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3D Modelling and Simulation Methods in RCC Building using Bim Software

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Abstract: ***The building can be designed by using Autodesk Revit Software. Autodesk Revit is a Building Information Modelling (BIM) software designed for landscape architects, structural engineers, MEP engineers, and contractors. The software allows users to create a building and its components in 3D, annotate the model with 2D drafting elements, and access building information from the building model's database. Our structures include G+14 Residential buildings and the LIC Ludhiana projects. G+14 is the residential project in which there are 10 blocks with two basement, shops on ground and 1st floor, and typical floors from 3rd to 13th floor level which also consist of two refuges floor, the project has different AutoCAD plan of architectural and structural layout having sizes of Beam, column, slabs designed according to IS456:2000 and IS800:2007 LSM. In the LIC Ludhiana project, the work involves rebarring of slabs, which includes the top and bottom rebar of the slab with different diameters or sizes of rebar, such as 8mm, 10mm, and 12mm. The schedule can be easily extracted from these Revit models, which will calculate the quantity of material required for construction purposes. Extensions or plugins, such as Diroots and Dynamo, that run in Revit reduce project time and provide more accurate ID assignment for elements.***

Keywords: BIM, DIROOTS, DYNAMO RUN, LSM

I. INTRODUCTION

AutoCAD is a commercial computer-aided design (CAD) and drafting software application. Developed and marketed by Autodesk, AutoCAD was first released in December 1982 as a desktop application running on microcomputers with internal graphics controllers.

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Before AutoCAD was introduced, most commercial CAD programs ran on or minicomputers, with each CAD operator (user) working at a separate graphics terminal. AutoCAD is also available as mobile and web apps. AutoCAD is utilised by architects, project managers, engineers, graphic designers, city planners, and other professionals across various industries. It was supported by 750 training centres worldwide in 1994. Whereas Charles River Software originally developed the software in 1997, it was renamed Revit Technology Corporation in 2000 and acquired by Autodesk in 2002. As shown in Fig. 1, Autodesk Revit is a BIM software for Architects, Interior Designers, Landscape Architects, Structural Engineers, MEP Engineers, Contractors, and more. Revit can be utilised as a powerful collaboration tool among various disciplines within the Architecture, Engineering, and Construction (AEC) industry. With the rapid adoption of BIM in the construction industry and its gradual implementation in the design industry, careful consideration must be given when transitioning from the traditional method of creating construction documents to a BIM approach. (M.Gopal Naik, 2019, [2])

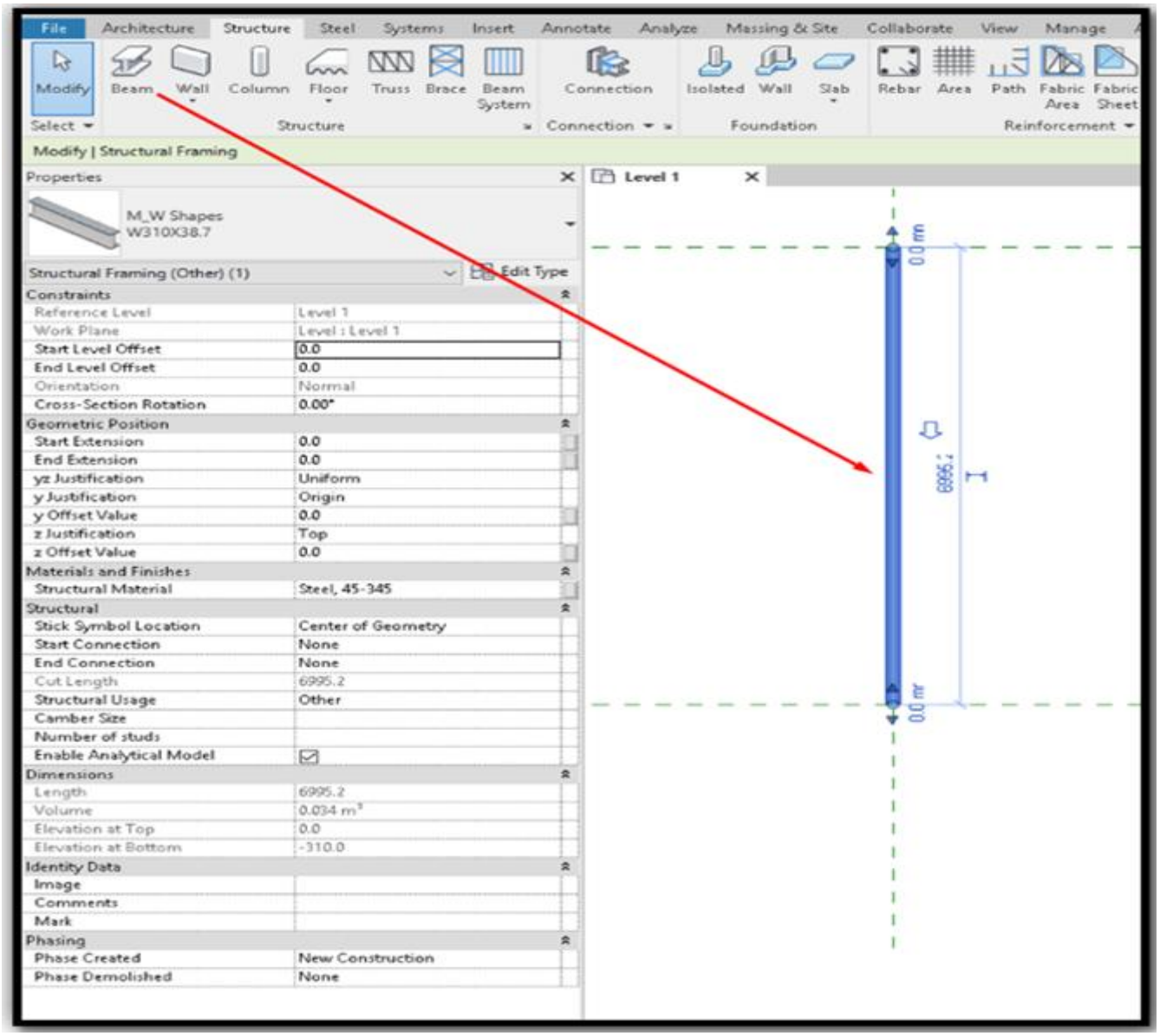

Fig. 1. Placing of the beam

II. LIC LUDHIANA PROJECT

Plain concrete is weak in tension and strong in compression. The tensile property of concrete structures is enhanced by incorporating steel reinforcement. The steel reinforcement is strong in both tension and compression. The tensile property provided by the steel reinforcement will prevent and minimise concrete cracks under tension loads. The coefficient of thermal expansion of steel reinforcement and concrete are similar in that they undergo identical expansions during temperature changes. This property will ensure that the concrete is subjected to minimal stress during temperature variations. The surface of the steel reinforcement bars is patterned to have a proper bond with the surrounding concrete material. The two primary factors that contribute to the strength of concrete structures are steel and concrete. The design engineer will combine both elements and design the structural element in such a way that the steel resists the induced tensile and shear forces. At the same time, the concrete takes up the compressive forces. Following the guidelines given in IS 800:2007 for steel design, we have worked on the rebar work of slabs on different floors, as shown in Fig. 2.

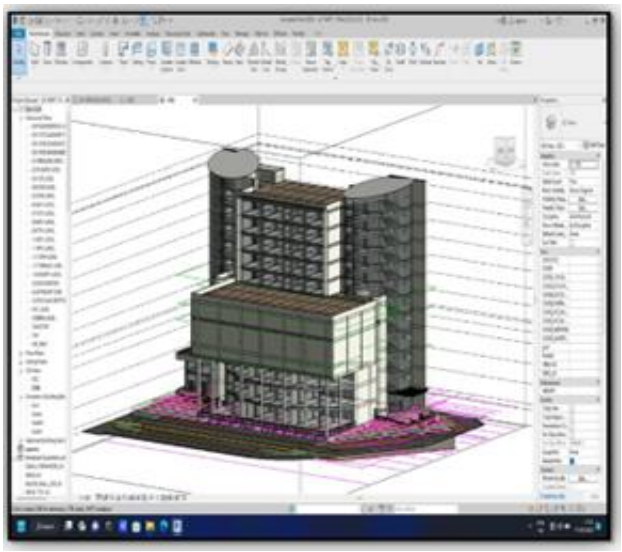

Fig. 2. LIC building 3d model

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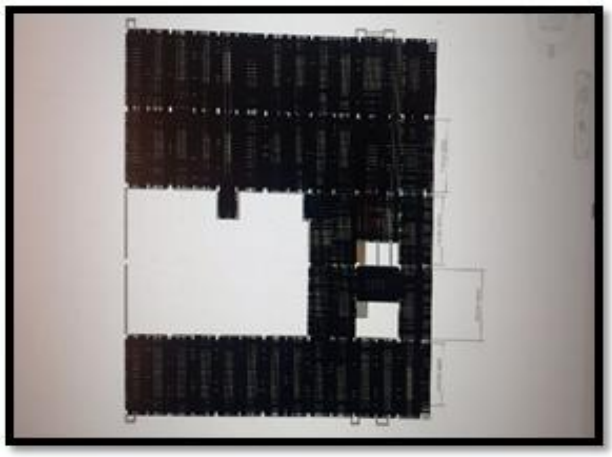

Fig. 3. Rebaring of slab's

Main Bars and Distribution Bars

Typically, Main bars are provided at the bottom of the distribution bar in slabs. But distribution bars are provided on top of the main bar. Main bars are provided in the shorter span of the slabs. But distribution bars are provided in the longer span of the slabs. A higher-dimensional bar is used as the main reinforcement bar. A lower-dimensional bar is used as a distribution bar. Primary reinforcement was provided to counter the bending moment, tensile stresses and superimposed load. However, distribution bars are used to distribute the load equally, resist shrinkage stress (Temperature variation), or hold the mesh in its desired position, as shown in Figs. 3 and 4. The main reinforcement bar is used to transfer the bending moment to the beams. Distribution bars are used to resist the shear stress, and cracks develop at the top of the slab. Main bars in the slab won't be less than 8mm if you are using (HYSD) or 10mm if you are using (Plain bars), and the Distribution bars are also not less than 8mm in diameter, and the bars won't be more than 1/8 of the thickness of the slab.

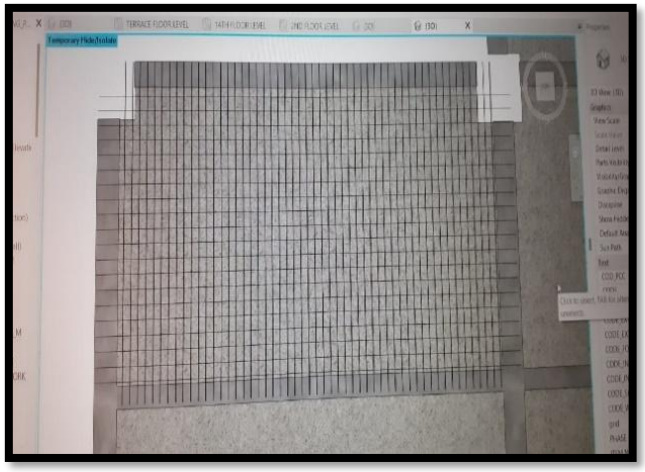

Fig. 4. Bottom bars

III. TRINE SHILP RESIDENCY PROJECT AT GOTA

The Trine Shilp modelling project is a project of the Trine infra group, which consists of 10 blocks. Each block has its own architectural and structural plans. This phase of planning is critical. We need to carefully read the drawings and identify similar work so that we can have the mirror work already prepared, saving us time. The project is of G+14 with having levels starting from 2nd basement to terrace and there are different plans of basements, plinth floor, ground floor, 1st floor, 2nd floor, and 3rd floor is the typical floor working plan and six and 8th floor is the refuge floor, and last we have the terrace floor.

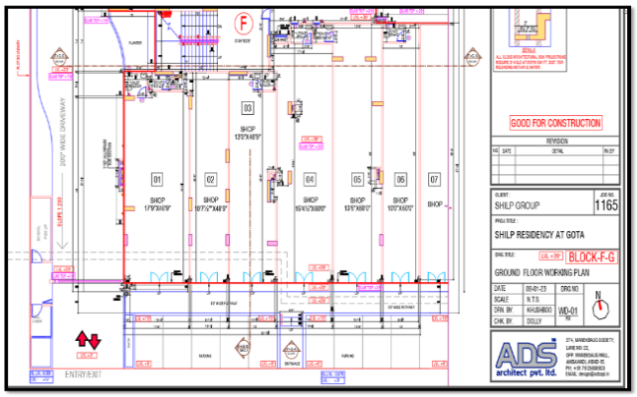

Fig. 5. Ground floor working plan of Block F&G

The centerline plan for column position in the modelling, with different sizes on different floors. Each column has a unique ID and size. Fig 5. Shows the typical floor level plan of the 3rd floor, which includes two blocks: the G block and the F block, as shown in Fig. 6, with basement columns detailing the F block.

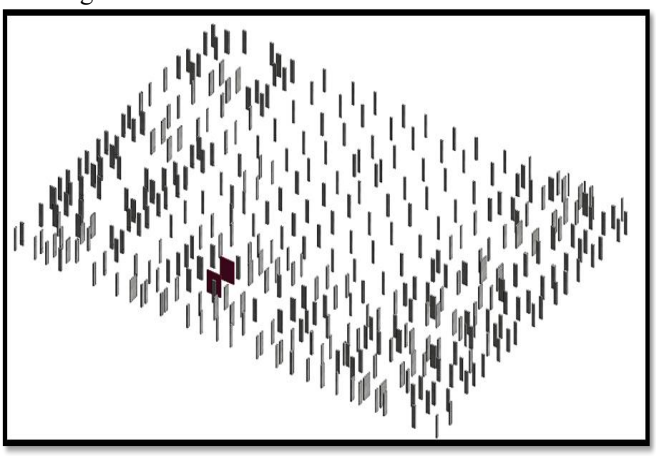

Fig. 6. 3D Modelling of columns of Block F&G

Fig. 6 shows the modelling work of the basement column at its particular grid with different sizes.

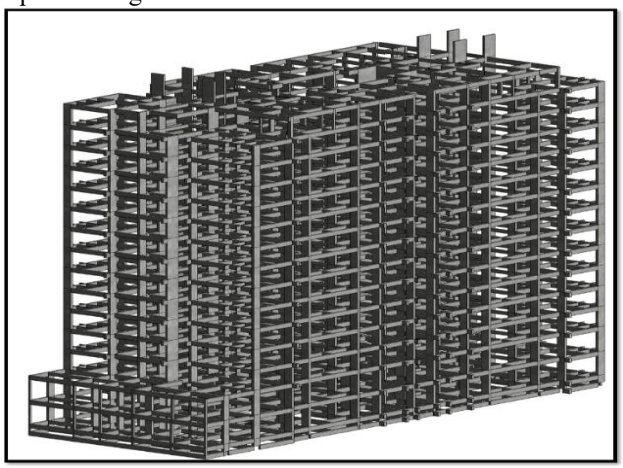

Fig. 7. 3D Modelling of Beams of Block F&G

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The above fig.7 is the combination of both beam and column which is the second step in the modelling work, while doing this work we need to make sure the beam should not merge inside the column so joint it properly, Modelling of Slab of Block F&G Below fig.8 is the placing of slab with having different sizes like somewhere it is of 5” and sometimes it is of 6” and also the sunk slab which is placed over the toilet is 3” having base offset. And the slabs are always drawn in a rectangular shape, which provides the accurate schedule quantity of material for the slab.

Fig. 8. 3D Modelling of Slabs

Fig. 9. 3D Modelling of the wall of Block F&G

Figure 9 below shows the placement of a wall which consists of Internal plaster, internal paint, external plaster, external paint and walls that have different sizes, like 4.5”, 9”, 1’, etc. To assign IDs to the walls, we use the Diroots extension, which directly identifies the position of each wall within the entire project and automatically assigns IDs accordingly. While working on walls, sometimes the walls merge into each other. In such cases, we need to disallow the wall join. Additionally, when walls are merging in a beam or column, we need to use the unjoin element. This will reduce the volume or amount of material. Building Information Modelling (BIM) is the digital data flow surrounding the lifecycle of an asset or element within the built environment, designed to provide better information management and support informed decision-making. (C. Thomson, 2015, [1])

The procedure that makes the workflow easier and faster is as follows: in the initial stage, read all the plans carefully and try to identify similar work. Then, start by importing the AutoCAD plan into Revit for each floor. Then, start the structural modelling of the column, beam, and slabs after completing the above work. Initiate the wall work, along with the external and internal painting and plastering. Then, by looking at the sectional drawing, draw the skirting and toilet dado. Complete the window and door work while also working on planters and the balcony simultaneously. This will reduce the time spent on 3D modelling.

IV. RESULTS

A. Lic Ludhiyana Project

Table 1. Scheduling of Slab Work

LEVEL	ID	L	B	H	QUANTITY	CODE	PHASE
9th Level	S2	3.54	7.6	0.15	4.035	RMC_9F_FLYASH_M25_CW	RA-13
	S2	3.55	7.6	0.15	4.047		
	S2	3.54	7.6	0.15	4.035		
	S2	3.45	7.6	0.15	3.933		
	S2	3.44	7.6	0.15	3.921		
	S2	3.55	7.6	0.15	4.047		

Table 2. Scheduling of rebaring work

Level	ID	Location	Type mark	Spacing	Bar Diameter	Bar Length	Quantity	Total Bar Length
9th Level	S4	F-G/4-5	Top Extra	200	8	8824	3	26473
9th Level	S4	F-G/4-5	Top Extra	200	8	4346	6	26079
9th Level	S4	F-G/4-5	Top Extra	200	8	1954	19	37126
9th Level	S4	F-G/4-5	Top Extra	100	8	2850	80	227991
9th Level	S4	F-G/4-5	Bottom Main	150	10	4384	53	232349
9th Level	S4	F-G/4-5	Bottom Dist.	200	8	8440	19	160360

B. Tine Shilp Residency Project At Gotta

Table 3. Scheduling of Slab Work

LEVEL	ID	L	B	H	QUANTITY	CODE	PHASE
GROUND FLOOR LEVEL	S13	2.019	1.333	0.127	0.342	M30_RCC_SLAB_VSI_CW	RA-3
	S7	3.545	1.524	0.127	0.68		
	S4	2.854	3.277	0.127	1.934		
	S8	3.45	4.6	0.127	2.296		
	S1	3.85	2.6	0.127	1.189		
	S2	3.55	7.6	0.127	4.047		

Table 4. Scheduling of Column work

LEVEL	ID	L	B	H	QUANTITY	CODE	PHASE
FIRST FLOOR LEVEL	C121	9”	36”	11’	0.175	M30_RCC_COLOUMN_VSI_CW	RA-5
	C122	12”	36”	11’	0.934		
	C126	12”	36”	11’	0.934		
	C127	36”	12”	11’	0.934		
	C129	36”	12”	11’	0.934		
	C131	36”	12”	11’	0.934		

Table 5. Scheduling of Beam w

LEVEL	ID	L	B	H	QUANTITY	CODE	PHASE
THIRD TYPICAL FLOOR LEVEL	B1a	7.48	0.229	0.584	0.999	M30_RCC_BEAM_VSI_CW	RA-7
	B60	5.601	0.229	0.584	0.784		
	B52	4.61	0.229	0.584	0.616		
	B2	4.458	0.229	0.584	0.595		
	B57	2.019	0.114	0.584	0.135		
	BK1	2.019	0.114	0.584	0.135		

V. CONCLUSION

1 Revit Software is a BIM (Building Information Modelling) software that can be used for preparing schedules and Modelling work.
2 Two extensions are being developed daily for eggs. Dynamo Run, Di Roots makes the work easy and saves time.
3 Before completing graduation, we gain industrial knowledge.
4 Working on an ongoing industrial project teaches us about deadlines and develops the discipline, quality, and time management skills in individuals.
5 Five BIM software solutions provide us with a realistic view of the projects that will be developed in the future.
6 Revit software has three parts: Architecture, structural, MEP (mechanical, electrical)

DECLARATION

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Ethical Approval and Consent to Participate	No, the article does not require ethical approval or consent to participate, as it presents evidence.
Availability of Data and Material/ Data Access Statement	Not relevant
Authors Contributions	All authors have equal participation in this article.

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Project 2: Utilisation of Industrial Sludge in Brick Manufacturing, Project 3: Analysis and Design of a PEB (Pre-Engineered Building) Shed using a STAAD PRO and ETABS Software, Project 4: Repair and Rehabilitation of RCC Column with Circumferential Pre-stressing and Jacketing. Extra-Curricular Activities, 1. Completed a soft-skill course offered by TCSion Career Edge in 2020 2. Completed online course on structural basis offered by Civilera in2021., 3. Completed online training of two weeks in AutoCAD introductory course (2D & 3D), four weeks, and completed a course on GST in 90 minutes offered by Tyson Career Edge in 2020.