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"A New Framework for Visual Interactive Modelling and Simulation for Construction Projects: (BIM)"

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Abstract— *the effect of BIM in the design phase of the construction process and how this technology can detect all existing clash in construction plans during the design phase. The research was carried out through a case study that contains an architectural, structural, and Mechanical, Electrical and Plumbing (MEP) BIM model and their following clash detection. The current study implemented Autodesk Revit and Autodesk Navisworks Manage as BIM tools to develop features to simplify and automatically clash detection process. The Clash Detection tool is one of the most useful applications 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 model and their consequent clash detection. In this case study, commercial software such as Autodesk Revit 2016, Autodesk 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

I. INTRODUCTION

Building Information Modeling is a shrewd model-based procedure that gives assistance to design, structure, develop, and oversee structures and foundation. BIM gives knowledge to singular structure parts (for example windows, dividers or chillers) just as giving framework and building-wide data and mindfulness (framework streams or building loads).

The BIM procedure includes members from the whole task life cycle (modeler, engineer, temporary worker, proprietor, offices the board, and so on.) who all contribute and speak with BIM creators, who are approached to give progressively exact vitality demonstrating information. BIM is to be considered as the way toward making and utilizing computerized models for plan, development as well as activities of building ventures. These models join shrewd 2D and 3D objects used to characterize a structure plan, alongside outside variables, for example, geographic area and nearby conditions, into a virtual structure database that gives a solitary, incorporated hotspot for all data related with that building's plan.

The "insight" ascribed to the items incorporates characterized graphical and non-graphical data, giving the designers, Mechanical Electrical Plumbing (MEP) specialists, and temporary workers the capacity to speak to geometric and utilitarian connections between building components. This data takes care of an incorporated database, which thus takes care of all structure archives and calendars for the structure venture. At the point when a change is made to the structure model, every single graphical view (plan, height, detail, and other development drawings), just as non-graphical perspectives, for example, the structure reports and calendars, consequently mirror the change.

1.1 Necessity of Building Information Modelling

a. Better Collaboration and Communication

Advanced BIM models consider sharing, working together, and forming that paper drawing sets don't. With cloud-based instruments, for example, Autodesk's BIM, BIM cooperation can happen over all orders inside the undertaking. The BIM biological system permits groups to share venture models and facilitate arranging, guaranteeing all plan partners have knowledge into the undertaking.

b. Model-Based Cost Estimation

Numerous Architecture, Engineering and Construction firms understand that incorporating estimator's prior in the arranging stage takes into account progressively compelling development cost estimation, which has prompted the development of model-based expense evaluating. Utilizing BIM instruments, for example, Autodesk's Revit computerizes the tedious undertaking of evaluating and applying costs, permitting estimators to concentrate on higher worth components, for example, distinguishing development congregations and calculating dangers.

c. Preconstruction Project Visualization

By utilizing BIM, one can design and envision the whole undertaking during preconstruction, before the scoop hits the ground. Space-use reenactments and 3D perceptions permit customers to encounter what the space will resemble offering the capacity to make changes before development start. Having a more prominent diagram from the earliest starting point limits costly and tedious changes later.

d. Improved Coordination and Clash Detection

BIM permits to more readily facilitate exchanges and subcontractors, recognizing any MEP, inner, or outside Clashes before development starts. By keeping away from Clashes, decrease in the measure of adjust required is accomplished on

some random activity. BIM gives the chance to design it directly before you construct nearby. Evading a minute ago changes and unexpected issues by empowering simple exploring and remarking over numerous controls.

e. Improved Scheduling/Sequencing

Similarly, that a significant number of these advantages set aside cash, they spare time by decreasing the hour of task cycles and disposing of development plan mishaps. BIM permits plan and documentation to be done simultaneously, and for documentation to be effortlessly changed to adjust to new data, for example, site conditions. Calendars can be arranged all the more precisely and conveyed precisely, and the improved coordination assists ventures with being bound to be finished on-schedule or early.

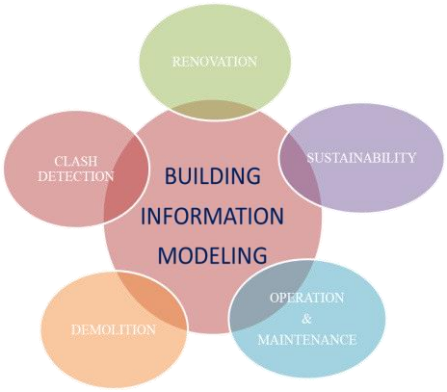

Figure1.1: BIM Model

f. Expanded Productivity and Prefabrication

BIM information can be utilized to in a split second create creation drawings or databases for assembling purposes, taking into consideration expanded utilization of construction and particular development innovation. By planning, enumerating and fabricating offsite in a controlled domain, you can lessen squander, increment effectiveness, and diminish work and material costs.

g. Uses of BIM during Construction

Development Phase: During the development stage the observing, investigation and assessment of the undertaking plan are basic to the capacity of the CM to comprehend and decipher venture progress, current status, and pending timetable improvements. With 4D planning, this ability will be upgraded and refined according to the accompanying focuses.

II. LITERATURE REVIEW

Building Information Modelling, Shrikant Bhuskade (International research journal of engineering and technology), 2020

Author shows that the Building Information Model are created, the amount takes off can be produced to give cost estimations on a development venture. BIM based 4D booking helps comprehension of the development parts and calendar progress than thus results better development arranging. At the end of the day, BIM gives time and cost reserve funds and yields better quality development items.

The research shows how BIM technology will benefit for Architect, Engineer and Contractors for estimating and schedule and cost controls. Autodesk Revit is BIM software for architects, structural engineers, MEP engineers, designers and contractors. It allows user to design a building and structure and it components in 3D, annotate the model with 2D drafting elements, and access the building information from the building models database.

BIM to follow up milestones in a project plan, Mejlaender-Larsen (WIT transactions on built environment), 2021

This study assesses how object status in a BIM can be related to milestones in a project plan. The paper examines how a project plan can be connected to a BIM, focusing in the benefits and possibilities of adding status to objects in the BIM and how project progress can be reported and visualized using BIM. By defining control objects in the BIM and adding quality levels that measures status related to milestones, control objects can be connected to activities in the project plan. Status on each activity related to each milestone can be obtained directly from the BIM. Instead of manual reporting, progress towards milestone in the project plan can be reported directly from BIM.
This paper has presented control items and how the quality levels on this are characterized utilizing distinctive status definition. Right quality levels on each control object for each order to every achievement in the plan stage can be reached by satisfying significant agenda.

BIM for developing countries, Nam Bui, Christoph Merschbrock, Bjorn Erik (Elsevier Ltd.), June2020

Contributes an update of BIM implementation in developing countries; they have highlighted increasing interest of developing countries in BIM. Amongst 135 developing countries which they have studied, BIM implantation studies were only reported in China, Malaysia, India which indicates research gap regarding other 132 developing countries. They found that developing country firms view BIM as risk investment since its business value remains unclear. BIM should be bolstered by customers, temporary workers, and government in creating nations. It prompts infer that more work is expected to grow new BIM arrangement that better location the setting of neighborhood development enterprises in creating nations.

BIM based supply chain (SC) model, E. Papadomikolaki, R. Vrijhoef, J.W.F. Wamelink (WIT transactions on the built environment), 2021

This paper proposes a model to integrate the construction supply chain through BIM. The various information flows in the construction SC are not cleared. BIM is an aspiring integrator of information that could potentially improve search multi-disciplinary information flows. The paper presents a method to bridge information gaps and integrate the team using BIM based SC modelling. The author studied that, BIM in support of the-

- Material flow
- Cash flow
- Information flow
- Stakeholder network.

The proposed multi model framework for SC integration identifies an analysis the organizational, operational and technical complexity and utilizes full potential of BIM technology and SCM theory, by using BIM as an information integrator and SCM as a trust in collaboration environment respectively. The building

process data combine stakeholder's information and joins to a structured representation and analysis framework for the AEC SC.

BIM and sustainability in construction Projects: A case study Bahriye Lihan, Hakan Yaman, Aug2021

The Author plans to inspect supportable development ventures for a setting up a sub structure to fill the hole of BIM combination with guidelines of feasible development by directing a contextual investigation, for a successful reaction to the examination destinations, the exploration procedure incorporates four primary advances:

- ✓ Preparing the principal points to be talked about and the inquiries
- ✓ Determining relating members to lead the contextual investigation and interview
- ✓ Performing the fundamental meetings and information assortment,
- ✓ Data examination and assessing the outcomes. The creator discovers the connection among BIM and maintainable development venture as the initial step of an utilitarian model for this combination by looking at the status of firms that complete reasonable activities in Turkey.
- ✓
- ✓ The consequences of the examination show that BIM isn't utilized altogether for supportable undertakings including all structure creation forms because of absence of distributed spending plan for proficient BIM use and qualified staff. The advantages gave by BIM programming in the structuring procedure are not yet acknowledged by the planner temporary worker and proprietor.

BIM; The Impact of project attribute towards client demand in BIM based project, N.A.H. Habzaman, R. Takim, A.H. Nawawi (WIT transaction on built environment), 2022

It examines the current views on identifying the correlation of project attribute, towards client demand. It revels seven project attributes i.e. feasibility, definition, duration, project location, objectives. While client demand is time, cost, quality. Cronbach's Alpha is used for examining the reliabilities in internal consistency. The calculation of Cronbach's Alpha is based on number of items and average interterm correlation

Aim & Objectives

Aim: "A New Framework for Visual Interactive Modelling and Simulation for Construction Projects: (BIM)"

- ❑ Analysis an Interpretation of all the data collected in BIM system and removal of the clashes encountered.
- ❑ Cost reduction through scheduling of project.
- ❑ To develop generalize guidelines to avoid clashes between various agencies during construction of a commercial building.

METHODOLOGY

What is Building Information Modelling?

The process of creating and managing all the information about a project mostly associated with design and preconstruction, allows projects to be built virtually before they are physically completed. Eliminating many of the inefficiencies and problems that arise during construction process

Scope of the project work

- To provide 5D representation of the building for better understanding.
- To decrease in rework by bringing out proper coordination which results in reduction of cost and time
- To provide simplified and standardize solution for clash detection process

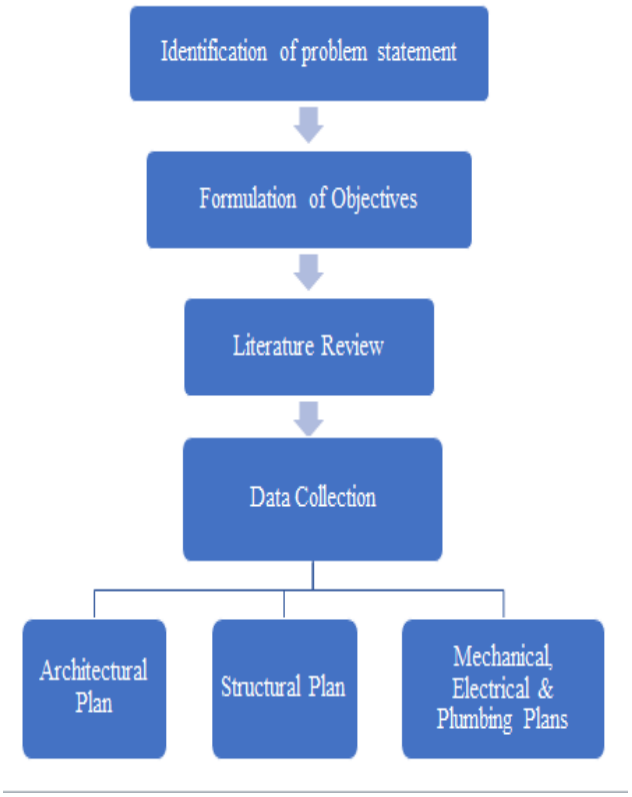

Figure1.1 Flow Chart of Methodology

Proposed Process Design

Determination of the site

- ✓ The assortment of the information with the end goal of the task is completed for making a 3D model.
- ✓ The locales to be chosen is business working in Pune district.
- ✓ To accomplish the destinations of the undertaking; the information from the locales is gathered which have the accessibility the accompanying plans:
  - ➢ Architectural Plan
  - ➢ Structural Plan
  - ➢ Mechanical, Electrical and Plumbing Plans

The site is chosen based on mechanical arrangements that is Ducting, electrical and plumbing. Each part of the MEP necessity ought to be present.

DATA ANALYSIS

Flowchart of the workflow of software's used for creating the BIM Model to bring out the clash detection in the office building

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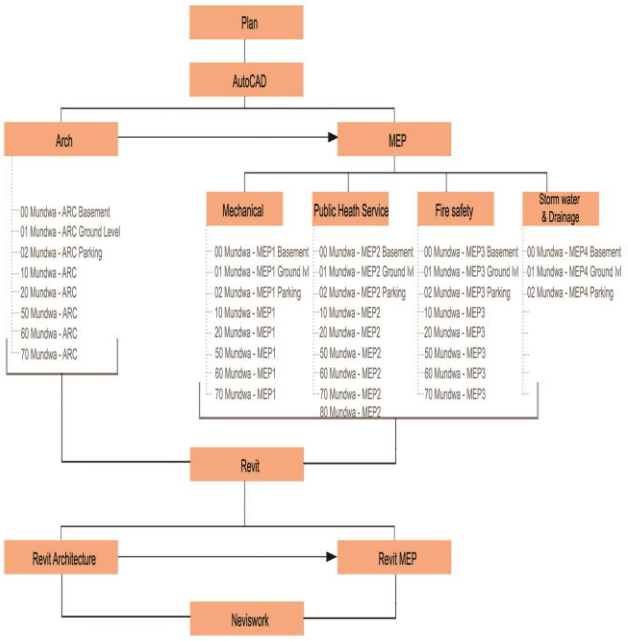


Building Services of the commercial building

This case study consists of following Building Services system of the workspace:

A. Mechanical Ventilation System

B. **Public Health Engineering Systems**:

- ✓ Domestic System
- ✓ Drainage System
- ✓ Sanitary Fixtures

C. Fire protection System

Clash Detection

1. Clash detection is a component of the Building Information Modelling (BIM) process and is the realization of conflicts or clashes, whether structural or MEP, through an automated and computerized approach.
2. Clash detection can be carried out on multiple 3D models and is an invaluable tool for designers, architects, builders, engineers and contractors to determine clashes or conflicts in the structures.
3. Clash detection is used for checking completed/ongoing work and reduces the risk of human error during model inspection.

Type of Clashes

1. Hard Clash - When two objects pass through each other. Most BIM modelling software eliminates the likelihood for this using clash detection rules based on embedded object data.
2. Soft Clash - Work to detect clashes which occur when objects encroach into geometric tolerances for other objects (for example, a building being modeled too close to a high tension wire).
3. 4D/Workflow Clash- Clash resolves scheduling clashes and abnormalities as well as delivery clashes (for example, work crews arriving when there is no equipment on site)

Design Work

AUTOCAD 2017

CAD (Computer Aided Design) is a tool that can be used for drafting activities. Since it uses the computing power of a processor, CAD drawings are faster, better and more accurate than their manually drafted counterparts.

Currently AUTOCAD is for a few different things. Depending on the scale and the complexity of MEP flow diagrams and one-line diagrams, CAD uses to develop and manage them. BIM template has views set up for legends for all of fittings.

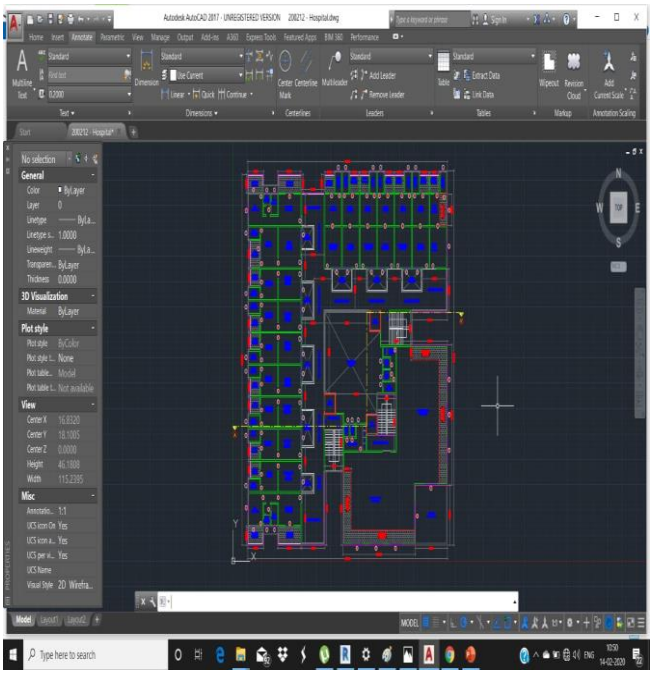
Anytime old detail will convert it to Revit and change all the line types and clean it up. Then it will be put into Revit details library file, archiving the old CAD detail. So, it is still being used to bring in details until ending up is done by going through them all. CAD is used extensively in BIM process but as for MEP and Architecture, it gets farther and farther away from it with each release of Building Design Systems as they add features that reduce the need for CAD."

Revit Architecture and MEP 2017

Revit is database structure and object definition modelling; is effective modelling software the preferable work practice is of course when all the modelling 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 report; trace Clashes, Status Clashes, Set Rules, Custom Clash Test, and Clearance Tests, Time Based Clashing or track changes.

MODEL APPLICATION, RESULTS & DISCUSSION

AutoCAD Plan



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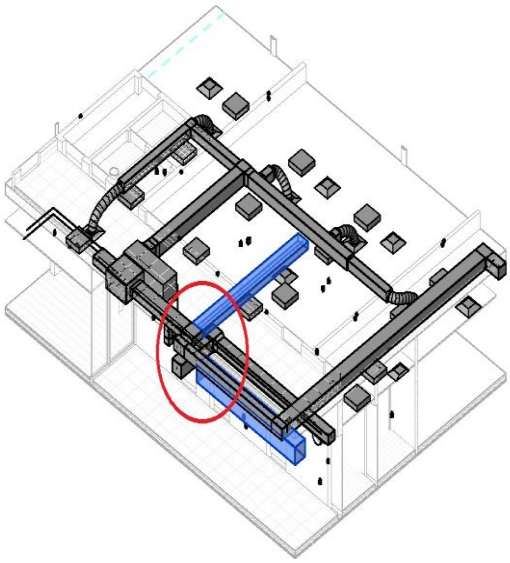
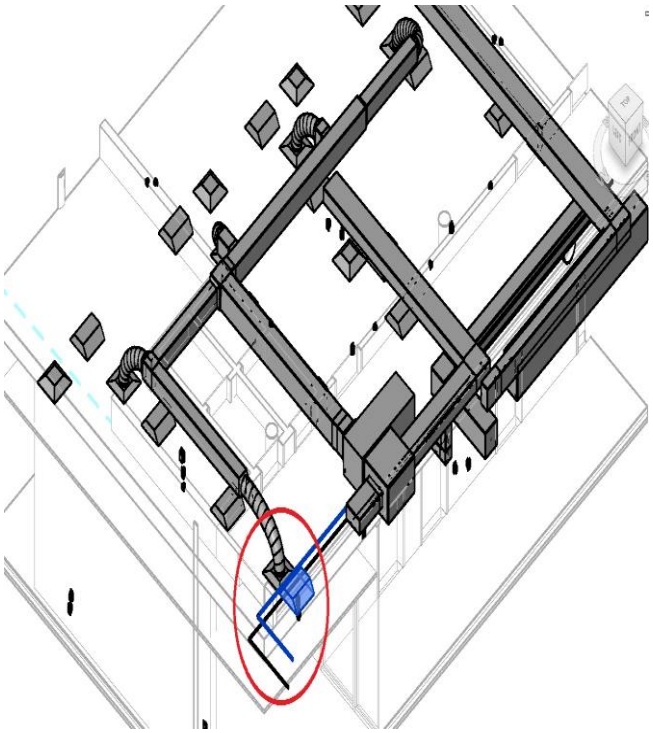
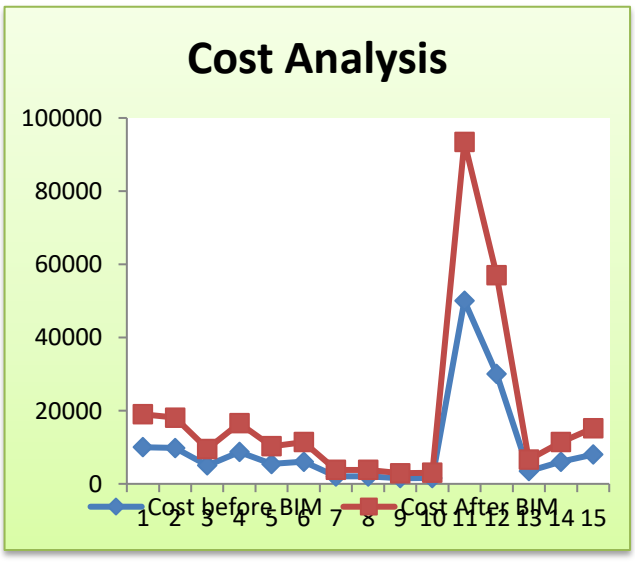
Clashes Occurred:
Clash of Structural member and MEP component
A. Clash between the beam and the duct



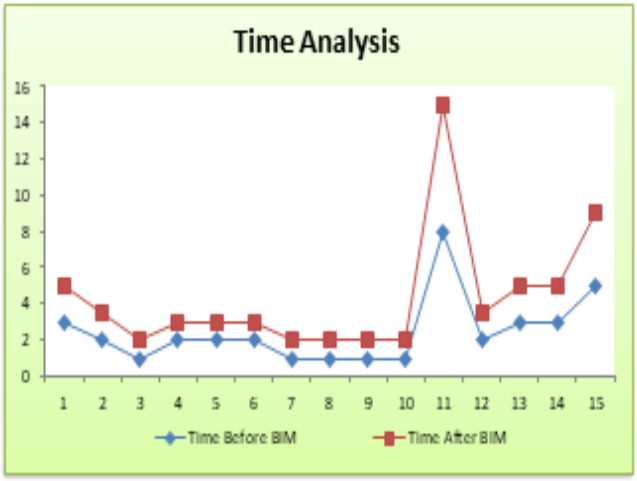
B. Clash has occurred between the AC inflow duct and the piping



Sr. Not	Name Of Re- Work	No. of floors	Time Before finding Clashes (Days)	Time After Considering Clashes (Days)	Cost Before finding Clashes	Cost Aftercosidering Clashes	remark
1	Clash between beam and duct	2	3	2	10000	9000	Duct position have to change to avoid clash
2	Clash between AC inflow duct and piping	3	2	1.5	9760	8784	Ac inflow and pipe length is changed that may increases cost
3	Clash between air terminal and ceiling	3	1	1	5000	4500	Air Terminal have to change
4	Clash between Duct and Mechanical unit	3	2	1	8700	7830	Mechanical unit place have to change
5	Clash between Duct and Pipe	3	2	1	5400	4060	Pipe length will increase
6	Clash between Duct fitting andduct	3	2	1	6000	5400	Duct fitting is change
7	Size changed between duct and pipe	3	1	1	2000	1800	Change pipe diameter
8	Clash between Pipe position and beam	3	1	1	2000	1800	pipe positing have to change
9	Clash detection between HVAC and electrical	3	1	1	1500	1350	Pipe length is increase
10	Clash detection between PHE pipe and HVAC duct	3	1	1	1570	1413	pipe length and position change
11	Clash detection between Plumbing and mechanical	3	8	7	50000	45000	At different location this clashes are found
12	Clash detection between Plumbing and structural	3	2	1.5	30000	27000	At different location this clashes are found
13	Clash detection between Electrical and structural	3	3	2	3458	3112.2	At different location this clashes are found
14	Clash detection between Electrical and Plumbing	3	3	2	6000	5400	pipe positing have to change
15	Clash detection between Electrical and mechanical	3	5	4	8000	7200	At different location this clashes are found
	Total		37	28	149388	134449.2	



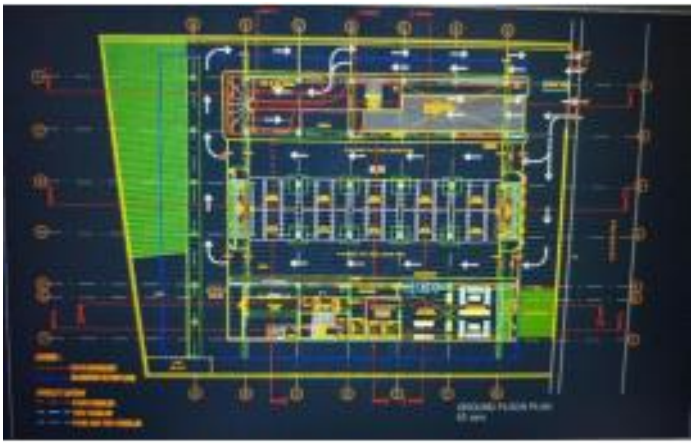
Time cost analysis



Mundhwa Office Building = Monthly Target Sheet = Dec 2023			
Task Name	**Duration**	**Start**	**Finish**
Mundhwa Office	828.9 days	3-Sep-18	9-Jun-21
RCC Floor Slab	485.8 days	15-Dec-18	23-Jul-20
Brick Work	10 days	13-Mar-20	31-Mar-20
Fabrication curtain system	1 day	28-Mar-20	30-Mar-20
Int. Plaster	16 days	25-Dec-19	7-Sep-20
Internal Back Coat/ Sanla Plastering to Walls	15 days	29-Feb-20	7-Mar-20
Internal Gypsum Plaster	179 days	17-Feb-20	11-Jan-21
Plumbing Work	14 days	17-Feb-20	4-Mar-20
Int. Plumbing Work (Toilet , W.B, Kitchen, Utility)	14 days	4-Mar-20	23-Mar-20
Ext. Plumbing Works	16 days	4-Mar-20	25-Mar-20
Ext. Plaster	261 days	26-Mar-20	16-Apr-20
Double ht Plaster	206 days	25-Mar-20	6-Feb-21
Waterproofing Works	236 days	3-Apr-20	16-Jan-21
Toilet Waterproofing (Basecoat)	188 days	3-Apr-21	21-Nov-22
Toilet Waterproofing (Brick Bat Coba)	191 days	22-Apr-21	14-Dec-22
Terrace + Utility W/P	235 days	4-Apr-22	16-Jan-23
Tiling Works	293 days	11-May-22	3-May-23
Window cill, Door Frames(Stone)	191 days	11-May-23	31-Dec-23
Toilet	186 days	27-Jun-23	12-Jan-24

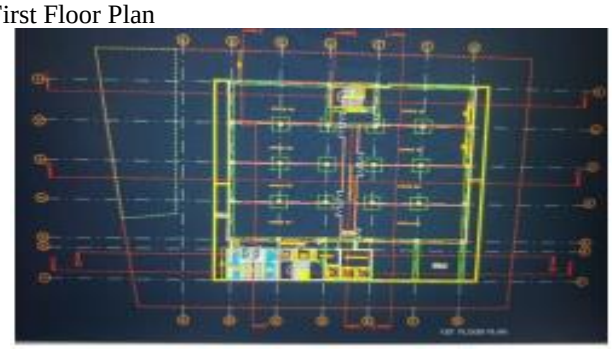
Basement Floor Plan

Ground Floor Plan



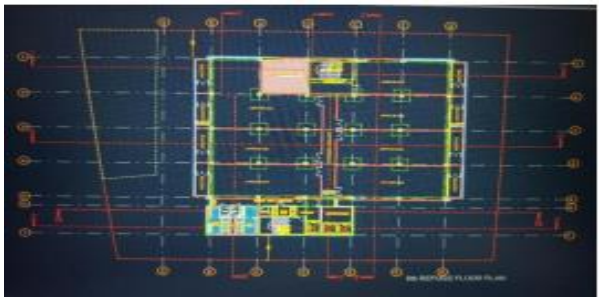
Two-Wheeler Floor Plan

First Floor Plan

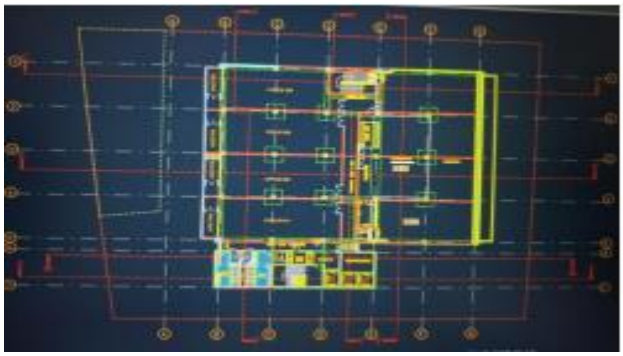


2nd, 3rd & 4th Floor Plan

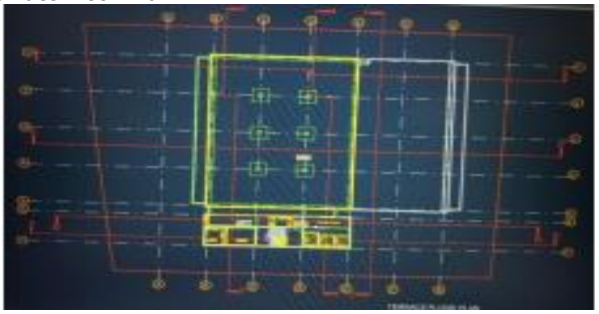
Fifth Floor Plan



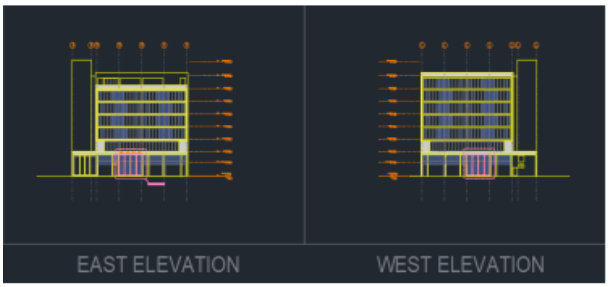
Sixth Floor Plan



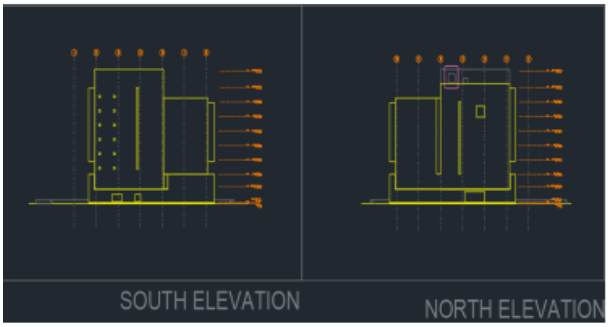
Terrace Floor Plan



Elevation

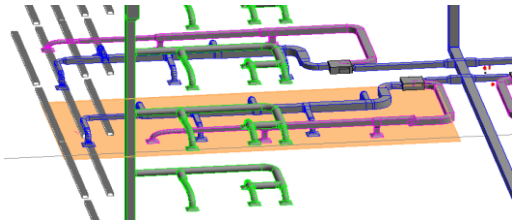


East Elevation & West Elevation

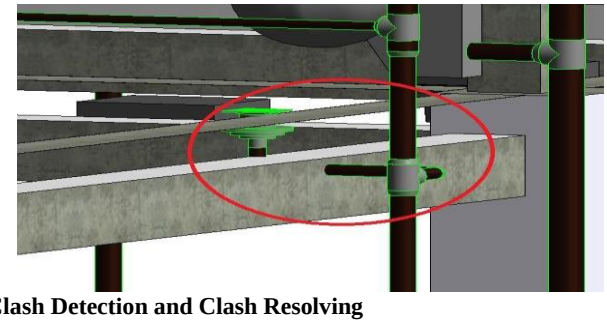


South Elevation & North Elevation

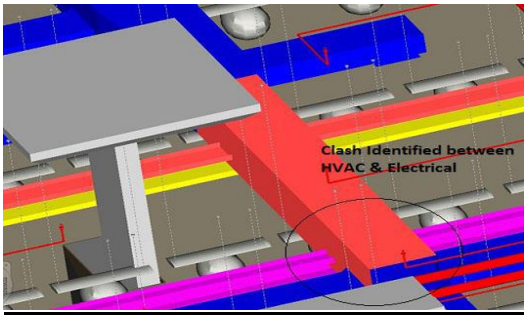
B. Interference Between Air Terminal and Ceiling



Clash between PHE Pipe and HVAC Duct



Clash Detection and Clash Resolving



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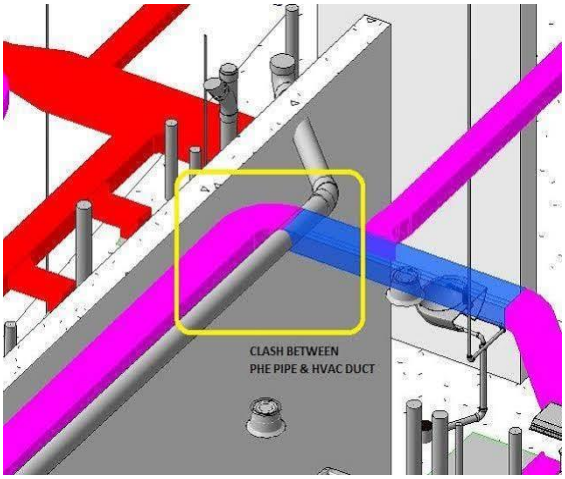
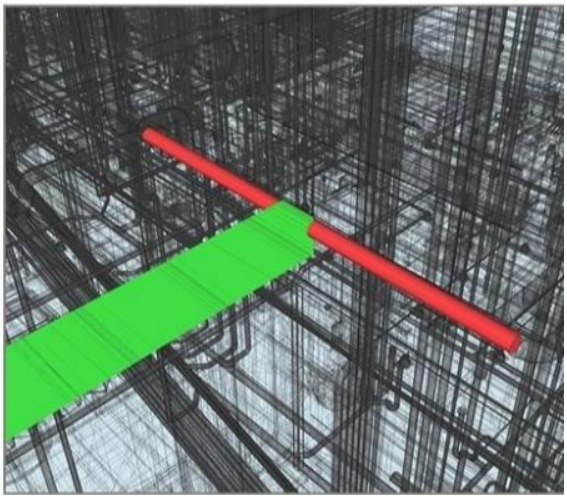
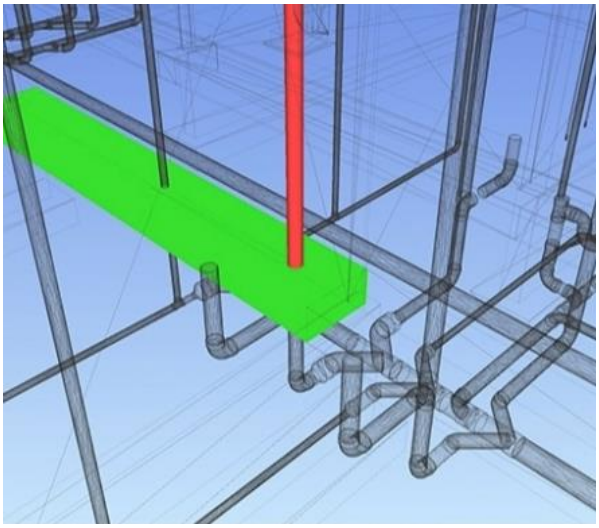


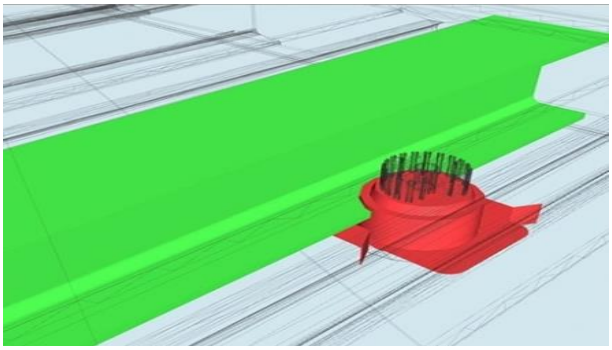
Interface Between Plumbing to Mechanical



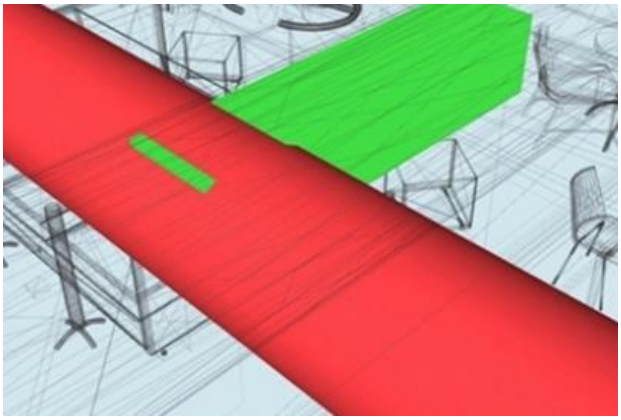
Clashes between Plumbing to Structural



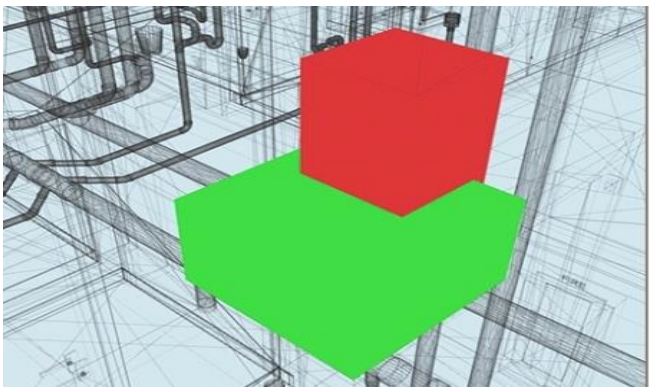
Clashes Between Electrical to Structural



Clashes Between Plumbing to Electrical



Clashes Between Mechanical to Electrical



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