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IMPORTANCE OF BIM IN CONSTRUCTION INDUSTRY

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Abstract - Structural engineering, construction companies have a series of deficiencies that hinder their processes and interactions, decreasing their productivity, lacking collaborative and interconnected processes, not including current work methodologies such as building information modeling (BIM). BIM methodology seeks to integrate processes and professionals involved in engineering tasks by working on platforms with coordinated and intelligent 3D virtual models. BIM has great potential for structural engineering companies and solves their most salient problems. Characterized by the optimization of resources, flexibility, and adaptability, the methodology proposed for BIM implementation within Structural engineering, construction companies clearly and objectively identify the resources and expectations of the organizations, sets out the requirements necessary to develop the BIM methodology, and provides practical and technical recommendations for planning and monitoring the implementation. Over the past decade the fields of civil engineering, structural engineering, have increasingly used the building information modelling (BIM) approach in both professional practice and as the focus of research.

***Key Words*:** BIM, Revit, MEP

1. INTRODUCTION

The use of new methods and software is one of the most important tools that structural engineers are using nowadays to stay competitive. Engineers are constantly looking for new ways to improve and keep the pace on economy, reaching to new heights in the aspects like productivity, coordination and problem solving. Building Information Modelling (BIM) can potentially help with these important aspects. The core feature that BIM offers is the ability to integrate intelligent objects in the model. These intelligent objects contain all the data regarding a specific component, from geometric characteristics to the way they interact with other components, making the entire model full of information.

Structural engineers can take advantage of BIM in different ways, as the model can be constantly updated with any changes in the design or general specifications, keeping all the data as accurate as possible. BIM transforms the way we handle and visualize components. It has given such impact on designing activities like, conceptual design and structural analysis. BIM ensures reduction in design and drafting errors and hence provides with lower designing cost and improved productivity. It also allows for better analysis of situations through simulation. The benefits that BIM represents for structural engineering in the areas of productivity, coordination and consistency of data, and visualization and simulation are also investigated, all this with the objective of obtaining a clear idea of the impact that BIM has in structural engineering.

By Using BIM in Construction Industry, the Architect, Engineer, Construction Companies& Structural Engineer work together i.e., Work in cloud means, on the same Project the Architect, Engineer, MEP Consultant can work together, this is the reason the quality of work will Improve and losses are minimized and the improper communication can be avoided and the work will be done fast.

Nowadays most of the structural engineers are using new methods and software to stay competitive. Engineers always look for new methods to increase and maintain the productivity, coordination and problem-solving abilities. BIM can possibly help these goals. BIM is referred as a platform that supports structural engineers, detailers, and fabricators to enhance robust structural design, reduces faults, and creates collaboration between stakeholders and organizations.

Revit (Architecture): Revit Architecture is Autodesk's BIM software solution for ACE companies and Engineers. The Architectural part of building i.e., Floor Plans, Elevations, Sections, Schedules, 2D and 3D views, and renderings can be done quickly and accurately. Optimize building performance in early-stage design, run cost estimates, and monitor performance over the lifetime of the project.

Revit (Structure): Revit Structure is Autodesk's BIM software solution for Structural engineering companies and Structural engineers, that provides a feature rich tool set helping to drive efficient design processes in a BIM (Building Information Modelling) environment, or when working with other construction disciplines using Autodesk. Autodesk Revit Structure helps revolutionize typical workflows between initial architectural conceptual design, through structural engineering and to detailed drafting by allowing all parties access to the same project database. This means that the impact and effect of model changes can be assessed immediately there by reducing errors in existing documentation and views are updated automatically using Revit's parametric technology saving time and streamlining coordination between Architects, Engineers and contractors.

Revit (MEP): Revit MEP is a powerful BIM authoring tool to build complex building systems i.e., Mechanical, Electrical, and Plumbing with simplicity and efficiency. It helps contractors, designers, and engineers across MEP trades create highly-detailed and coordinated models. Revit MEP is software; it is a Building Information Modeling platform by Autodesk. It is used to develop Mechanical (HVAC, Fire Protection), Electrical (Lighting, Power, Low Voltage- TV, Communication), Plumbing (Water Supply & Drainage) BIMs. It is most widely used for development of Coordinated

and Clash free BIMs. Also, Drawings and Quantities can be directly retrieved from the Model; this in turn can reduce cost and time during installation on site.

2. METHOD OF ANALYSIS

BIM (Building Information Modeling) methodology intents the integration of all phases of the construction process, i.e., the integration and promotion of collaborative work by all the design disciplines involved in the design phase. Besides, it is supported by three-dimensional visualization applications. The great potential of BIM concept is also in standardization of information, by the standardization of methods objects modeling process can be performed.

Thus, a research work under a master's was carried out in order to clarify the concept of modeling rules and levels of development, when the development and management of a design is proposed using BIM methodology. Assuming that at starting point the design documents prepared by the traditional method (CAD 2D drawings), the structural design and several design disciplines were modelled according to BIM methodology, in order to assess the ability of communicate and exchange information between the project carried out by the different design disciplines as well as to assess the ability of aggregation and management of all information related with the project (with special attention to the structural design) in a single BIM model.

Analysis of building is done by two methods i.e. by, Equivalent Static Analysis and Dynamic Analysis. Seismic codes are unique to a particular region or country, In India, Indian Standard Criteria for Earthquake Resistant Design of Structures IS 1893 (Part-1) : 2016 is the main code that provides outline for calculating seismic design force. This force depends on the mass and seismic coefficient of the structure and the latter in turn depends on properties like seismic zone in which structure lies, importance of the structure, its stiffness, the soil on which it rests and its ductility.
The code recommends following methods of analysis.

i. Equivalent Static Analysis

ii. Dynamic Analysis

   a. Response Spectrum Analysis
   b. Time History Analysis

In this Study Dynamic analysis i.e. Response spectrum analysis method is used for design of building.

Response Spectrum Analysis:

Response Spectrum analysis allows the users to analyze the structure for seismic loading. For any supplied response spectrum (either acceleration v/s period or displacement v/s period) joint displacement, member forces and support reaction may be calculated. Model response may be combined either Square Root of Sum of Square (SRSS) or complete quadratic combination (CQC) method to obtain the resultant response, as given in clause 7.7.5 of code IS1893 (Part 1) : 2016.

Some Important Points about Response Spectrum Method:

- Response Spectrum Analysis (RSA) is an elastic method of analysis and lies in between equivalent force method of analysis and nonlinear analysis methods in terms of complexity.
- RSA is based on the structural dynamics theory and can be derived from the basic principles (e.g. Equation of motion).
- RSA, unlike equivalent force method, considers the influence of several modes on the seismic behavior of the building.
- Damping of the structures is inherently taken into account by using a design (or response) spectrum with a predefined damping level.
- The maximum response of each mode is an exact solution.
- The sole approximation used in RSA is the combination of modal responses.

Criteria: Those modes shall be considered for which:

- The sum of the modal masses is at least 90 % of the total building mass.
- Response of all modes shall be considered that contribute significantly to the global building response (i.e., important for buildings of a certain height)

3. MODELLING

Architectural Modeling (G+6): Proposed modeling of Dental College G+6 Building for the project work. Following output of all working drawing from The Revit Architecture with the Room Legend

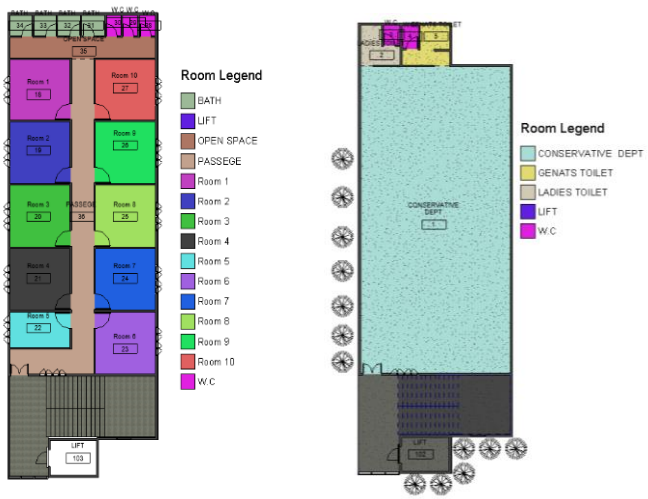
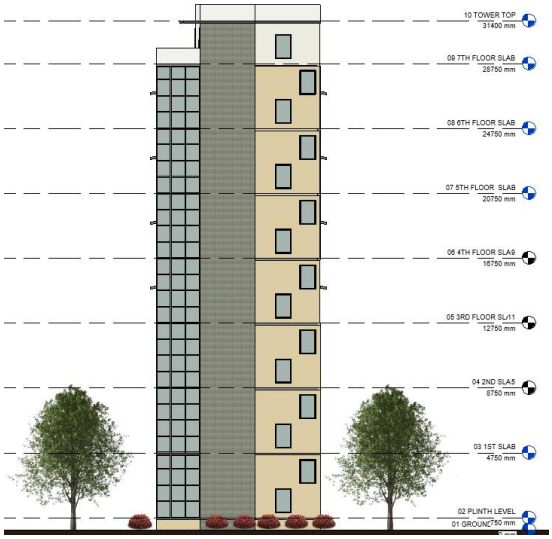


Fig -1: Floor Plan view of Building



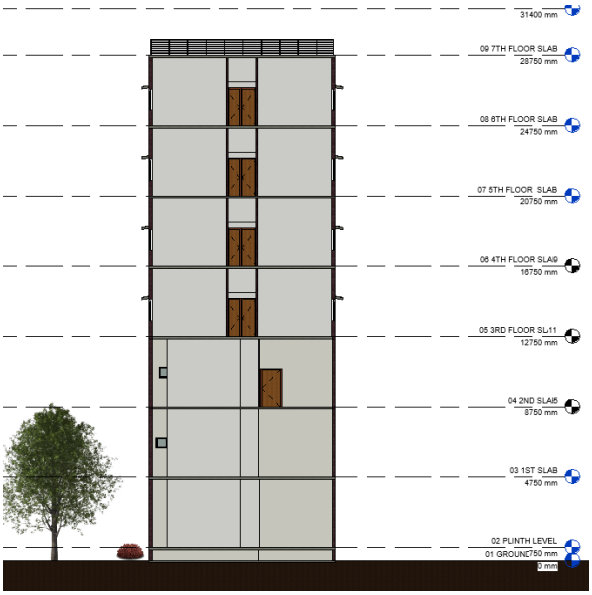


Fig -3: Section of Building

Fig -2: Elevation of Building

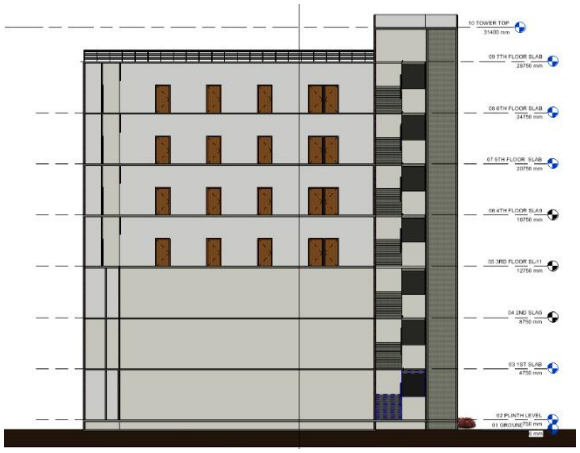


Table 1: Door Schedule with Total Quantity (From Revit)

Door Schedule				
Type	**Family and Type**	**Width**	**Head Height**	**Count**
Toilet Door	M_Single-Flush: TOILET DOOR	900 mm	2100 mm	34
Room Door	M_Single-Flush: ROOM DOOR	1000 mm	2100 mm	42
Right hinged	Steel Door_vision_front: Right hinged	1500 mm	2100 mm	8
Hall Door	M_Door-Double-Flush_Panel	1200 mm	2100 mm	7
			Total Doors	91 nos

Table 2: Window Schedule with Total Quantity (From Revit

Window Schedule			
Family	**Width**	**Height**	**Count**
M_Fixed	600 mm	600 mm	34
Window-Casement-Multi-Sash-Horizontal	1800 mm	1200 mm	48
M_Fixed	1000 mm	1500 mm	15
M_Fixed	406 mm	1830 mm	1
		Total	**98**

Table 3: Room Schedule with all Room Area (From Revit)

Room Schedule		
Name	Area (m²)	Count
CONSERVATIVE DEPARTMNET	195	2
GENTS TOILET	5	2
LADIES TOILET	5	2
OPEN SPACE	13	1
PASSEGE	36	1
Room	13	4
Room	15	8
Room	16	39
Room	211	4
Room	36	1
Room	49	2
Room	9	1
STORE ROOM	10	1
TOILET	6	2
W.C	1	12
W.C	2	3
BATH	2	12
Total Area and count	624	12

Table 4: Wall Material Quantity (From Revit)

All Type of Material quantity and Material take off will be obtained form Revit modal which helps to estimate work. This work is very fast and accurate. It focuses on one Revit category, quantifies the elements and shows their information. Exceptionally can contain parameters from other related categories. It's only for model categories plus detail item families, analytical categories, rooms and areas. Multi-category all model categories are included (we cannot select just some of them), except those that are system categories (walls, floors, roof)

Material Takeoff Show detail about material quantifying, and informs about from which elements that material comes from. Multi-category Unlike in Quantities Schedules, these material take-off multi-category schedules will include system categories.

Structural Modeling: - The Arrangement of Structural Members i.e., Column, Beam, Slab, Shear wall, is shown in model of Revit Structure.

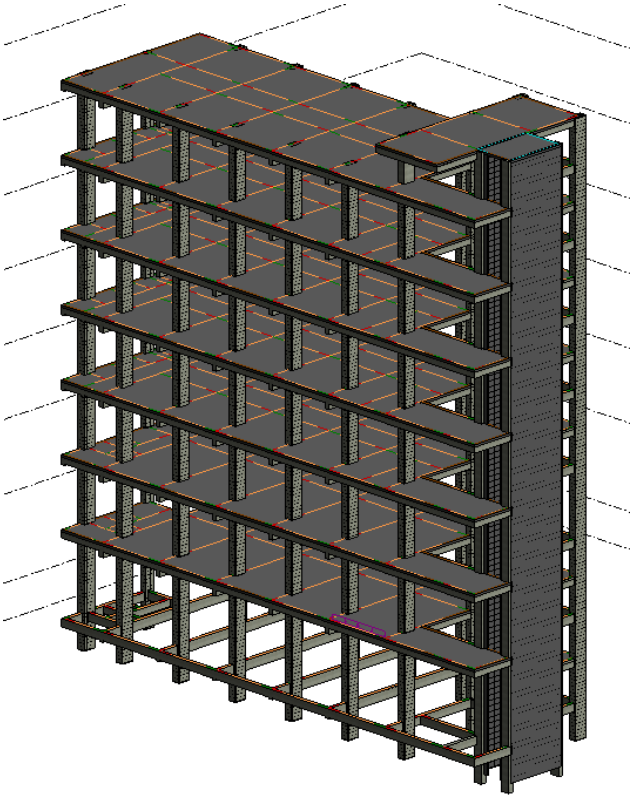


Fig 4: Structural Member's Arrangement in Revit

Wall Material Takeoff			
Family	Material: Name	Type	Volume
Basic Wall	Concrete, Precast	LIFT WALL	71.23 m³
		Total Lift Wall	71.23 m³
Basic Wall	Brick, Common	Inner 100 MM 2	112 m³
		Total Brick Req. for Wall	56000
Basic Wall	Inside Paint	Praimer	52 m³
Basic Wall	Out Side Paint	Glosy Wheit	52 m³

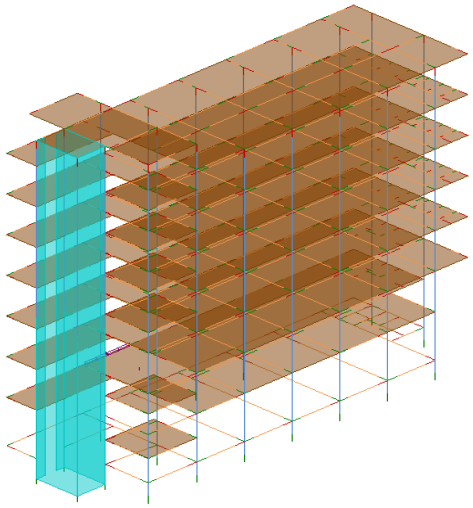


Fig 5 Analytical Model of Revit Structure

An Institutional Building structural model is used throughout this project. The building is designed in ETABS 2019. Model is asymmetric with respect to both X and Y axis to demonstrate many of the features expected from multi-story buildings subjected to wind and seismic loading using Dynamic Analysis method [Response Spectrum Analysis Method].

Table -5: Designed data of building

Grade of concrete	M25
Grade of steel	Fe500 & Fe 415
Density of concrete	25kN/m3
Density of AAC Block	7.5kN/m3

Table -6: Earthquake data of building

Seismic Zone	II
Importance factor	1.5
Response reduction factor	5 (SMRF)
Type of soil	TYPE II (Medium)
Damping	5%

Institutional Building Model:

The building is seven storey reinforced concrete moment resisting frame. The building is Institutional Building with plan dimension is 9.82 m X 29.36 m with a height of 32.9 m having 1.9 m cantilever portion as shown in figure. The ground, first and second storey is of hall and other storey having rooms. The building has two different sizes of column & five different sizes of beams. The building is designed in ETABS 2019 Software using Latest IS codes for earthquake and wind Using Dynamic method i.e. Response spectrum analysis method. Shear wall is designed in ETABS Software. Torsion is considered in Building. The table 7 shows the structural data of building.

Table -7: Structural data of building

Plan dimension	9.82 m X 29.36 m
No of storey	7
Ground storey height	4.6 m
Intermediate storey height	4 m
Depth of footing	1.8 m
Slab thickness	140 mm
External wall thickness	230 mm
Internal wall thickness	115 mm
Parapet (1 m height)	230 mm

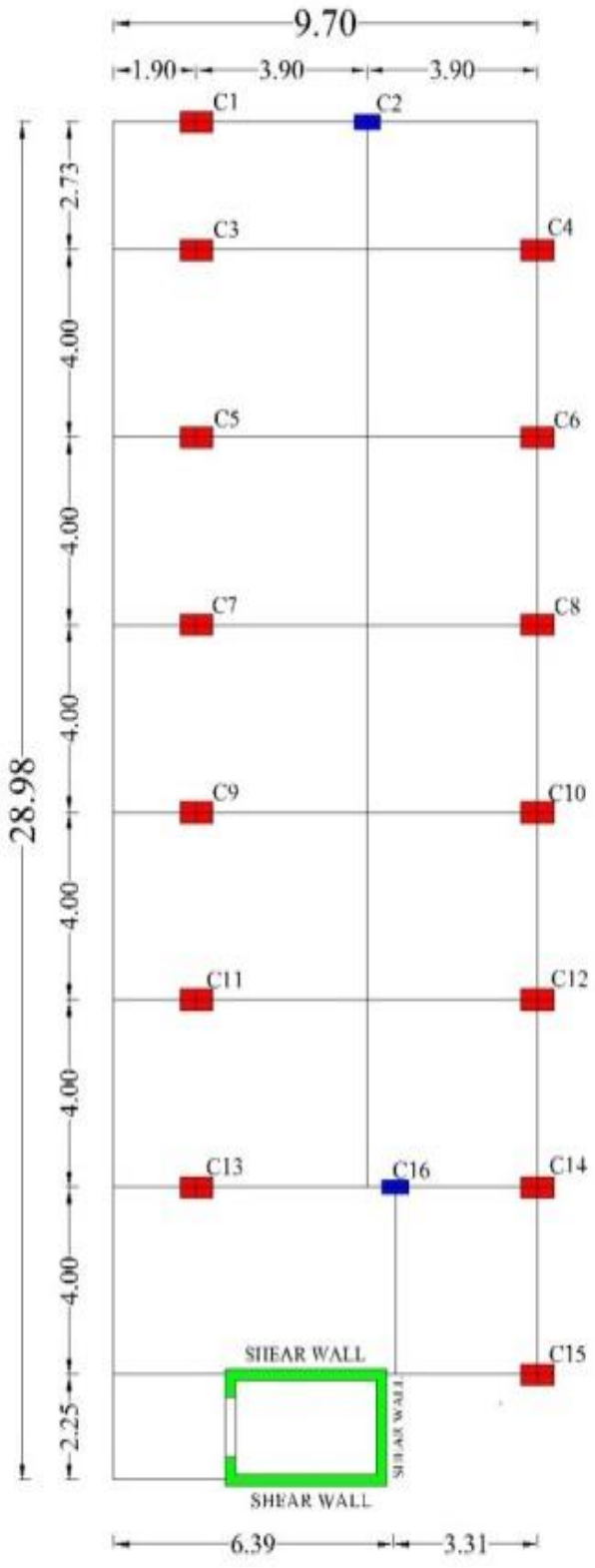


Fig -6: Plan view of Building

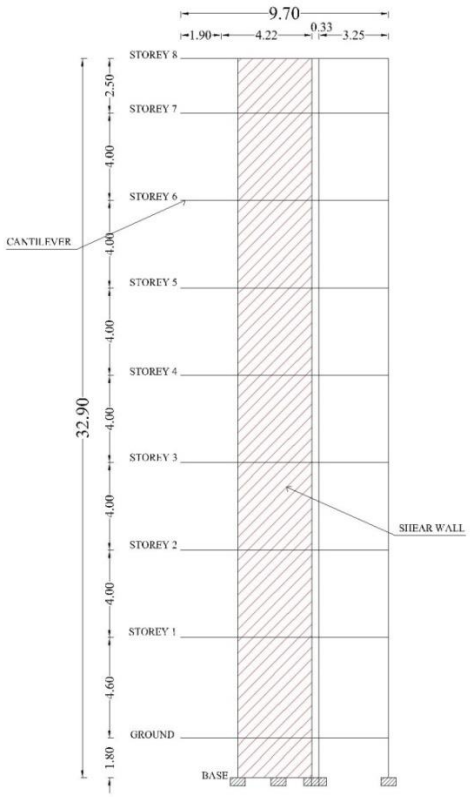


Fig- 7: Front Elevation view of Building

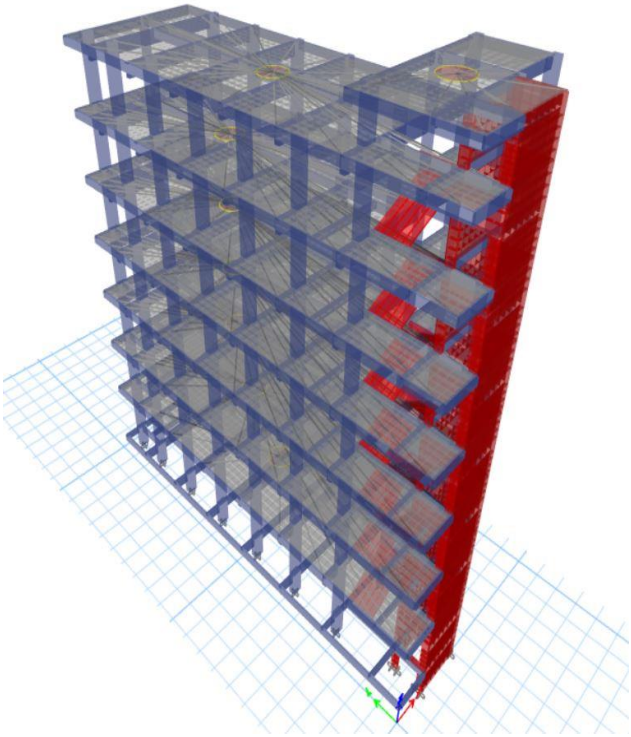


Fig :-8: 3D view of Building [ETABS 19 Software]

Response spectrum analysis was carried out employing ETBAS using IS 1893:2016 (part 1) code for earthquake and IS 875 Part 3 2015 for wind analysis. The design is carried out of building using IS 456:2000and IS 13920:1993 codes. The designed forces *i.e.* axial force, moments and shear forces are taken from the ETABS analysis results.

An accidental eccentricity is introduced in IS code. But it is observed in field design these codal provisions are generally not followed which is very dangerous for structure. From this study it is observed that after considering torsion in building with addition of shear wall, exhibits better results.

4.3 Mechanical (MEP)

Help drive accurate design, analysis, and documentation of efficient building (services) systems from concept through construction.

- Building systems modelling and layout.
- Duct and pipe system modelling
- Duct and pipe sizing/pressure calculations
- HVAC and electrical system design
- Conduit and cable tray modelling
- Sustainable design with building performance analysis

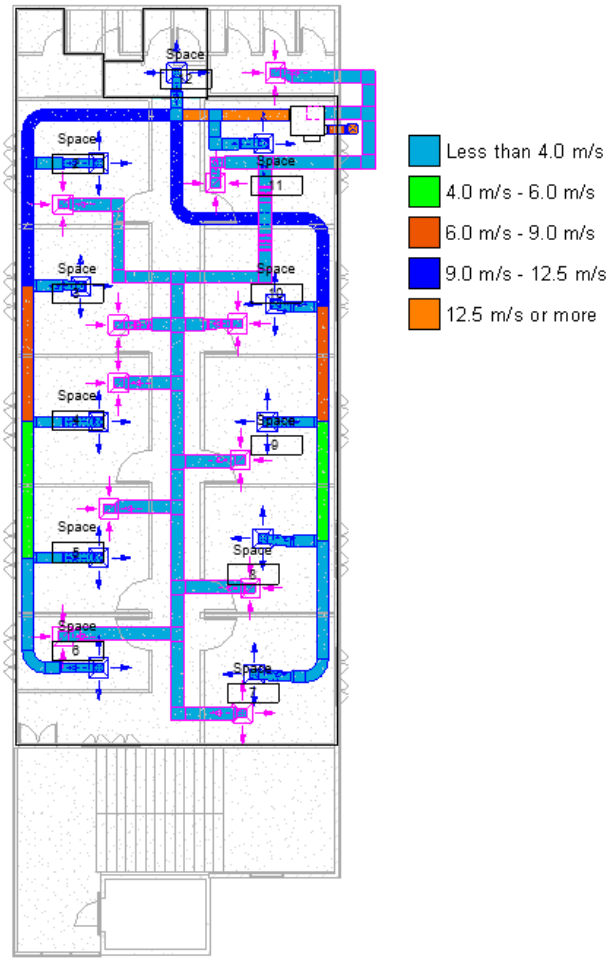


Fig: 9 HVAC Typical All floor Plan

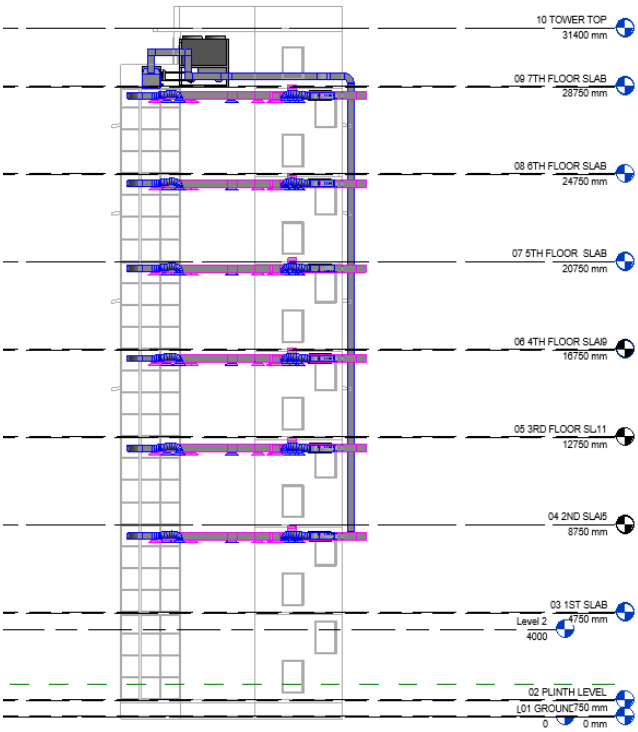


Fig: 10 HVAC Elevation

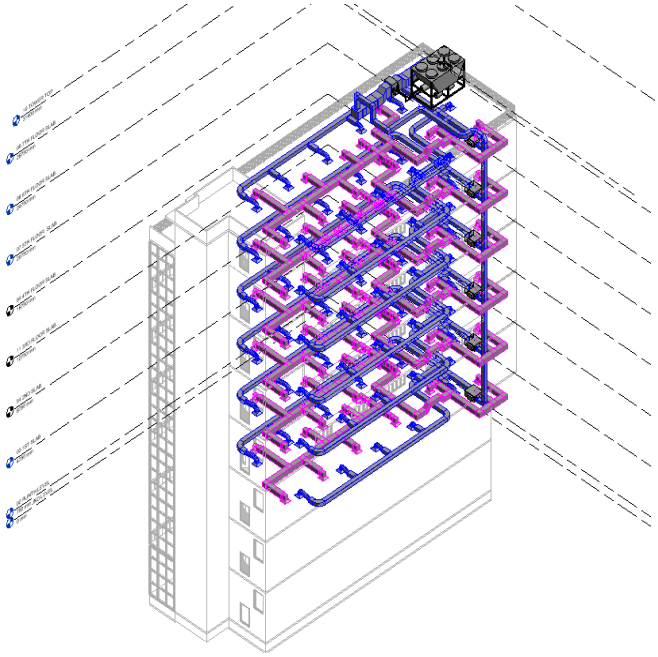
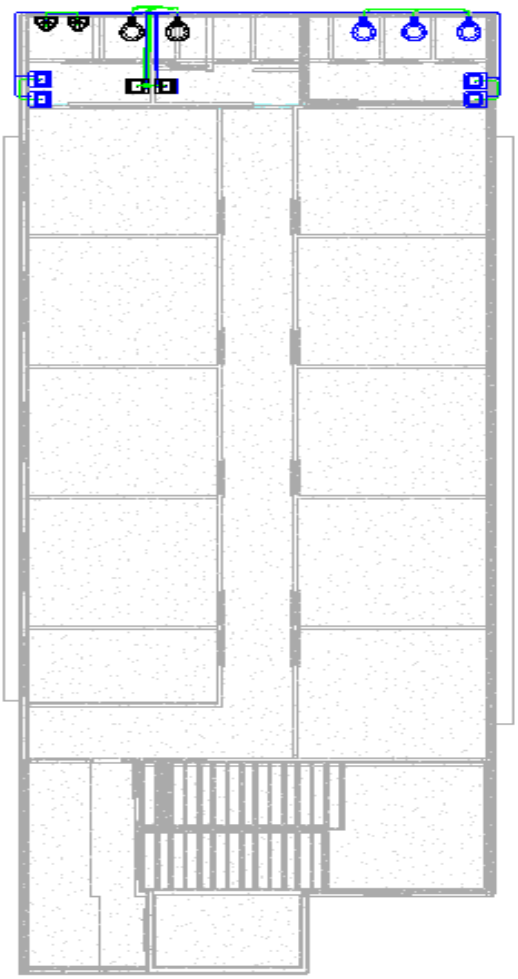


Fig: 11 HVAC Iso matric View

Plumbing Modeling

Plumbing systems are logical entities that facilitate calculations for flow and sizing of equipment. we can adjust the layout and justification of piping in a piping system. Revit automatically calculates specific pipe sizing for the systems created in a project.



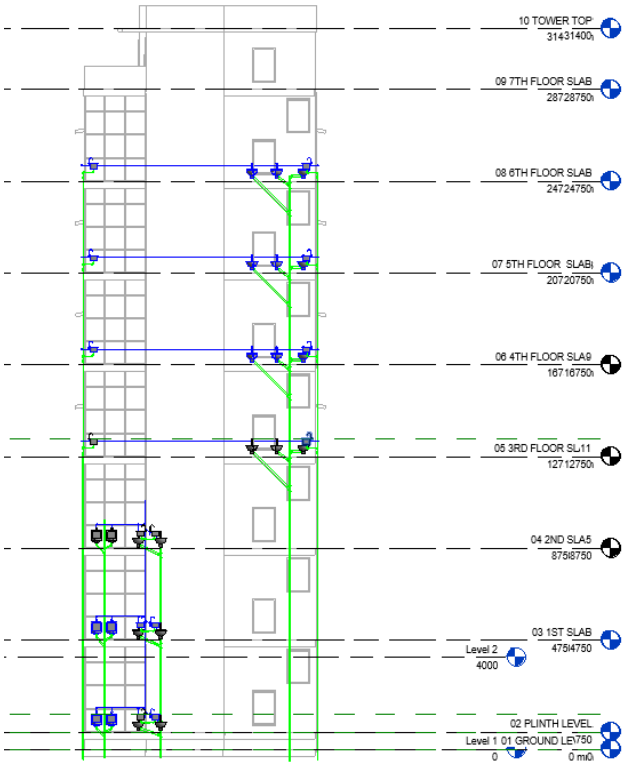


Fig 12 Working Plumbing Plan & Working Plumbing Elevation.

Table :8 Schedule of Pipe (From Revit)

Pipe Schedule			
Diameter	**Length**	**System Classification**	**Type**
15 mm	3934	Domestic Cold Water	PVC - DWV
20 mm	92273	Domestic Cold Water	PVC - DWV
25 mm	1320	Domestic Cold Water	PVC - DWV
40 mm	69162	Sanitary	PVC - DWV
50 mm	12593	Sanitary	PVC - DWV
80 mm	46467	Sanitary	PVC - DWV

Electrical Modeling

Create electrical systems (circuits) to place devices, lighting fixtures, and electrical equipment in a project. The ribbon provides tools to add electrical components and wiring, check the circuits in a project, and create panel schedules.

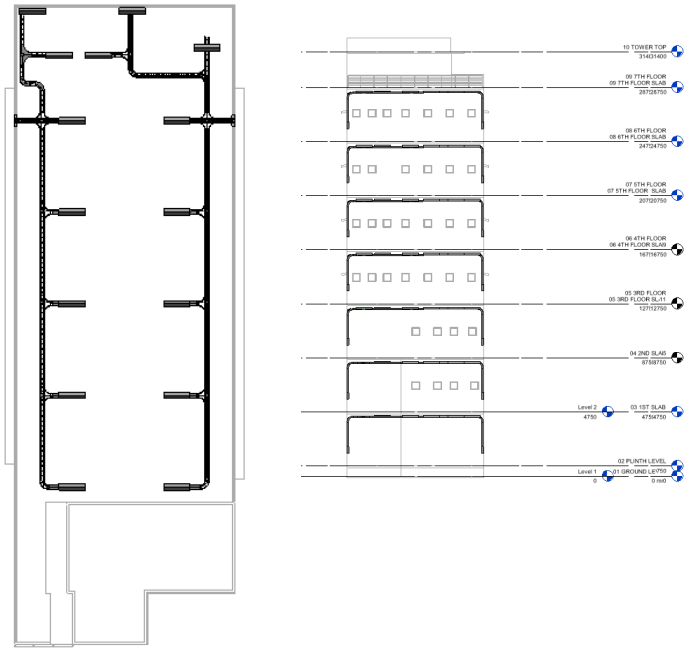


Fig 13 Working Electrical Plan & Elevation

4. RESULT AND DISCUSSION

After Preparing the all Modal of BIM i.e. Architectural, Structural, Mechanical (HAVC), Electrical, Plumbing. We prepared the Digital Building. The all Parameter of building will be checked before construction. some of parameters are as follow.

Clash Deduction (Interference Check)

Clash detection is a critical part of the integrated BIM modeling process. BIM modeling involves creating a comprehensive master model that includes design models from different disciplines of engineering design. A 'clash' is the result of two elements in design taking up the same space. In Building Information Modeling (BIM), clash detection is the technique of identifying if, where, or how two parts of the building (e.g., plumbing, walls, etc.) interfere with one another. Clash detection aids in effectively identifying, inspecting, and reporting interference in a construction project model. It is useful in checking work status and wanes down human errors during model inspections. Clash detection is important in BIM because it integrates several models (structural, MEP)

There are several options available to find and resolve the interferences in Revit model:

1. Visual checks in Navis works Freedom, Simulate or Manage.
2. By Element ID search in Revit.
3. Use Switchback function between Navis works and Revit.

We can select components to check and set options for types of interferences to find, and then calculate results.

To open this Property Manager: **Click Interference Detection (Assembly toolbar) or Tools > Evaluate > Interference Detection**.

A clash report is a document shared with stakeholders on a given project using PDF, XML, HTML or another type of format. It is the “traditional” way of sharing issues found with the clash detection software and requires some extra time to set up and track problem-solving over time

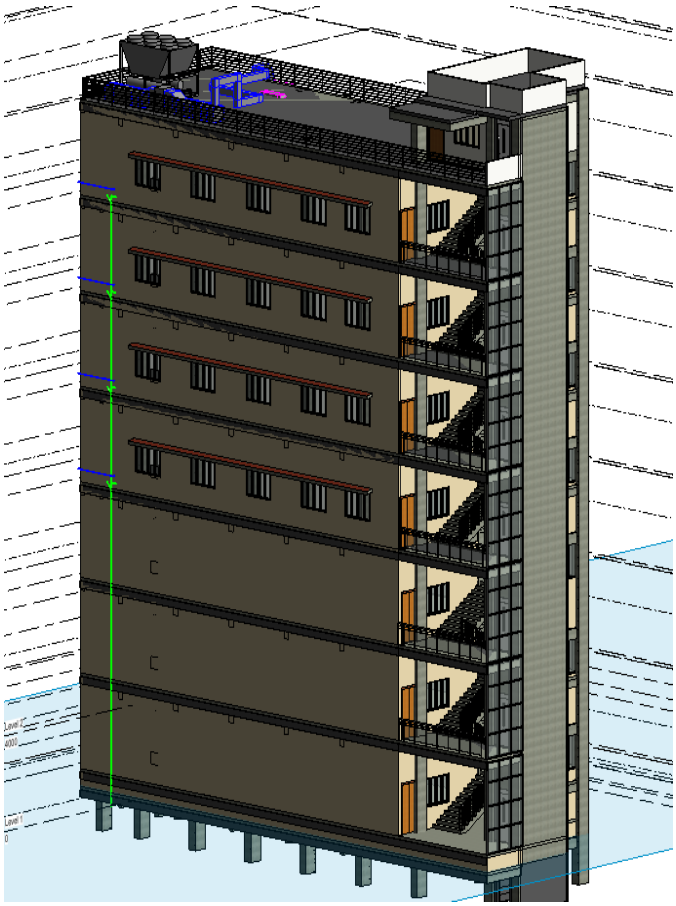


Fig -14: Clash Modal From Revite

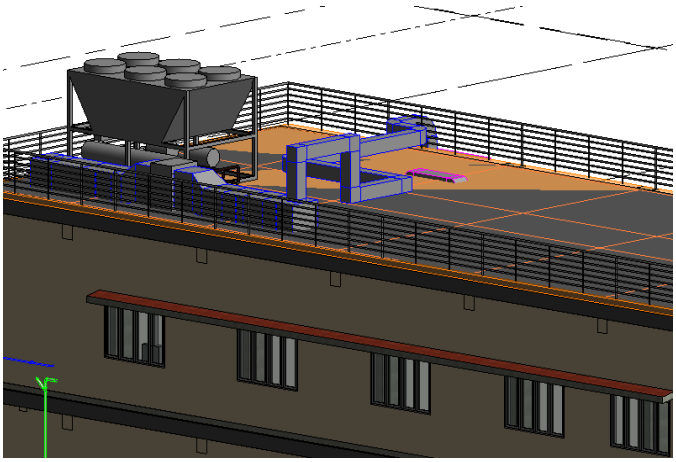


Fig -15: Clash Between HVAC Duct

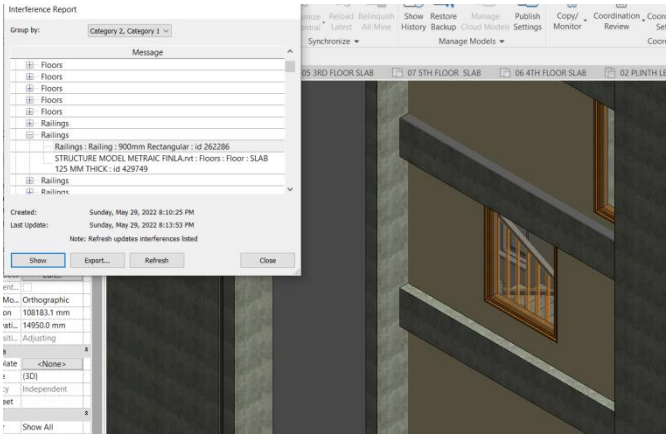


Fig -16: Clash Between Railing And Window

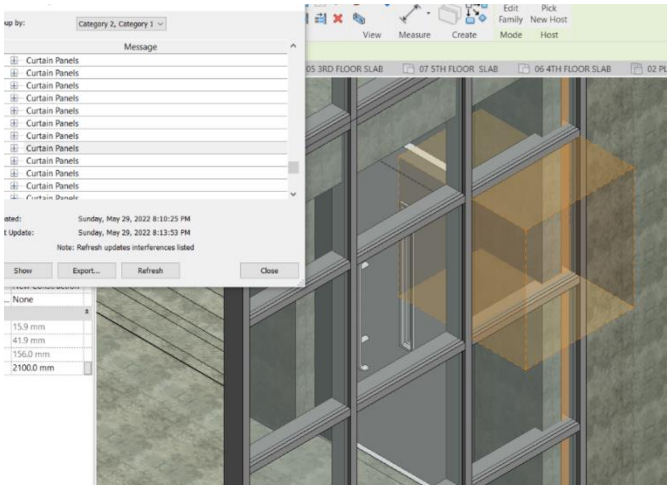


Fig -17: Clash Between Glass And Wall

5. CONCLUSION

In this study Dental College Building of G+6(Seven storey) is structurally analyzed on ETABS & BIM model i.e. Architectural, HAVC, Plumbing & Electrical Models are prepared on BIM tool i.e. Revit. The Importance of BIM in Construction & Structural Industry can be seen from the Following Conclusions got from this study.

1. The Advantage of BIM is the work is in cloud, So that the single file of the project can be accessed by all the stakeholders.
2. The benefit of Cloud modeling is, single change done by any stockholder can be immediately get reflected into the all drawings and can be easily accessed by others.
3. Difficulties and errors generated by improper communication can be avoided at the initial stage.
4. With the help of single and whole model of structure on Revit proper sequence of execution of work can be maintained.
5. With the help of BIM model problems that could occur on site can be cured before it occurs.
6. From the structural engineering point of view, the miscommunication may occur between architectural firm and RCC consultants, that can cause a sever economical damage. This can be avoided.
7. Clash deduction test (Interference check) can be performed on model. Clash deduction means, any intersection between any plumbing/electrical member with RCC member then that problem can be checked and corrected at planning stage only.
8. Using Revit quantities of all structural and architectural elements can be easily calculated. So that proper project planning (stage wise) with estimation can be done.

REFERENCES

1. [1] Abd, A. M., Hameed, A. H., & Nsaif, B. M. (2020). Documentation of construction project using integration of BIM and GIS technique. Asian Journal of Civil Engineering, 21(7), 1249–1257. https:// doi. org/ 10. 1007/ s42107- 020- 00273-9.
2. Ahmed, S. (2018). Barriers to implementation of building information modeling (BIM) to the construction industry: A review. Journal of Civil Engineering and Construction, 7(2), 107–113. https:// doi. org/ 10. 32732/ jcec. 2018.7. 2. 107.
3. Ahuja, R., Sawhney, A., Jain, M., Arif, M., & Rakshit, S. (2020). Factors influencing BIM adoption in emerging markets—the case of India. International Journal of Construction Management, 20(1), 65–76. https:// doi. org/ 10. 1080/ 15623 599. 2018. 14624 45.
4. Al-ashmori, Y. Y., Othman, I., Rahmawati, Y., Amran, Y. H. M., & Sabah, S. H. A. (2020). Civil Engineering BIM benefits and its influence on the BIM implementation in Malaysia. Ain Shams Engineering Journal. https:// doi. org/ 10. 1016/j. asej. 2020. 02. 002.
5. Amarnath, CB. (2020). BIM implementation in India. India building information modelling association. https:// www. ibima. co. in/ post/ bim- imple menta tion- in- India. Arunkumar, S., Suveetha, V., & Ramesh, A. (2018). A feasibility study on the implementation of building information modeling (BIM): From the architects' and engineers' perspective. Asian Journal of

Civil Engineering, 19(2), 239–247. https:// doi. org/ 10. 1007/ s42107- 018- 0020-9.
6. Azhar, S. (2011). Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry. Leadership and Management in Engineering, 11(3), 241–252. https:// doi. org/ 10. 1061/ 97807 84413 777. 015.
7. Azhar, S., Khalfan, M., & Maqsood, T. (2012). Building information modelling (BIM): Now and beyond. Construction Economics and Building, 12(4), 15–28. https:// doi. org/ 10. 5130/ ajceb. v12i4. 3032.
8. Bansal, V. K. (2011). Application of geographic information systems in construction safety planning. International Journal of Project Management, 29(1), 66–77. https:// doi. org/ 10.1 016/j. ijpro man. 2010. 01. 007. Barlish, K., & Sullivan, K. (2012). How to measure the benefits of BIM—a case study approach. Automation in Construction, 24, 149–159. https:// doi. org/ 10. 1016/j. autcon. 2012. 02. 008.
9. Charlesraj, V. P. C., & Gupta, V. (2019). Analysis of the Perceptions of Beneficiaries and Intermediaries on Implementing IPD in Indian Construction. In ISARC proceedings of the international symposium on automation and robotics in construction (Vol. 36, pp. 937–944). IAARC Publications. https:// doi. org/ 10. 22260/ isarc 2019/ 0125.Eadie, R., Odeyinka, H., Browne, M., McKeown, C., &
10. Yohanis, M. (2014). Building information modelling adoption: An analysis of the barriers to implementation. Journal of Engineering and Architecture, 2(1), 77–101. https:// doi. org/ 10. 1007/ s13398- 014- 0173-7.2.
11. Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2008). BIM Handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors (2nd ed.). Wiley. Ebrahimi, H., & Akhbari, H. (2015). Construction of management and sustainable construction in the engineering by building information modeling. International Journal of Materials Engineering, 5(3), 64–75. https:// doi. org/ 10. 5923/j. ijme. 20150 503. 04.
12. Elyamany, A. H. (2016). Current practices of building information modelling in Egypt. International Journal of Engineering Management and Economics, 6(1), 59–71. https:// doi. org/ 10. 1504/ ijeme. 2016. 079836.
13. Gerrish, T., Ruikar, K., Cook, M., Johnson, M., Phillip, M., & Lowry, C. (2017). BIM application to building energy performance visualization and management: Challenges and potential. Energy and Buildings, 144, 218–228. https:// doi. org/ 10. 1016/j. enbui ld. 2017. 03. 032.
14. Giretti, A., Carbonari, A., Naticchia, B., & DeGrassi, M. (2009). Design and first development of an automated real-time safety management system for construction sites. Journal of Civil Engineering and Management, 15(4), 325–336. https:// doi. org/ 10. 3846/ 1392- 3730. 2009. 15. 325- 336.