cycle i.e. from foremost generality to obliteration. A introductory premise of BIM is the collaboration by different stakeholders at different phases of the life cycle of a installation to fit excerpt, update or modify information in BIM to support and reflect the places of that stakeholder".

1.1 AIM

The aim of the study is to identify barriers to strategic implementation Of Building Information Modeling (BIM) within construction industry & Minimization of construction waste through BIM based clash detection tool.

OBJECTIVE

1) To explore the process of Building Information Modelling.
2) To Create and integrate project delivery (IPD) system using BIM .That unifies Different Disciplines (Architecture, Structure & MEPF)
3) To Use Navisworks for Clash Detection.

1.2 SCOPE OF WORK

In this project, A G+3 Residential model of Alameda Point Block 9, Atlantic Ave Alameda, California 3D model is modelled. Building architecture had been created by Revit Architecture software. Structural details of this building had been created by Revit Structure software and MEPF (Mechanical, Electrical Plumbing & Fire) services had been created by Revit MEPF software. The Architectural, structural and services models were imported into Navisworks software to identify the clashes among various disciplines. The clashes were identified.

The main objectives of this thesis is to test and validate the integrity and correctness of the created 3D parametric model by exporting BIM content in a format that maintains the integrity of the created objects in the 3D parametric

model, not only from a geometric point of view but also from a data and information point of view, after which to carry out an analysis to identify the conflicts between the different disciplines taken into consideration, in this case the architectural, structural and the mepf one. In order to obtain a consistent and as complete as possible data integrity, it was necessary to establish from the early stages of the project which types of parameters were needed.

2. WHAT IS BIM?

Building Information Modeling (BIM) is the holistic process of creating and managing information for a building project. Based on digital model and created by a BIM platform, BIM integrates structured, multi-disciplinary data to produce a digital representation of a project through its lifecycle, from planning and design to construction, operating and maintenance.

"BIM simulates the construction project in a virtual environment. With BIM technology, an accurate virtual model of a building, known as a building information model, is digitally constructed. When completed, the building information model contains precise geometry and relevant data needed to support the design, procurement, fabrication, and construction activities required to realize the building"

Adopting BIM methodology benefits to a great degree all the parties concerned with the project, starting with the different designing teams as it enhance the collaboration between them, minimizing the errors that results if each team worked separately without sharing information about their work, it also helps to have a fast and correct design process as the checking process will be in all disciplines combined in one model so conflicts can be detected before construction starts. For the owners with complete BIM model, it is easier to operate and apply maintenance to the project.
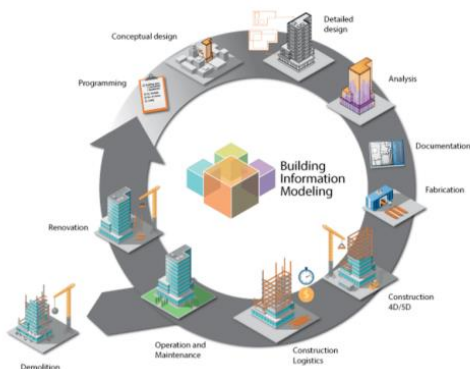
Fig -1: Project management with the BIM methodology [source: https://BIMmda.com/en/what-is-BIM]

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.

3.1 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

4-METHODOLOGY

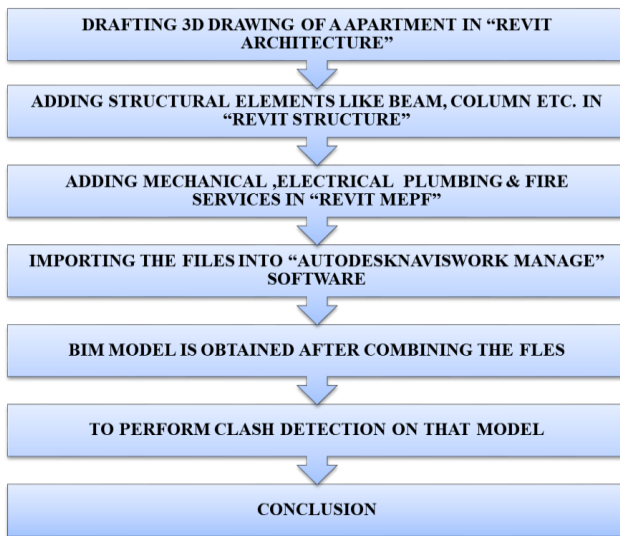The following flowchart explains the methodology of this report.

Chart- 1-Methodology

4.1- Model creation

4.1.1-Data Collection

The plan of a G+3 residential apartment, which is a proposed project in Alameda CA of Alameda point block 9 A building, is taken for study. CAD file of extension ".dwg" is been used for all disciplines before starting the modeling.

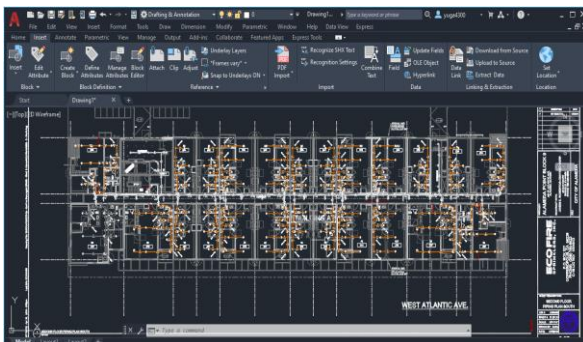Figure-2 shows CAD drawing of the Fire system of Block A

Fig -2: AutoCAD dwg screenshot

4.1.2 Autodesk Revit

• There are lot of software's available for creating 3D model, but Autodesk Revit which is the best software in this area is used here.

• In this project Revit software 2021 version is used for creating the 3D file.

• In Autodesk Revit, Revit Architecture, Revit Structure and Revit MEPF (Mechanical, Electrical Plumbing & Fire) are to be created separately in different revit files.

• The templates for different disciplines should be used and proper levels and co-ordinates of project should be set, it is very important for coordinating model at same place and finally it is to be coordinated with each other by linking all models together as linking process explained in point no 3.4

• Each discipline have separate template file for making model.

• Revit architecture 3Dis represented in figure 3. Revit Structure 3D view is shown in figure 4. And Revit MEP 3D view and Coordination image are shown in figure 5,6 & 7
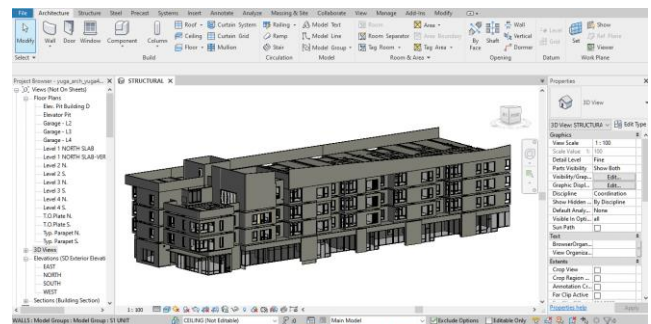
Fig. 3-Revit Architecture 3D model
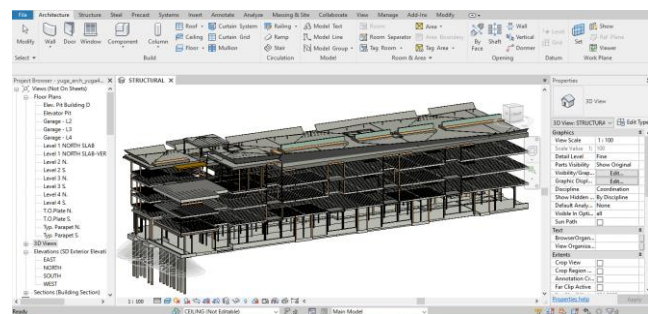
Fig. 4- Revit Structure 3D model
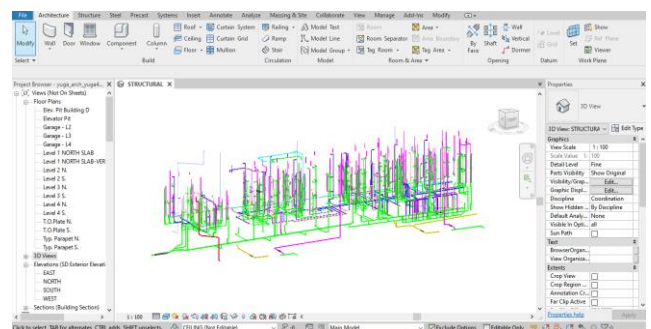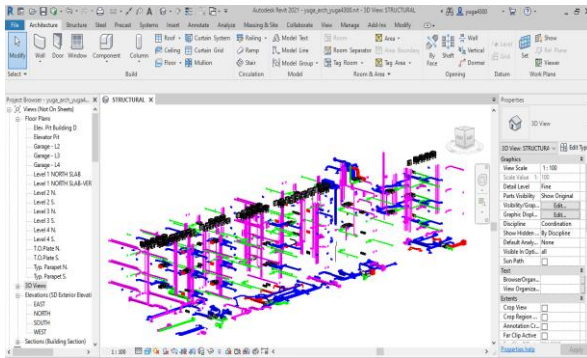

Fig. 5- Revit plumbing model
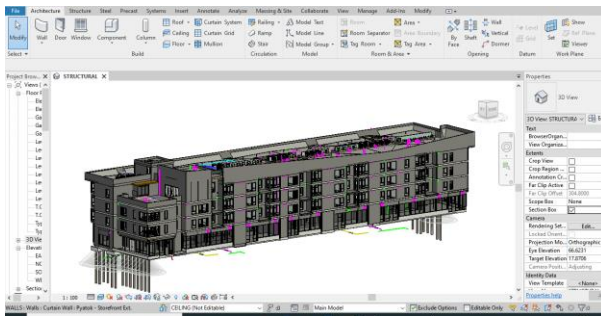
Fig. 6-Revit MEPF model

Fig. 7- Revit Co-ordination (Architecture, Structure, MEPF)

5-BIM MODEL CHECKING

5.1 Model checking

BIM is based on data exchange between the different involved actors during all the project phases, therefore it is of significant importance to verify these data in order to guarantee reliable results in the next phases such as analysis, operating and maintenance. The checking process includes all the different data implemented in the digital model either geometrical or non geometrical information by testing the BIM model thorough validation domains.

There are three main phases to carry out model checking process, each one is concerned about specific type of model testing, Figure-8 shows these three phases.
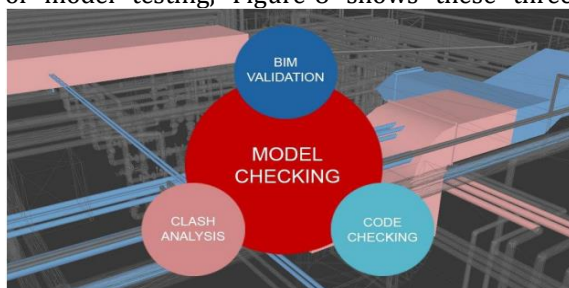
Fig-8: BIM Model Checking Phases.

There are several platforms and tools to do such important phases of BIM such as:

• usBIM.Checker

• Solibri Model Checker

• Autodesk Naviswork

6- CLASH ANALYSIS

Nine separate clash tests were conducted:

1) Architectural Model versus Structural Model (AR Vs ST),

2) Architectural Model versus Mechanical Model, (AR Vs HAVC)

3) Architectural Model versus plumbing Model, (AR Vs PHE)

4) Architectural Model versus Electrical Model, (AR Vs EE)

5) Architectural Model versus Fire Model, (AR Vs FF)

6) Structural Model versus Mechanical Model, (AR Vs HAVC)

7) Structural Model versus plumbing Model, (AR Vs PHE)

8) Structural Model versus Electrical Model, (AR Vs EE)

9) Structural Model versus Fire Model, (AR Vs FF)

The software was set to detect only hard clashes, with a tolerance of 0.05 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 study software used for clash detection process is Autodesk Navisworks Manage 2022. 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 to run clash analysis in Navisworks is to open the models which we want to check conflicts between them, to do that from Home tab in Navisworks we can choose Append and then choose the required models as shown in Figure 9 .
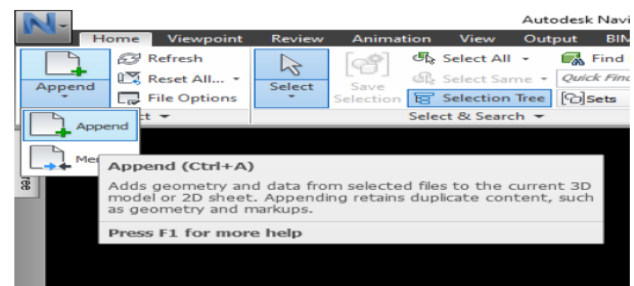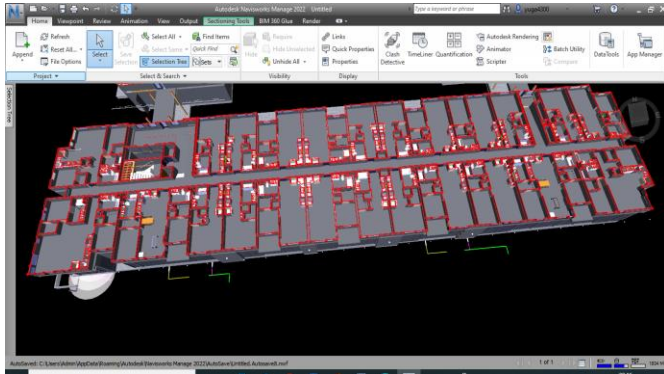

Fig-9 : Adding different models to Navisworks.

2- Architectural-Structural and MEPF models were opened after exporting each one of them form Revit as NWC files, Figure 10 shows them in navisworks after merging them together.

**Fig-10** Architectural, Structural and MEPF models merged in Navisworks.

3-To run the clash analysis, it is easy to click on Clash Detective icon which can be found in Home ribbon as shown in Figure 11
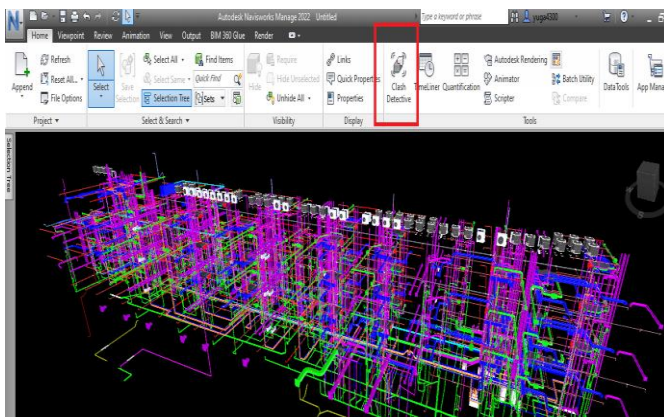
Fig-11 Opening Clash detective in Navisworks

4-After that Clash Detective window open where we can click on Add Test, then give it a name and chose the models we want to run the test between them.

In the bottom of the window there is the zone of clash test settings where we can define the rules of the test such as type and tolerance. It was chosen to run test between Architectural-Structural model and Mechanical model of the underground parking zone. It was chosen to run hard clash test with tolerance equals to 0.05 m as shown in Figure 12
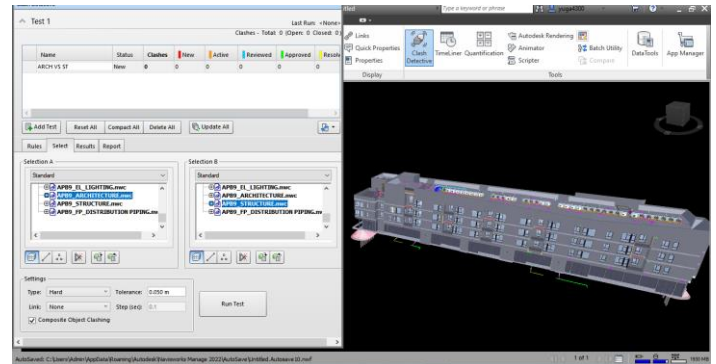
Fig-12: Defining rules for clash test in Navisworks.

5- After setting the criteria for the test and then clicking on Run Test, the software takes some seconds and then shows the results of the test, for each detected clash, the software shows some information about it in terms of level, grid, date and what are the elements which have the clash between each other as shown in report which shows elements IDs.

The software also gives the possibility to highlight the clash in the model, it gives two distinct colors (green and red) for the clashed elements, in this way it is easier to visualize and to know the position of the clash in the model and the type of elements that has intersection between each other, as shown in fig-13
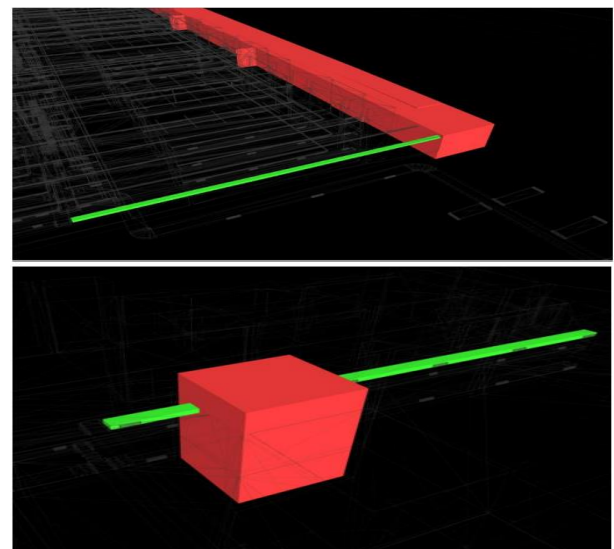
Fig-13: Navisworks highlighting the detected clashes

6- After the clashes between element of Architectural Model versus Structural Model ,Architectural Model versus MEPF Model & Structural Model versus MEPF being easily recognized. Result inspection is done using Results tab.

7-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 14
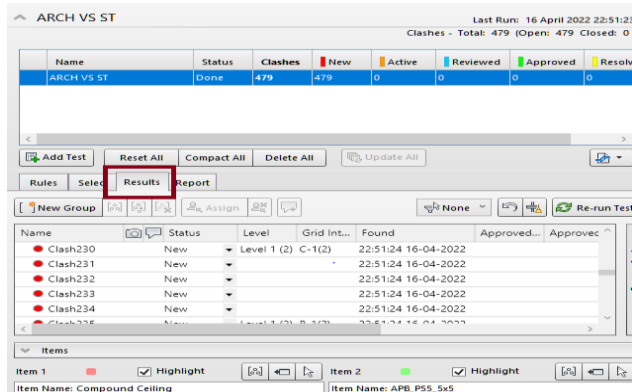

Fig. 14- Clash Detective showing the results tab

8-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 15

Fig 15: Exported report of clashes

9-Clashes can be resolved using clash report element ID by changing position of particular element i.e. figures 4.8, 4.9 & 4.10 shows the clash can be resolved by changing the length of pipe.

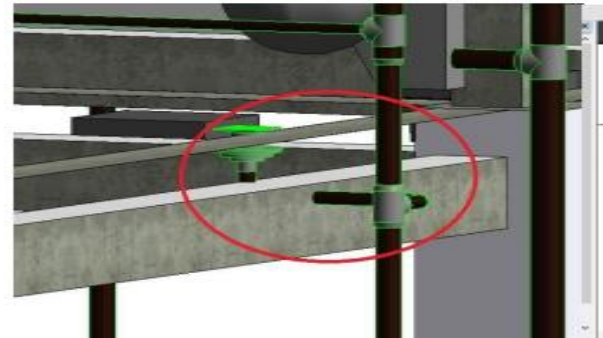**Fig 16:** Clash between pipe (Red) and Structural Beam (Green)

Fig 17-: Pipe position before clash resolving

Fig- 18-: Resolving clash between pipe & beam by changing length of pipe

In this project totally around 3826 clashes are detected in clash test from all disciplines. And all the clashes are resolved using element ID exported in clash report. The clash we assigned is visible in Autodesk Revit, once we open it and paste the element ID in Select by ID‟ tab in Revit. Each clash can be selected to know the location of it and separate labeling can be done too. From Revit Architecture the rectified file is exported in .nwf‟ format. Once the changes are done the file Navisworks is opened again to check for clashes. The clash report can be exported as text file or HTML file
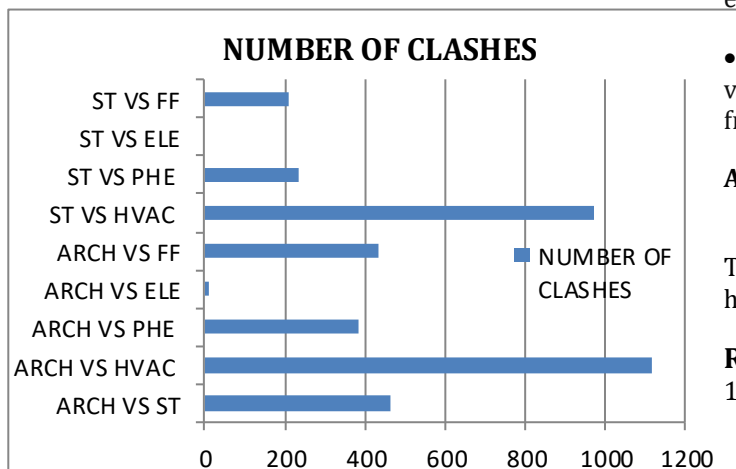
7-RESULTS & DISCUSSIONS

In this study while conducting clash detection test, nine various disciplines were compared with each other. The final result of clash test reports for Architectural Model versus Structural Model are 463 clashes, Architectural Model versus Mechanical Model 1117, Architectural Model versus plumbing Model 383, Architectural Model versus Electrical Model 9, Architectural Model versus Fire Model 436, Structural Model versus Mechanical Model 971, Structural Model versus plumbing 235 Model, Structural Model versus Fire Model 212 & Structural Model versus Electrical 0.Each clash was separated by category and resolved using element ID of that clashing members. The element ID was copied from the clash report and that ID pasted into the Revit to

locate the clashing elements. Finally it is resolved by changing the element.

Chart-2-Clash test results

Chart -3-Clash test chart

As per the results shown the no of clashes are more between MEPF by resolving this clash a lot of time and rework is saved before execution .To solve these clashes will depend on the type of element in ARC-STR model, for example if the clash is a wall with duct line it can be easily resolved by making an opening in the wall but if the clash is with structural element such as a column a decision has to be made in the coordination meetings to decide which discipline will modify his work in order to eliminate that clash.

8-CONCLUSION

• The Indian construction industry is less accustomed to using the true power of BIM tools and its power.

• Using clash detection on this examine rather than traditional approach detects the Clash in 3D veiw before starting of real construction so that it's far beneficial to decrease coordination mistakes, human mistakes which leads to excessive degree of accuracy of fashions. therefore re-work in project may be avoided.

• In this report totally 3826 clashes were identified and they were resolved. So in the result of G+3 apartment building

nearly 1% of saving can be done design phase only, when in this model implement in real time construction, it helps to save more time & cost.

• Autodesk Navisworks makes the clash detection manner faster and easier together with absolutely lowering the scope of human errors during its execution. design clashes that arise among constructing factors are successfully identified via Navisworks and they're well timed solved. as a result whole elimination of layout errors, optimize time and price may be very important for AEC industry before actual construction starts off evolved on site

• Therefore, implementation of clash detection could be very important for Error free model which lead to less error free clash at actual site .

ACKNOWLEDGEMENT

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