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Building Information Modeling (BIM)

Shrikant Bhuskade

Assistant Professor,
Department of Civil Engineering,
Prof. Ram Meghe Institute of Technology & Research, Amravati (M.S.) (India)

Abstract - The case study shows that BIM does enhance the traditional scheduling and cost estimating methods with a more reliable and automated technology. Based on the reviews on BIM and the case study, the work finds out that there are three areas of potential development in the future: i) higher levels of detail (LOD) in BIM model will be available as BIM technology develops, ii) linking time and cost parameters concurrently to BIM components in the building model to deliver a scheduled financial analysis, and iii) allocation of resources on 4D BIM model to analyse and plan the resource usage based on the most updated design, and even simulate the resource allocation.

Key Words: BIM, modelling, cost estimation, resources allocation, construction scheduling

1. INTRODUCTION

Building Information Modeling (BIM) is a set of interacting policies, processes and technologies generating a "methodology to manage the essential building design and project data in digital format throughout the building's life-cycle". As a key part in the project lifecycle, contractors play an important role in making sure the project will be delivered on time and within the budget. This project will show how BIM technology will benefit for Architect, Engineer and contractors for Estimating & schedule and cost controls. It begins with a general introduction of BIM technology and the different ways it works compared with traditional CAD (Computer Aided Design) method, and continues with evaluation of BIM tools. It then explains the uses of Scheduling and Cost Estimating in BIM respectively and provides a case study to show how BIM can work for Architect. Engineer and contractor.

Building Information Modeling (BIM) is an emerging technology throughout the world in the Architecture, Engineering, and Construction (AEC) industries. BIM technology provides users with accurate and consistent building/project data and information, accommodating the functions needed to model the building and provides a virtual view of it. Building information models are increasingly used, for several purposes by the diverse stakeholders during the different phases of the project and building lifecycle.

BIM revolutionize the AEC industry, being not only a change between CAD and parametric modeling with 3D capabilities, but a change of workflows, methodologies, process, and relations. Basically it changes the way business is done throughout the industry. Although all of these changes may seem too much to be easily accepted by the industry, the benefits are much greater, making BIM the future for the industry.

Nowadays, Construction and BIM technologies are built for the trailer and the office. To improve productivity and efficiency in construction, these technologies need to be built it for the field, where the work is done and money is spent. According to the Construction Industry Institute 75% of all construction dollars are spent in the field, however, 90 % of the technology is made for the trailer and the office.

2. AUTODESK REVIT

Autodesk Revit is a building information modeling software for architects, structural engineers, MEP engineers, designers and contractors. It allows user to design a building and structure and its components in 3D, annotate the model with 2D drafting elements, and access building information from the building model's database. Revit is 4D BIM capable with tools to plan and track various stages in the building's lifecycle, from concept to construction and later demolition.

Revit was intended to allow architects and other building professionals to design and document a building by creating a parametric three dimensional model that included both the geometry and non - geometric design and construction information, what later becomes known as Building Information Modeling or BIM. At the time, several other software packages such as Archi CAD and Reflex allowed working with a three dimensional virtual building model, and allowed individual components to be control by parameters. Two key differences in Revit were that its parametric components were created using a graphical "family editor" rather than a programming language, and all relationships between components, views and annotations were captured by the model so that a change to any element would automatically propagate to keep the model consistent. For example, moving a wall would update the neighbouring walls, floors and roofs, correct the placement and values of dimension and notes,

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adjust the floor area reported in schedule, redraw section views, etc., so that the model will remain connected and all documentation would be coordinated. The concept of bi-directional associativity between components, views and annotations was a distinguishing feature of Revit for many releases. The ease of making changes inspired the name Revit, a contraction of Revise-It. At the heart of the Revit is a parametric change propagation engine that relied on a new technology, context driven parametric, that was more scalable than the vibrational and history driven parametric used in mechanical CAD software. The term parametric building model was adopted to reflect the fact that changes to parameters drove the whole building model and associated documentation, not just individual components.

3. LITERATURE REVIEW

Jia Qi1 at el studied that the construction industry has incurred the most fatalities of any United States industry in the private sector in recent years. Whereas many factors may contribute to this statistic, one likely cause is due to designers who often lack design for construction safety knowledge, which results in many safety hazards being built into project designs. Therefore, there is a compelling need for tools that can put the safety-in-design concept into practice. To improve the current situation, a prevention through design (PTD) tool based on computer software was developed. Construction safety best practices were compiled into computable rules so that the PTD tool can automatically conduct compliance checking.

Brittany K. Giel1 at el studied that the recent emergence of building information modeling (BIM) and the evolution of virtual design and construction (VDC) in the architecture, engineering, and construction (AEC) industry are fundamentally changing the process by which buildings are designed and constructed. However, the perceived high initial cost of implementing BIM has deterred many industry professionals from adopting this technology. The potential savings to an owner choosing to invest in BIM as an additional service were estimated based on the measurable cost benefits associated with reduced schedule overruns, fewer requests for information (RFIs), and reduced change orders.

Nawari O. Nawari studied that Building information modeling (BIM) is rapidly gaining acceptance as the preferred method of communicating the design professional's intent to the owner and various stakeholders. These data-rich models can be used effectively by other members of the design team to coordinate the fabrication of a building's different systems. This has innumerable advantages in off-site construction domain in- cluding speed, economy, sustainability, and safety.

3. RESULT & DISCUSSION

The model or project is a frame structure consist of a one residential building. The building consist of floor such as parking level, Ground Floor, First floor, Terrace Floor and staircase cap level. In front of the building there is lawn area and in side portion there is ramp which connected with the parking area for parking purpose. Staircase is provided from parking area up to the terrace level.

Revit works exactly opposite to AutoCAD. In AutoCAD, first to draw 2D drawing and then move towards 3D (Not BIM). In Revit first to create direct 3D model and then get directly 2D drawing with material quantity and many more which is essential to manage construction of building. In the present work it is created 3D model and able to get 2D drawing as shown below and material quantity as per the requirements. The schedule of foundation, column, beam, floor and wall is tabulated.

Fig -1: Model with Rendering

Fig -2: Side Elevation-1

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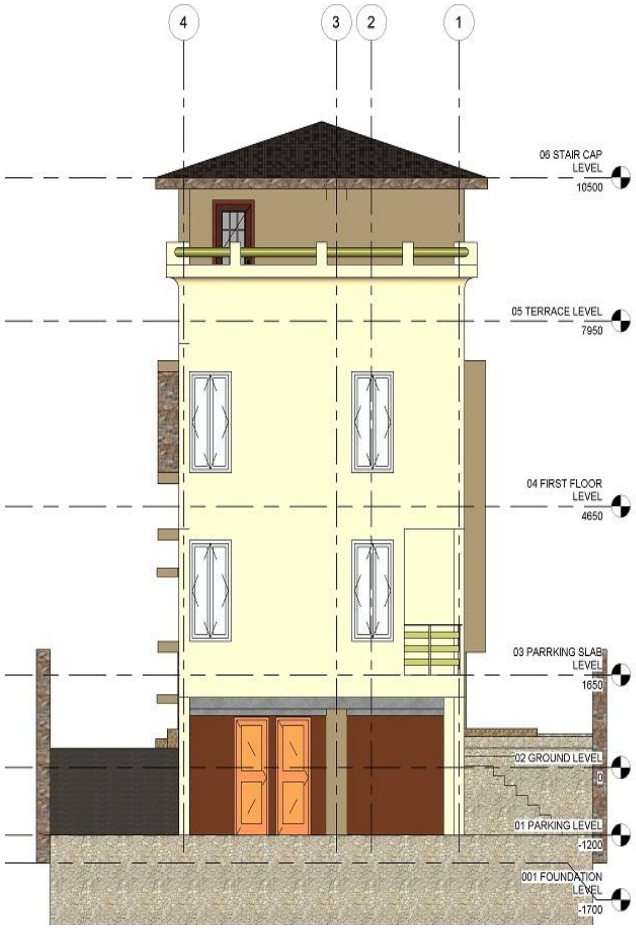

Fig -3: Back Elevation

Fig -4: Front Elevation

Fig -5: Side Elevation-2

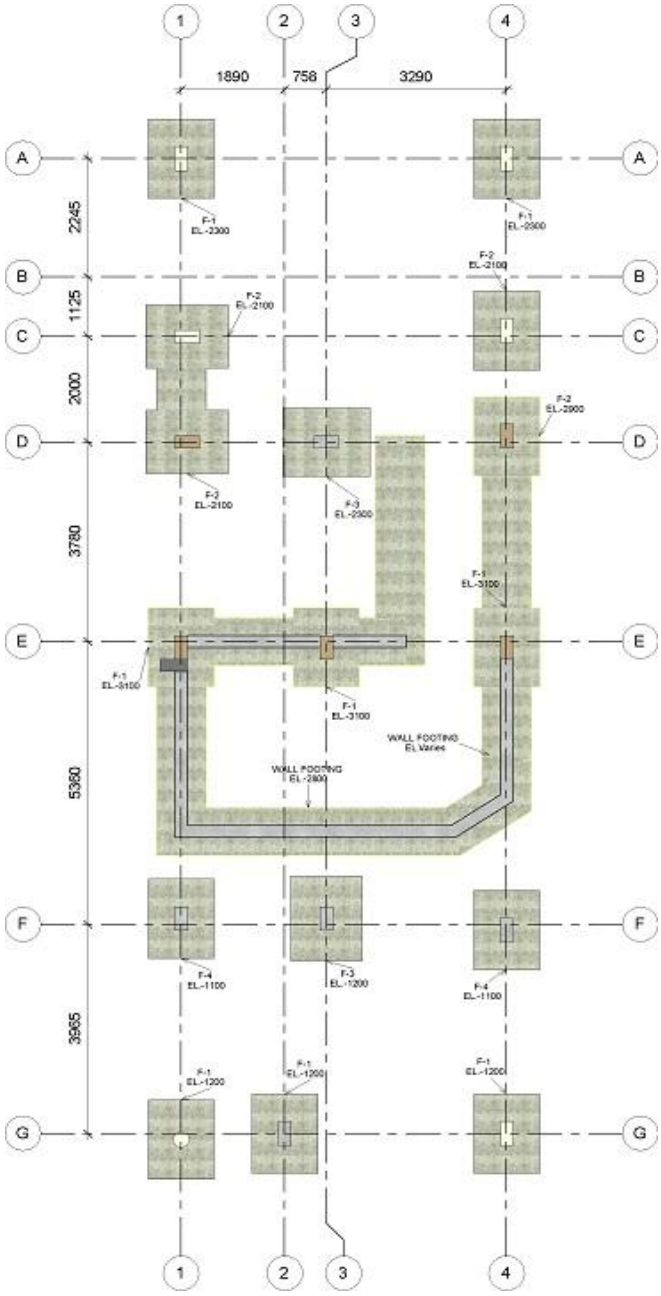

Fig -6: Foundation Plan

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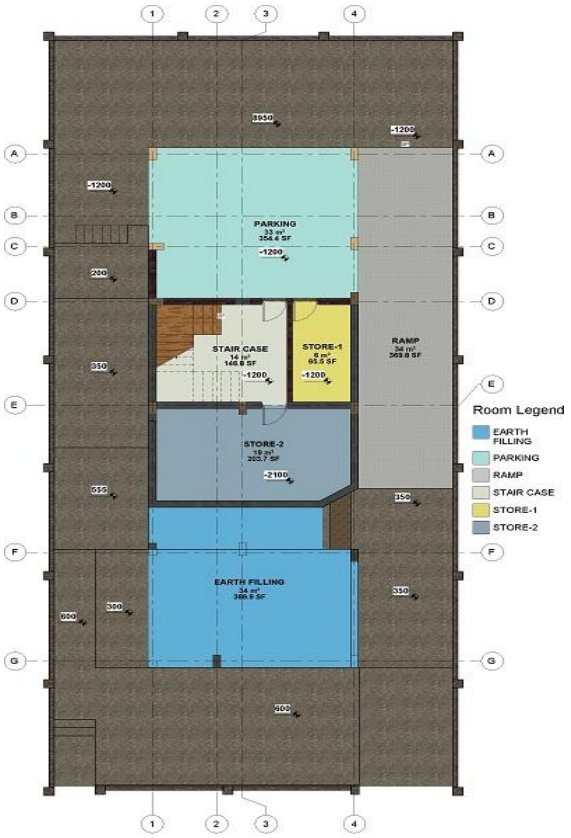

Fig -7: Parking Level Plan

Fig -9: First Floor Plan

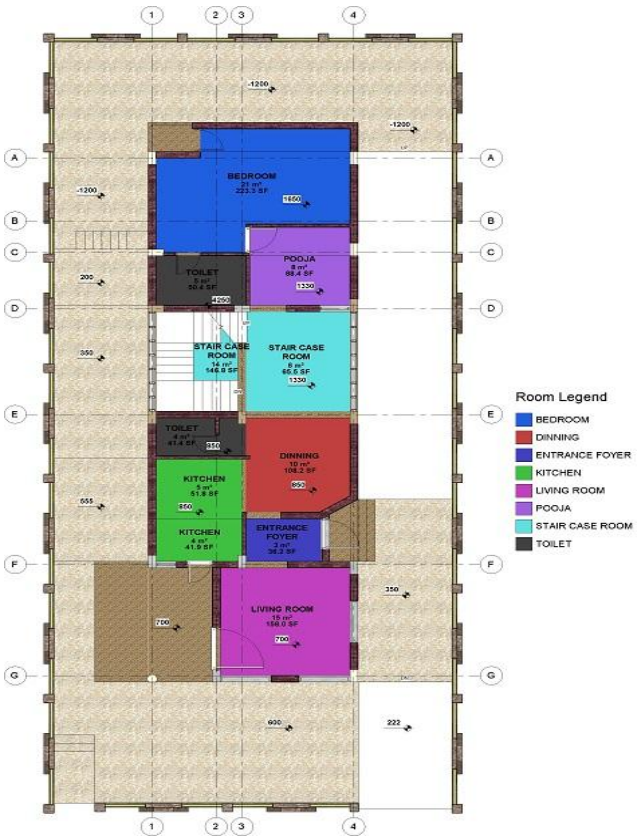

Fig -8: Ground Floor Plan

Fig -10: Terrace Floor Plan

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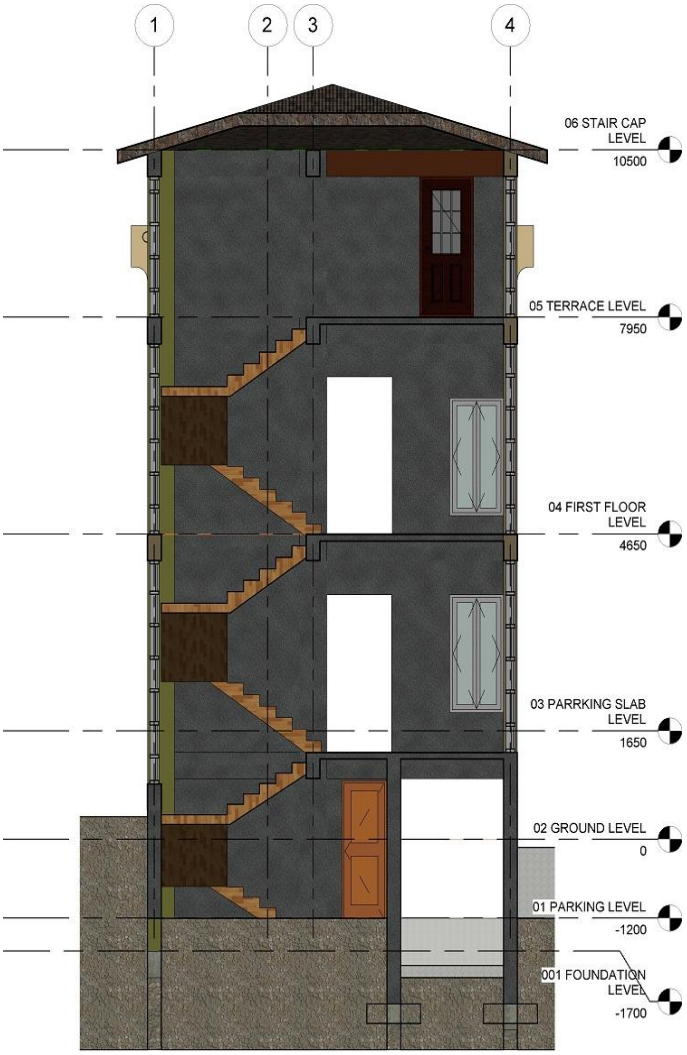

Fig -11: Section Cutting Staircase Room-1

Fig -12: Section Cutting Staircase Room-2

Table -1: Foundation Schedule

Foundation Schedule				
Type	Length	Width (mm)	Offset (mm)	Volume. (m^3)
F-4	1500	1200	1100	0.90 m^3
F-1	1500	1200	-800	1.08 m^3
F-3	1600	1300	1100	1.25 m^3
F-4	1500	1200	1100	0.90 m^3
F-1	1500	1200	1100	1.08 m^3
F-1	1500	1200	1100	1.08 m^3
F-1	1500	1200	-800	1.08 m^3
F-1	1500	1200	-800	1.08 m^3
F-2	1500	1200	-800	0.72 m^3
F-3	1600	1300	0	1.25 m^3
F-2	1500	1200	0	0.72 m^3
F-2	1500	1200	0	0.72 m^3
F-2	1500	1200	0	0.72 m^3
F-1	1500	1200	0	1.08 m^3
F-1	1500	1200	0	1.08 m^3
W.F.	5233	900		1.46 m^3
W.F.	1070	900		0.46 m^3
W.F.	2842	900		0.42 m^3
W.F.	1345	900		0.23 m^3
W.F.	2418	900		0.39 m^3
W.F.	3150	900		0.62 m^3
F-1	1500	1200	1100	1.08 m^3
W.F.	3780	900		1.02 m^3
W.F.	3550	900		0.68 m^3
W.F.	1770	900		0.22 m^3
Total	49358	27500		21.31 m^3

Table -2: Column Schedule

Column Schedule				
Type	Column Location	Base Off. (mm)	Length (mm)	Vol. (m^3)
C-230 X 450	A-1	0	9650	1.00
C-230 X 450	G-2	1100	8550	0.88
C-230 X 450	A-4	0	9650	1.00
C-230 X 450	E-4	-800	13000	1.34
C-230 X 450	F-4	1100	8550	0.88
C-230 X 450	C-1	0	9650	1.00
C-230 X 450	D-4	-800	13000	1.34
C-230 X 450	C-4	0	9650	1.00
C-230 X 450	E-3	-800	13000	1.35
C-230 X 450	F-3	1100	8550	0.88
C-230 X 450	D-3	0	12200	1.26
300mm	G-1	1100	5250	0.37
C-230 X 450	F-1	1100	8550	0.88
C-230 X 450	G-4	1100	8550	0.88
C-230 X 450	D-1	0	12200	1.26
C-230 X 450	E-1	-800	13000	1.34
C-230 x 230	G-1	0	3300	0.17
Total: 17			166300 mm	16.86 m^3

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Table -3: Floor Schedule

Floor Schedule		
Level	Area (m^2)	Vol. (m^3)
Ground Level	20	2.03
Parking Slab Level	21	2.10
Parking Slab Level	26	2.58
First Floor Level	98	9.76
Terrace Level	98	9.76
Stair Cap Level	41	8.22
Total	303 m^2	34.44 m^3

Table -4: Beam Schedule

Beam Schedule			
Type	Cut Length (mm)	Volume (m^3)	Count
FB-1	770	0.14 m^3	2
FB-1	789	0.07 m^3	1
FB-1	820	0.08 m^3	1
FB-1	1050	0.10 m^3	1
FB-1	1550	0.14 m^3	1
FB-1	1679	0.15 m^3	1
FB-1	1770	0.16 m^3	1
FB-1	2088	0.19 m^3	1
FB-1	2418	0.44 m^3	2
FB-1	2810	0.26 m^3	1
FB-1	2950	0.27 m^3	1
FB-1	3030	0.28 m^3	1
FB-1	3060	0.56 m^3	2
FB-1	3405	0.31 m^3	1
FB-1	3550	0.98 m^3	3
FB-1	3612	0.33 m^3	1
FB-1	3818	0.35 m^3	1
FB-1	3850	0.35 m^3	1
FB-1	4690	0.86 m^3	2
FB-1	4910	0.45 m^3	1
FB-1	5488	0.50 m^3	1
FB-1	5708	0.52 m^3	1
FB-1	5938	0.55 m^3	1
FB-1	6168	0.57 m^3	1
GB-1	820	0.15 m^3	2
GB-1	1550	0.14 m^3	1
GB-1	1770	0.16 m^3	1
GB-1	2088	0.19 m^3	1
GB-1	2810	0.26 m^3	1
GB-1	2950	0.26 m^3	1
GB-1	3030	0.28 m^3	1
GB-1	3550	0.65 m^3	2
GB-1	4690	0.43 m^3	1
GB-1	4910	0.45 m^3	1
GB-1	5708	0.39 m^3	1
GB-1	6168	0.57 m^3	1
GB-2	2418	0.33 m^3	1
GB-2	3060	0.42 m^3	1
GB-2	5488	0.63 m^3	1
PLINTH BEAM	2418	0.22 m^3	1
PLINTH BEAM	3060	0.28 m^3	1
PLINTH BEAM	3405	0.31 m^3	1
PLINTH BEAM	3625	0.33 m^3	1
PLINTH BEAM	3818	0.35 m^3	1
STB-1	2088	0.19 m^3	1
STB-1	2418	0.22 m^3	1
STB-1	2950	0.27 m^3	1
STB-1	3060	0.28 m^3	1
STB-1	3550	0.61 m^3	2
STB-1	3550	0.33 m^3	1
Str. Fram.		9.43 m^3	1
TB-1	770	0.21 m^3	3
TB-1	820	0.15 m^3	2
TB-1	1550	0.14 m^3	1
TB-1	1660	0.15 m^3	1
TB-1	1770	0.16 m^3	1
TB-1	2088	0.19 m^3	1
TB-1	2418	0.44 m^3	2
TB-1	2810	0.26 m^3	1
TB-1	2950	0.27 m^3	1
TB-1	3030	0.28 m^3	1
TB-1	3060	0.56 m^3	2
TB-1	3405	0.31 m^3	1
TB-1	3550	0.98 m^3	3
TB-1	3625	0.33 m^3	1
TB-1	3818	0.35 m^3	1
TB-1	3845	0.35 m^3	1
TB-1	4690	0.86 m^3	2
TB-1	4910	0.45 m^3	1
TB-1	5488	0.50 m^3	1
TB-1	5708	0.53 m^3	1
TB-1	6168	1.13 m^3	2
Total: 90		35.43 m^3	90

Table -5: Wall Schedule

Wall Schedule				
Type	Area	Length	Volume	Count
RET. WALL	9 m^2	3035	2.14 m^3	1
G-Wall-230	3 m^2	2418	0.74 m^3	1
G-Wall-230	5 m^2	3625	1.17 m^3	1
G-Wall-230	7 m^2	3818	1.67 m^3	1
G-Wall-230	9 m^2	3405	2.06 m^3	1
G-Wall-230	7 m^2	2950	1.70 m^3	1
G-Wall-230	5 m^2	1857	1.07 m^3	1
RET. WALL	17 m^2	4959	3.78 m^3	1
RET. WALL	6 m^2	3550	1.35 m^3	1
RET. WALL	5 m^2	1770	1.07 m^3	1
BASE. WALL	5 m^2	2088	1.26 m^3	1
BASE. WALL	1 m^2	1005	0.25 m^3	1

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RET. WALL	14 m²	3550	3.13 m³	1
RET. WALL	8 m²	2630	1.88 m³	1
RET. WALL	3 m²	1167	0.61 m³	1
RET. WALL	14 m²	3895	3.24 m³	1
RET. WALL	8 m²	2418	1.80 m³	1
RET. WALL	4 m²	1345	1.00 m³	1
G-Wall-115	5 m²	1540	0.60 m³	1
G-Wall-230	6 m²	2253	1.14 m³	1
G-Wall-230	10 m²	2630	2.16 m³	1
G-Wall-230	6 m²	1167	1.06 m³	1
G-Wall-230	13 m²	4690	2.89 m³	1
G-Wall-230	7 m²	2418	1.62 m³	1
G-Wall-230	6 m²	2088	1.40 m³	1
G-Wall-230	4 m²	2950	1.01 m³	1
Curtain Wall	10 m²	3543		1
G-Wall-230	3 m²	1550	0.67 m³	1
G-Wall-230	6 m²	2810	1.31 m³	1
G-Wall-230	3 m²	935	0.63 m³	1
G-Wall-230	9 m²	4638	2.03 m³	1
G-Wall-230	1 m²	1050	0.25 m³	1
G-Wall-230	6 m²	3030	1.49 m³	1
G-Wall-230	4 m²	1770	0.94 m³	1
G-Wall-115	9 m²	2873	1.08 m³	1
G-Wall-115	3 m²	1470	0.37 m³	1
G-Wall-115	5 m²	1885	0.59 m³	1
G-Wall-115	5 m²	2500	0.54 m³	1
G-Wall-230	3 m²	1185	0.71 m³	1
G-Wall-115	8 m²	3123	0.88 m³	1
G-Wall-115	0 m²	1015	0.06 m³	1
G-Wall-230	2 m²	2418	0.51 m³	1
G-Wall-230	3 m²	3625	0.77 m³	1
F-Wall-115	5 m²	2418	0.60 m³	1
F-Wall-230	7 m²	3405	1.53 m³	1
F-Wall-115	4 m²	1310	0.44 m³	1
F-Wall-230	14 m²	5938	3.20 m³	1
F-Wall-230	11 m²	4910	2.53 m³	1
F-Wall-230	10 m²	4690	2.22 m³	1
F-Wall-230	7 m²	2418	1.61 m³	1
F-Wall-230	6 m²	2088	1.39 m³	1
F-Wall-230	4 m²	2950	0.99 m³	1
Curtain Wall	10 m²	3543		1
F-Wall-230	3 m²	1550	0.66 m³	1
F-Wall-230	7 m²	2810	1.50 m³	1
F-Wall-230	3 m²	935	0.70 m³	1
F-Wall-230	14 m²	5938	3.22 m³	1
F-Wall-230	7 m²	3030	1.70 m³	1
F-Wall-230	4 m²	1770	0.93 m³	1
F-Wall-115	5 m²	1885	0.63 m³	1
F-Wall-115	5 m²	2480	0.60 m³	1
F-Wall-115	9 m²	3123	0.98 m³	1
F-Wall-115	1 m²	1015	0.09 m³	1
F-Wall-230	10 m²	4048	2.23 m³	1
F-Wall-230	2 m²	885	0.51 m³	1
F-Wall-230	2 m²	1000	0.51 m³	1
F-Wall-230	3 m²	1660	0.69 m³	1
F-Wall-230	8 m²	3845	1.91 m³	1
F-Wall-115	2 m²	1235	0.21 m³	1
F-Wall-115	10 m²	3348	1.17 m³	1
F-Wall-230	6 m²	3060	1.43 m³	1
F-Wall-115	6 m²	2900	0.68 m³	1
F-Wall-230	2 m²	935	0.55 m³	1
Terr. Floor Wall	5 m²	2418	1.20 m³	1
Terr. Floor Wall	4 m²	2088	1.03 m³	1
Terr. Floor Wall	4 m²	2950	1.01 m³	1
Terr. Floor Wall	5 m²	3060	1.07 m³	1
Curtain Wall	8 m²	3543		1
Parapet Wall	26 m²		14.70 m³	1
Curtain Wall	12 m²	3543		1
Curtain Wall	10 m²	3543		1
Curtain Wall	8 m²	3543		1
Compound Wall	17 m²		2.42 m³	1
Compound Wall	17 m²		2.42 m³	1
Compound Wall	17 m²		2.42 m³	1
Compound Wall	17 m²		2.42 m³	1
Compound Wall	17 m²		2.42 m³	1
Compound Wall	17 m²		2.42 m³	1
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Compound Wall	17 m²		2.42 m³	1
Compound Wall	17 m²		2.42 m³	1
Compound Wall	17 m²		2.42 m³	1
Compound Wall	17 m²		2.42 m³	1
Compound Wall	16 m²		2.08 m³	1
Compound Wall	17 m²		2.42 m³	1
Compound Wall	16 m²		2.37 m³	1
Compound Wall	16 m²		2.31 m³	1
Compound Wall	17 m²		2.42 m³	1
Compound Wall	17 m²		2.50 m³	1
Parapet Wall	23 m²		0.26 m³	1
Total: 102	882 m²	214448	154.88 m³	102

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3. CONCLUSIONS

The Building Information Model are produced, the quantity take offs can be generated to provide cost estimations on a construction project. BIM based 4D scheduling helps understanding of the construction components and schedule progress that in turn results better construction planning. In other words, BIM provides time and cost savings and yields better quality construction products. Overall, Building Information Modeling is a great concept.

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BIOGRAPHIES

Shrikant Bhuskade
Assistant Professor,
Department of Civil Engineering,
Prof. Ram Meghe Institute of Technology & Research, Badnera, Amravati. 444701(M.S.) (India)
Teaching Exp.:1Yr.
Industrial Exp.: 5Yr.

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