STRUCTURAL STRENGTH COMPARISON OF RCC AND STEEL FRAME STRUCTURE AND MODELING IN MULTIPLE BIM DIMENSION

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ABSTRACT

Today's cities reveal skies punctuated by buildings so tall and austere, even architectural tour guides experience the occasional pain in the neck. So, which material reigns supreme in the world of development today - concrete or steel? Both provide numerous benefits. Building Information Modeling **(BIM)** has become an essential part of any design project by facilitating smarter, faster, stronger designs that make economic sense while reducing environmental impact. BIM provides support every step of the way from design and visualization, to simulation and construction. This software **AUTODESK REVIT** richest software for BIM its helps teams collaborate, innovate, and connect with clients in more productive ways.

This project aims that preparing completestructural strength comparison between RCC and Steel design of frame. The analysis of a structural frame excitation is an essential step in the design of a structure to resist earthquake seismic response and wind simulation of a RCC and steel frame is analyzed by the linear analysis approaches of Equivalent Static Lateral Force and Response Spectrum methods using **STAAD.Pro& ROBOT STRUCTURAL ANALYSIS** Professional 2017software as per the IS- 1893-2002-Part-1and IS875-part-3.IS:875(1987)code of practice for design loads (other than earth quake)for buildings and structures Part 1dead loads, Part 2 imposed loads, Part 3 wind loads, Part 5 Combinations, IS 1893(part 1):2002 criteria for earthquake resistance.

Finally compare the structural strength of G+20 RCC frame structure with Steel frame structure. Modeling in multiple **BIM** dimension by using Autodesk Revit software as requirement **1D**, drawing **2D, BIM 3D** to communicate the design intent, **4D** cad or what happens to the schedule in case of project. **5D** cad or what happens to the cost in case of project**, 6D** cad or how to optimize the energy consumption. **7D**cad or how to manage assetslife cycle.

Keywords- BIM Softwares, Lateral Loads, 7D modelling, RCC Design, Steel Design.

I.INTRODUCTION

There are various important structures which should withstand the seismic motion. But as buildings are becoming slender and slender (vertical growth due to the land problem), building structures are considered for the study.

IJARSE
ISSN: 2319-8354

While designing a building for its survival under seismic actions, following factors must be taken into consideration.

- Type of construction material (concrete or steel)
- Type of structure (rigid or ductile)
- Configuration of the load resisting structural system to control response of building.

What is BIM?

- BIM is a process to plan, design, construct and manage a project based on an intelligent digital prototype, developed prior to construction and coordination through the model during the project life cycle.
- BIM helps us to plan, design, construct and manage the buildings and infrastructure virtually insight.

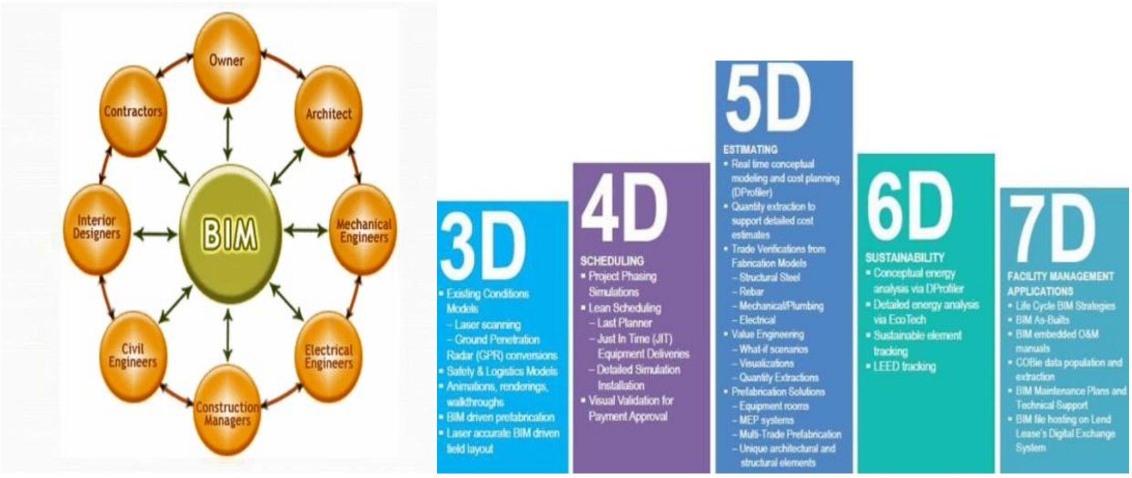

Fig1: Transfer from 3D to 7D

II.ANALYSIS AND RCC DESIGN OF STRUCTURAL FRAME SUBJECTED TO WIND AND SEISMIC FORCES

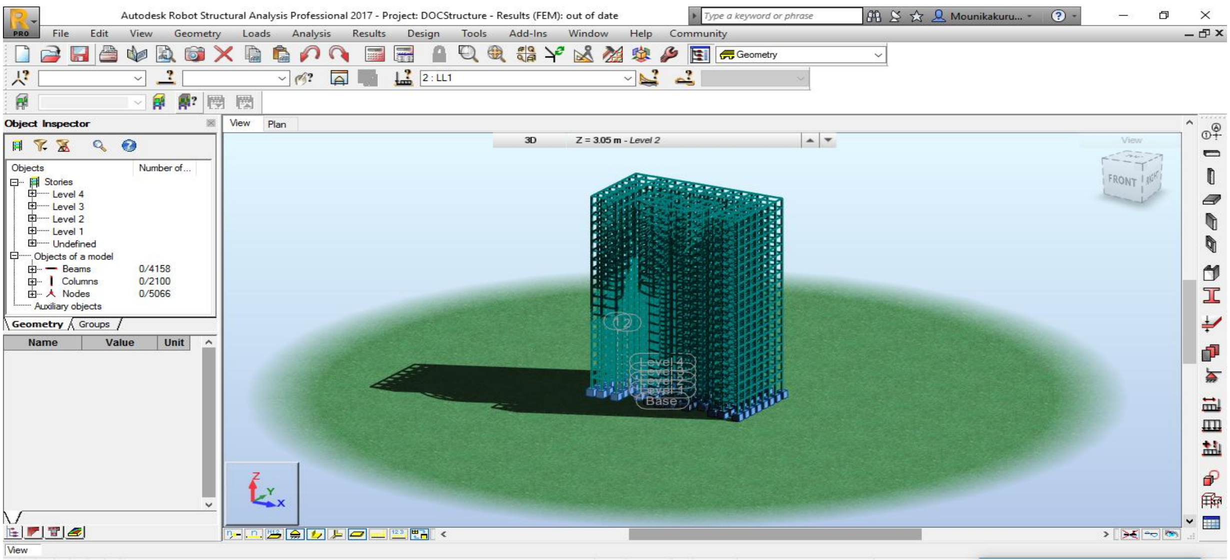

Fig4: Structural frame in ROBOT structural analysis professional 2017software.

IJARSE
ISSN: 2319-8354

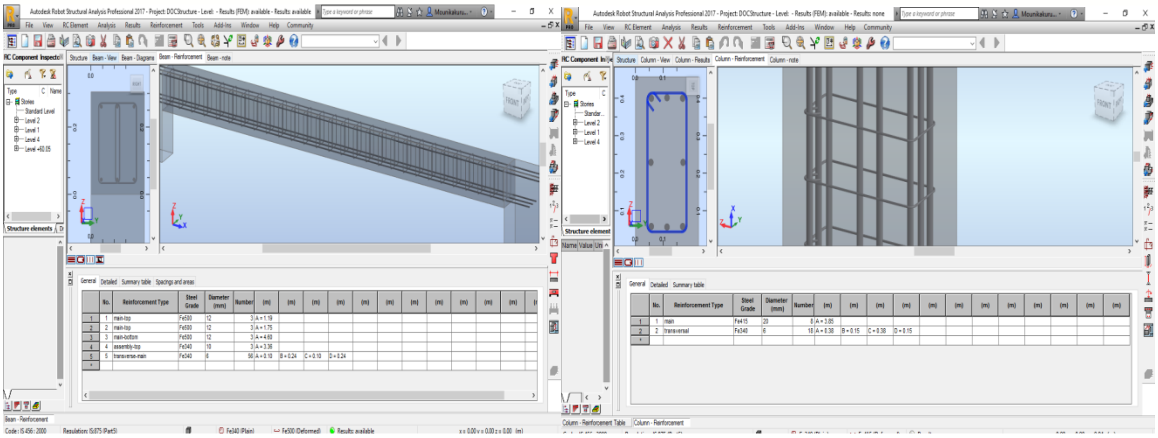

Fig5: RCC design results for beam in ROBOT structural analysis professional 2017software.

2.1The structural strength details of RCC frame

Floor Details	Member No	Bending moment (kN.m)	Shear force (kN)	Displacements (mm)	Axial forces (kN)	Torsion (kNm)
G-floor	10	80.489	-66.36	0.001	32.00	0.300
1st floor	101	81.480	-98.32	0.012	56.23	0.320
2nd floor	225	81.889	-40.23	0.019	98.45	0.390
3rd floor	295	81.900	-20.56	0.020	112.78	0.210
4th floor	303	82.033	10.33	0.100	129.58	0.230
5th floor	396	82.666	15.89	0.110	199.65	0.330
6th floor	410	82.900	19.89	0.160	225.36	0.450
7th floor	487	83.560	20.31	0.200	312.58	0.560
8th floor	515	84.233	23.78	0.230	396.14	0.680
9th floor	576	84.997	27.85	0.290	404.45	0.630
10th floor	610	85.332	33.41	0.300	415.36	0.890
11th floor	714	86.445	34.02	0.330	425.85	0.890
12th floor	789	87.077	45.36	0.350	453.20	0.990
13th floor	823	87.996	50.89	0.550	487.00	-0.230

14th floor	869	88.441	51.63	0.650	536.56	-0.110
15th floor	905	89.664	52.56	0.750	558.23	-0.160
16thfloor	987	90.556	54.12	0.900	578.25	-0.230
17th floor	999	90.999	55.36	1.200	598.32	-0.350
18th floor	1002	91.023	59.48	1.560	601.23	-0.440
19th floor	1038	92.347	60.78	1.580	613.00	-0.560
20th floor	1110	93.555	61.65	1.590	625.89	-0.567
21th floor	1198	94.112	65.23	1.990	630.12	-0.567

Table1:Analysis results of RCC frame fromROBOT structural analysis professional 2017software.

III. ANALYSIS AND STEEL DESIGN OF STRUCTURAL FRAME SUBJECTED TO WIND AND SEISMIC FORCES.

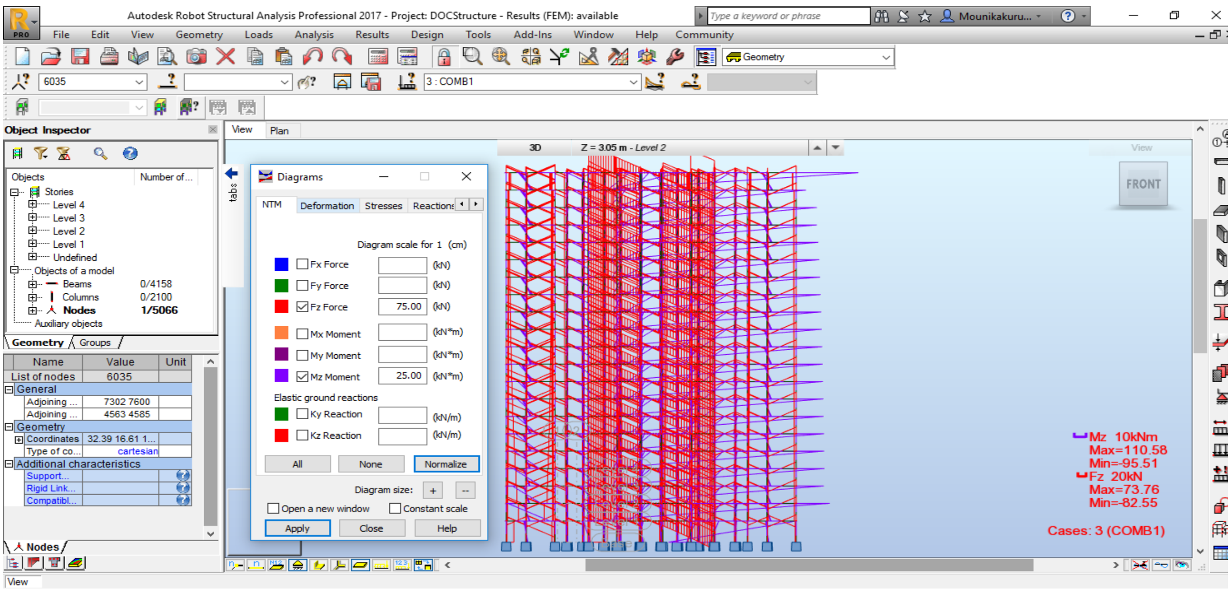

Fig7: Analysis results in ROBOT structural analysis professional 2017software.

International Journal of Advance Research in Science and Engineering
Volume No.07, Issue No.03, March 2018
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ISSN: 2319-8354

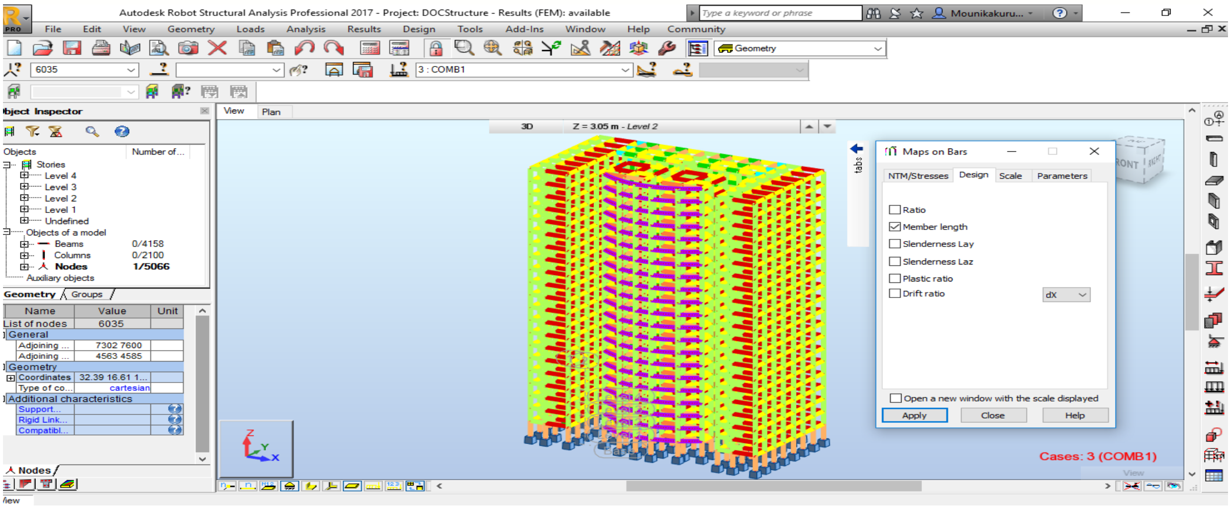


Fig8: Stresses developed in ROBOT structural analysis professional 2017software.

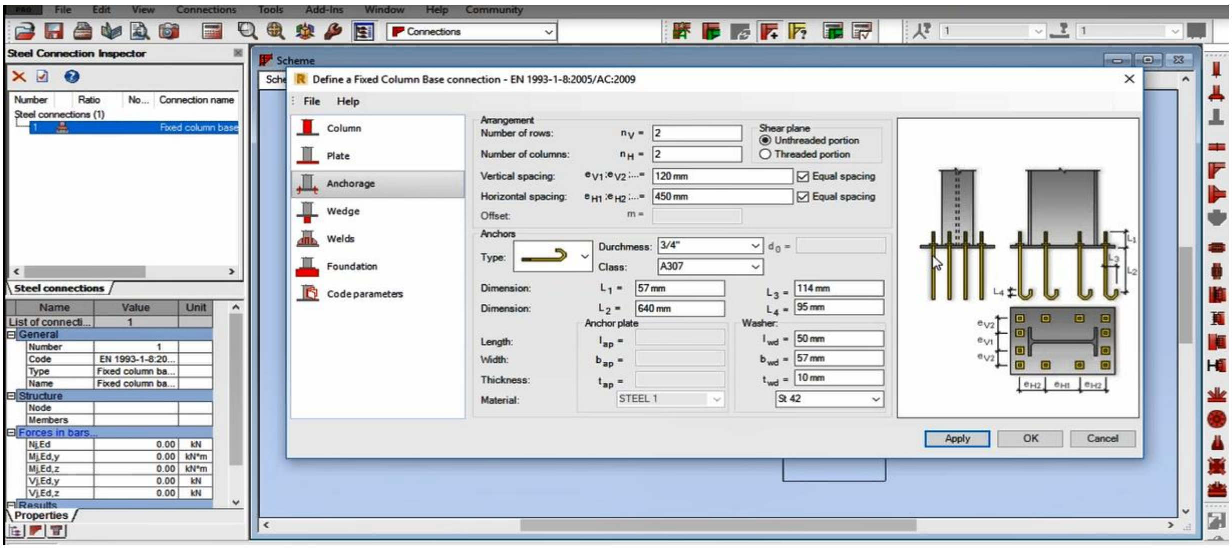


Fig9: Steel connection details in ROBOT structural analysis professional 2017software.

3.1The structural strength details of Steel frame.

Floor Details	Member No	Bending moment (kN.m)	Shear force (kN)	Displace ments (mm)	Axial forces (kN)	Torsion (kNm)
Ground floor	10	79.239	-60.36	0.006	56.00	0.792
1st floor	101	80.460	-89.32	0.046	92.23	0.678
2nd floor	225	80.269	-56.23	0.046	64.45	0.148

3rd floor	295	80.540	-25.56	0.079	66.78	0.794
4th floor	303	81.483	41.33	0.112	168.58	0.457
5th floor	396	81.766	16.89	0.115	315.65	0.165
6th floor	410	81.970	54.89	0.147	168.36	0.799
7th floor	487	82.970	65.31	0.554	652.58	0.649
8th floor	515	82.643	15.78	0.454	187.14	0.797
9th floor	576	83.897	79.85	0.445	365.45	0.948
10th floor	610	84.162	45.41	0.454	187.36	0.698
11th floor	714	85.795	64.02	0.112	274.85	0.879
12th floor	789	86.977	13.36	0.454	167.20	0.697
13th floor	823	86.645	56.89	0.797	368.00	-0.792
14th floor	869	87.445	98.63	0.797	271.56	-0.498
15th floor	905	88.457	46.56	0.164	624.23	-0.191
16th floor	987	89.464	54.12	0.978	287.25	-0.989
17th floor	999	89.974	55.36	1.775	268.32	-0.979
18th floor	1002	90.654	56.48	1.487	688.23	-0.964
19th floor	1038	91.787	65.78	1.145	726.00	-0.981
20th floor	1110	92.974	89.65	1.899	726.89	-0.478
21th floor	1198	93.797	16.23	1.644	981.12	-0.698

Table2:Analysis results of steel frame fromROBOT structural analysis professional 2017software.

3.2Structural Strength comparison between RCC and Steel frame.

	Column no.	RCC Frame			Steel Frame		
		F_X(kN)	F_Y(kN)	M_Z(kN.m)	F_X(kN)	F_Z(kN)	M_Y(kN .m)
G-floor	229	82.968	0.211	0.561	52.05	0.24	0.37
	237	64.309	0.230	0.611	66.34	0.29	0.43
1st floor	485	46.423	0.358	0.669	38.60	0.51	0.79
	487	61.246	0.322	0.597	48.60	0.65	1.02
2nd floor	691	28.326	0.541	1.260	25.28	0.44	0.67
	683	39.606	0.470	1.092	32.40	0.51	0.80
3rd floor	1017	8.934	0.651	1.270	12.46	0.69	0.87
	1025	5.250	0.748	1.469	16.24	0.85	1.08

Table 3: analysis comparison for columns

	Beam no.	RCC Frame			Steel Frame		
		F_X(kN)	F_Y(kN)	M_Z(kN.m)	F_X(kN)	F_Z(kN)	M_Y(kN .m)
G-floor	165	0.240	3.699	2.704	0.61	3.72	2.67
	172	0.129	2.709	1.456	0.25	2.80	1.52
1st floor	492	0.135	2.620	1.349	0.21	3.75	2.76
	502	0.331	3.746	2.852	0.17	2.59	1.21
2nd floor	697	0.194	3.702	2.645	0.60	3.77	2.84
	707	0.07	2.716	1.415	0.14	2.62	1.27
3rd floor	902	0.612	2.689	1.389	1.43	3.72	2.58
	912	1.398	3.721	2.717	0.53	2.47	1.90

Table 9.2 : analysis comparison for beams

IV.PLANNING-2D

The Plot Area of shopping mall is 216’10” * 165’10”.

The Carpet Area of shopping mall is 12856 Sq ft.

The Plinth Area of shopping mall is 14309 sq ft.

Floor Space Index (FSI)=0.39.

Rear Side set back distance=36’.

Front side set back distance =23’.

Side set back distance=20’.

International Journal of Advance Research in Science and Engineering
Volume No.07, Issue No.03, March 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

V.MODELLING-3D

5.1Autodesk RevitArchitecture

Autodesk Revit Architecture is a robust architectural design and documentation softwareapplicationcreatedbyAutodeskforarchitectsandbuildingprofessionals.The tools and features that make up Revit Architecture are specifically designed to support building information modelling (BIM) workflows.

5.1Basement & Ground floorplans

Fig10:Description of basement floor plan

- The Basement Parking refers to parking located below grade within an occupied building.
- Ground floor is divided into wine gallery and Kirana&cosmetics.

5.2 First,Second and Third floorplans

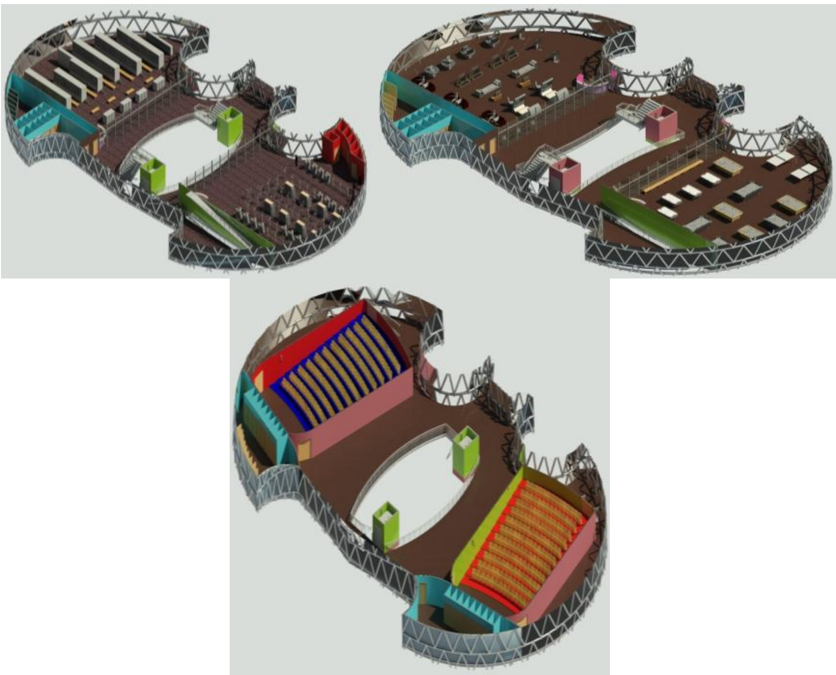


Fig12: Description of first floor plan

International Journal of Advance Research in Science and Engineering
Volume No.07, Issue No.03, March 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

- One side consists of Electronics stuffs and the other side is used for Gamingzone.
- Electronics deals with equipment intended for everyday use, typically in private homes. Consumer electronics include devices used for entertainment (flat screen TVs, DVD players, DVD movies, iPods, video games, remote control cars, etc.), communications (telephones, cell phones, e-mail-capable laptops,etc.)

5.4Exterior Designing

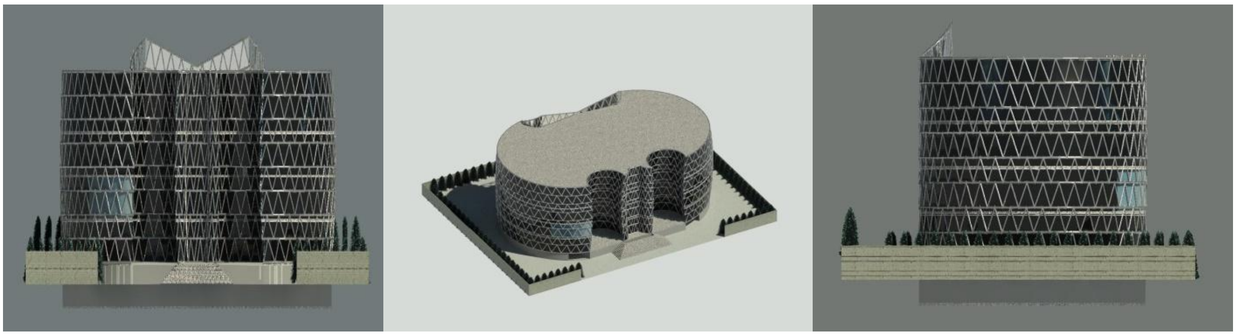


Fig 27: Description of side view

VI.SCHEDULING

6.1Bill ofquantities

A bill of quantities (BOQ) isA bill of quantities (BOQ) is a document used in tendering in the constructionindustry in which materials, parts, and labour (and their costs) are itemized. It also (ideally) details the terms and conditions of the construction or repair contract and itemizes all work to enable a contractor to price thework for which he or she isbidding.

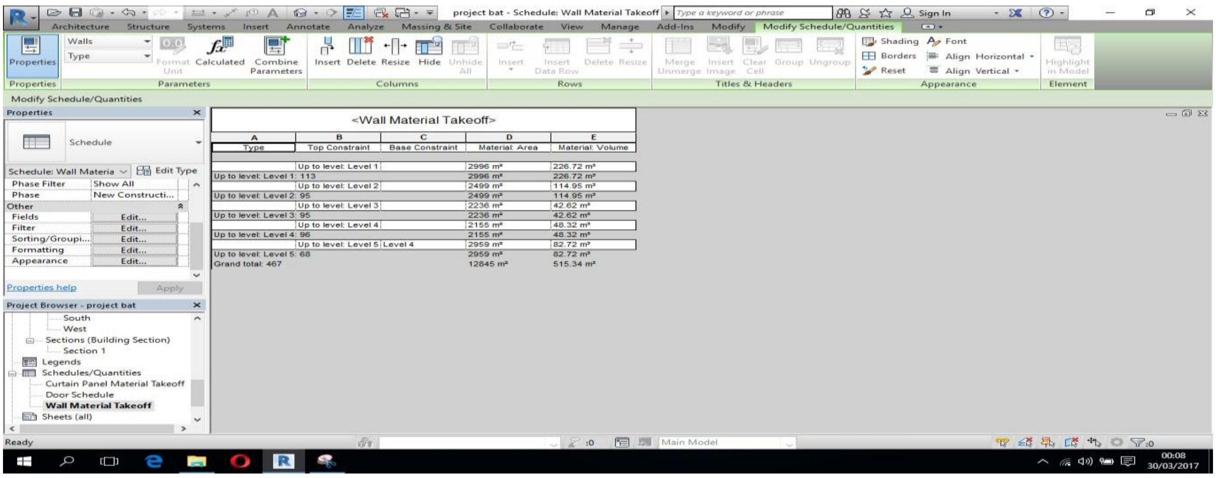


Fig 27: Description of the scheduling of quantities

Category	**Count**	**Dimensions**	**Material**	**Volume(cum)**
Column	1	450×600 mm	RCC	0.99
Total column	100	450×600 mm	RCC	99
Exterior wall	1	315mm	Generic Wall	106.63
Interior wall 1	1	105mm	Basic generic wall	51.02
Interior wall 2	1	140mm	Block work	74.66
Floor	1	4381 sq.m	In-situ concrete	296.74

Table3: Description of scheduling of basement floor.

category	Count	Dimensions	Material	Volume(cum)
column	1	450×600 mm	RCC	0.99
Total column	100	450×600 mm	RCC	99
Exterior walls				
a)mullion	1	304.8mm	Aluminium	
b) Glass	1	5641 sq.m	Chromatic Glass	289.87
Interior Wall				
Interior Wall1		79mm	Brick	25.86
Interior Wall2		140mm	Brick	12.91
Interior Wall3		105mm	Brick	68.19
Doors	26			
a)Door1	20	762×2032mm	wooden	
b)Door2	6	1700×2000	wooden	
Slab	1	4381 sq.m	In-situ concrete	296.74

Table 7 Description of scheduling of Third floor

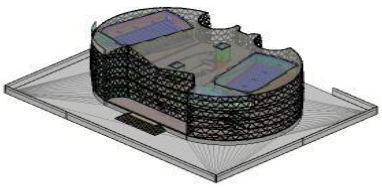
Finally, the overall estimates of all floors in the shopping mall has been given in a tabular form which is given below.

S.no	Floors	Total cost Rupees
1	Basement Floor	2077250
2	Ground Floor	5255162
3	1stFloor	5298366
4	2ndFloor	5254032
5	3rdFloor	5453161
Total Cost		23337971 /-

Table 8: Description of overall estimation of all floors

VII.SUSTAINABLE RESULTS-6D &FACILITY MANAGEMENT-7D

AUTODESK.



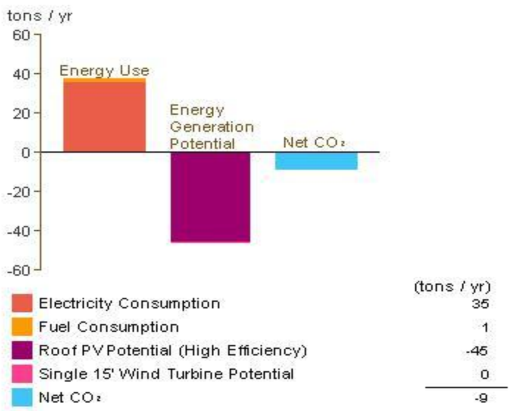
Building Performance Factors

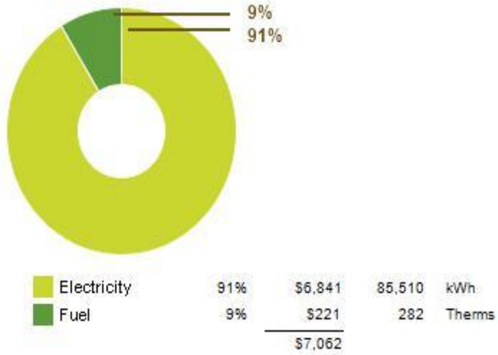
Location:	Bangalore, India
Weather Station:	719105
Outdoor Temperature:	Max: 98°F/Min: 50°F
Floor Area:	7,024 sf
Exterior Wall Area:	11,963 sf
Average Lighting Power:	0.90 W / ft²
People:	25 people
Exterior Window Ratio:	0.27
Electrical Cost:	$0.08 / kWh
Fuel Cost:	$0.78 / Therm

Energy Use Intensity ,Life Cycle Energy Use/Cost

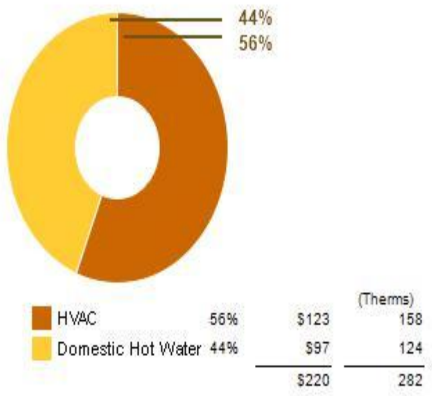
Life Cycle Electricity Use:	2,565,312 kWh
Life Cycle Fuel Use:	8,465 Therms
Life Cycle Energy Cost:	$96,184
*30-year life and 6.1% discount rate for costs	
Fuel EUI:	4 kBtu / sf / yr
Total EUI:	48 kBtu / sf / yr

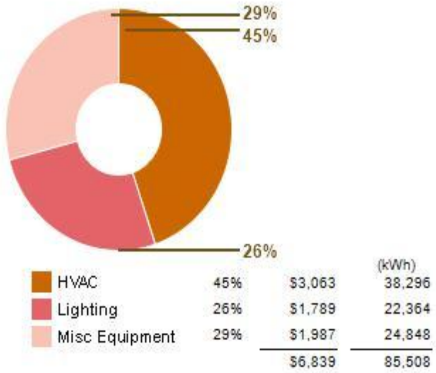
Annual Carbon Emissionsand Annual Energy Use/Cost



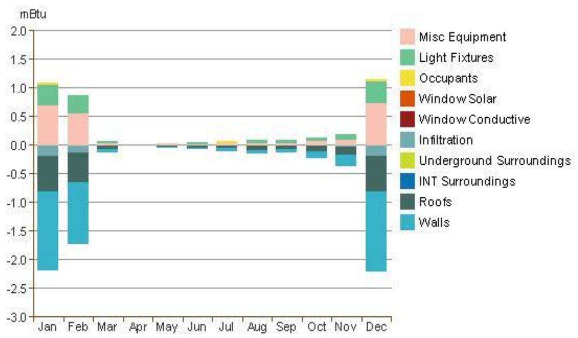


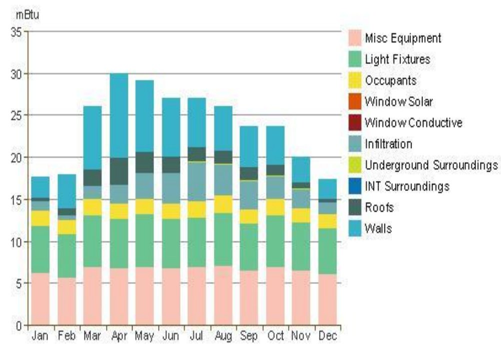
Energy Use: Fuel and Energy Use: Electricity



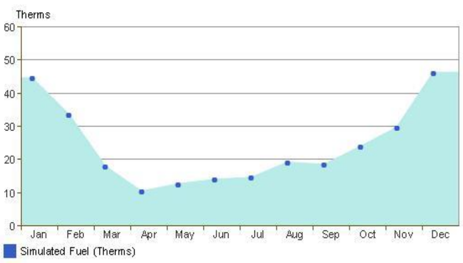


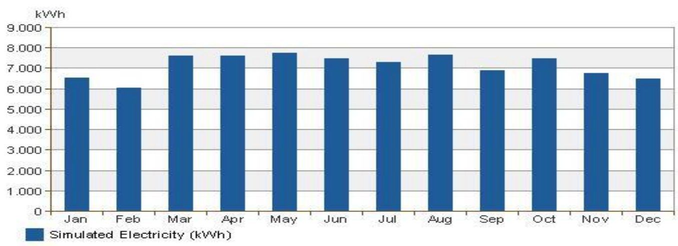
Monthly Heating Load and Monthly Cooling Load



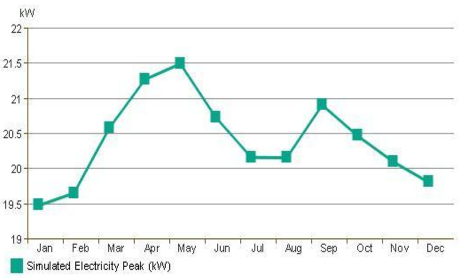


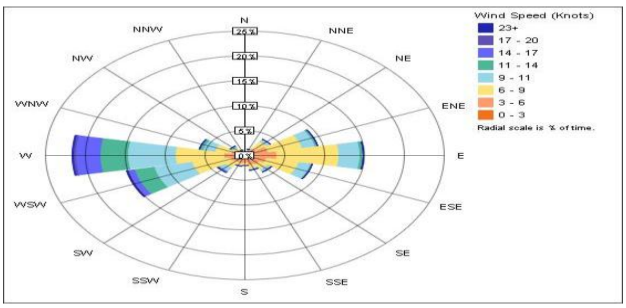
Monthly Fuel Consumption and Monthly Electricity Consumption





Monthly Peak Demand and Annual Wind Rose (Speed Distribution)





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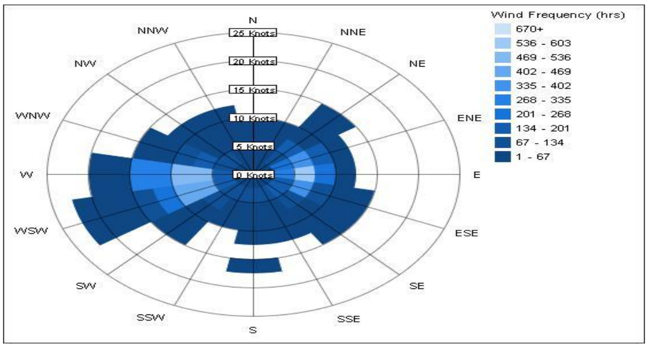
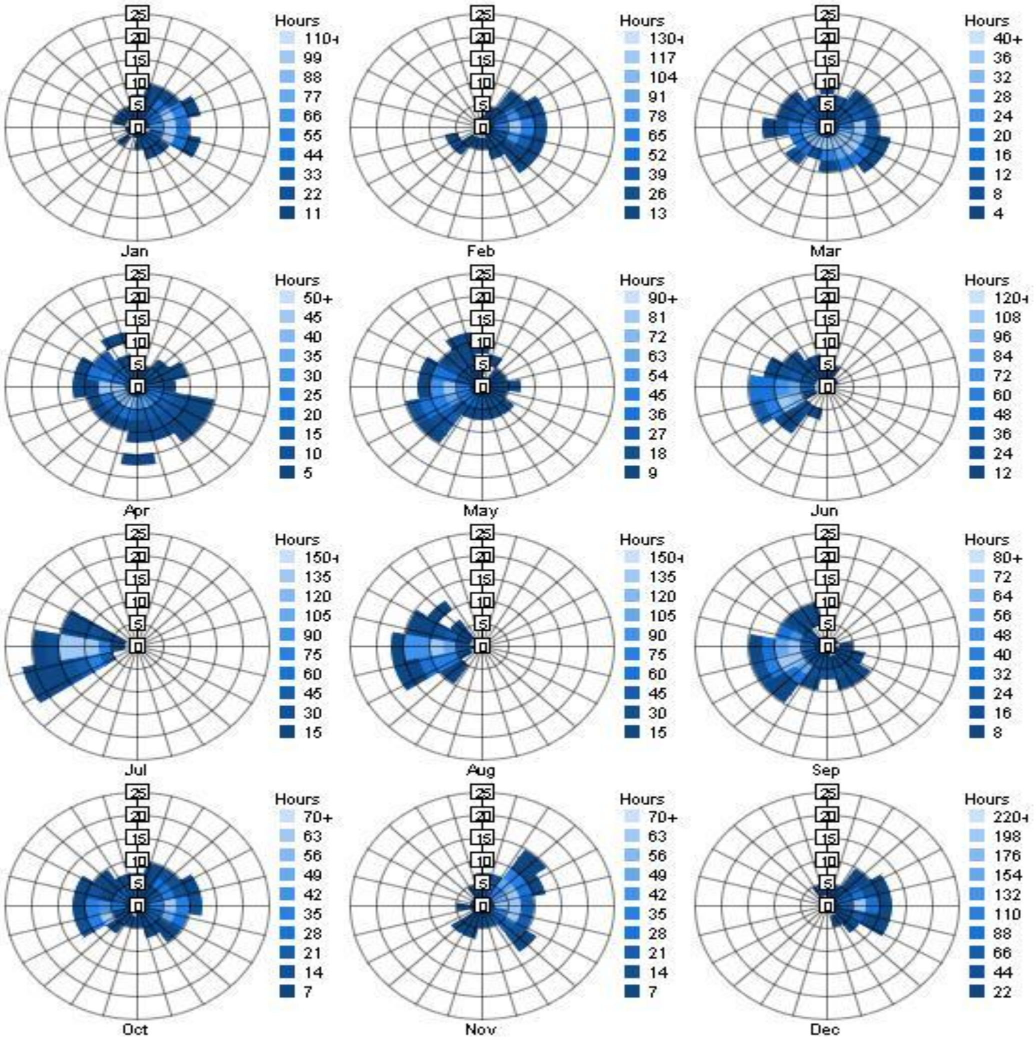
ISSN: 2319-8354

Annual Wind Rose (Frequency Distribution)



Monthly Wind Roses



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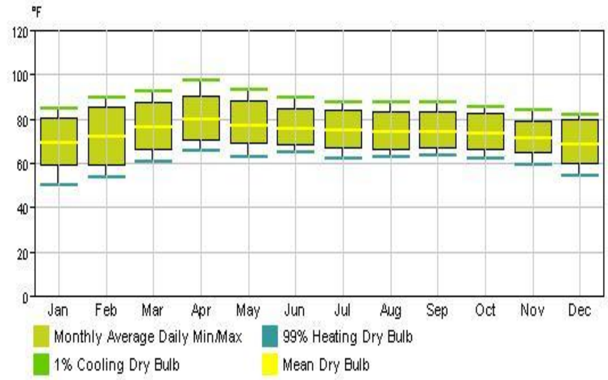
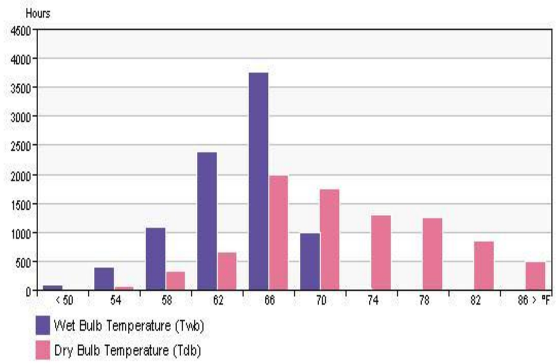
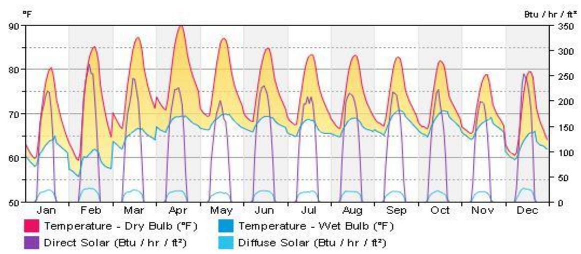
ISSN: 2319-8354

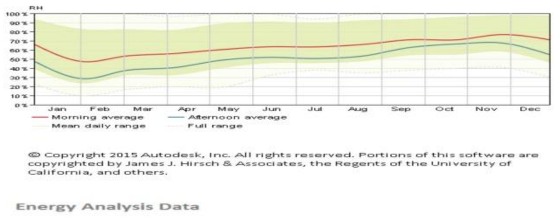
Monthly Design Data and Annual Temperature Bins





Diurnal Weather AveragesHumidity





Renewable Energy Potential

Roof Mounted PV System (Low efficiency):	36,273 kWh / yr
Roof Mounted PV System (Medium efficiency):	72,546 kWh / yr
Roof Mounted PV System (High efficiency):	108,819 kWh / yr
Single 15' Wind Turbine Potential:	1,021 kWh / yr

*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

VIII. CONCLUSION

- Analysis of the structural RCC and Steel frame is completed by using ROBOT structural analysis 2017 software against wind and seismic loads. The results obtained from ROBOT analysis are compared for the better construction material.
- The steelstructural members are super-quick to build at the site,as a lot of work can be pre-fabbed at the factory and the RCC structural members can endure very high temperatures from fire for a long time without loss of structural integrity.
- planning and modelling with the latest software’s likeAUTODESK REVIT and ROBOT Structural analysis professional 2017.

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[2.] **s**www.revitcity.com