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Design and Analysis of a Multi-Storey Building Using AutoCAD and SketchUp

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***Abstract*: Design and analyzing multi-storied buildings are crucial in the modern world due to increasing urbanization and shortage of land resources. Using AutoCAD, Sketch Up, and the planning phases, designing and analyzing of a multi storied building will be done. AutoCAD is used for precise two-dimensional drawings like floor plans, elevations and construction drawings, while Sketch Up is used to make a 3D model for a better view of building. the project begins with collecting basic data consisting of site conditions, building requirements and design standards. Based on the information, AutoCAD drawings are drawn. These drawings will be modelled in SketchUp to get a better understanding of overall looks and feel and spatial arrangement of building. Structural design will involve load transfer, safety, stability and efficiency of materials etc. The use of software tools increases precession, lower manual errors, reduces involvedness, and saves time in design. The show cases efficient design tools which are capable of designing a safe economical, and above all drafting with 3D modelling in civil works.**

***Keywords*: Multi-storied building, AutoCAD, SketchUp, Drafting, 3D modelling, Rendering and Visualization, Estimation.**

1. Introduction

A multi-storey building is a structure that has been designed for use on more than one level. These structures assist in conserving space and are typical in urban areas. The design of building is prepared using the software AutoCAD and sketch up. AutoCAD is for drawing 2D plans like floor plans, elevations, section drawings etc. clear drawings are made possible with the help of this. A 3D model of the building is prepared using Sketch Up. It aids in comprehending more profoundly the form or appearance of the building. By using these two software tools, it is possible to design plan, plan and visualize the building easily. It makes the process much quicker, precise and understandable.

2. Literature Review

Rachana Arun Giri et al. (2023) and Monika Verma et al. (2023) highlight the importance of the structural analysis and design of building components namely beams, columns and slabs. The studies make use of AutoCAD (2D and 3D) for drafting and STAAD Pro for analysis and designing. It is important to follow the relevant design codes and the standards for safety and stability. Moreover, the advent of software has also increased accuracy, efficiencies, savings in time etc. in construction.

3. Objectives

- To plan and develop detail drawings in AutoCAD and design and analysis of loads acting on the building.
- To determine and estimate the materials and cost for construction.
- To develop a 3D model of multi-story building in SketchUp

4. Methodology

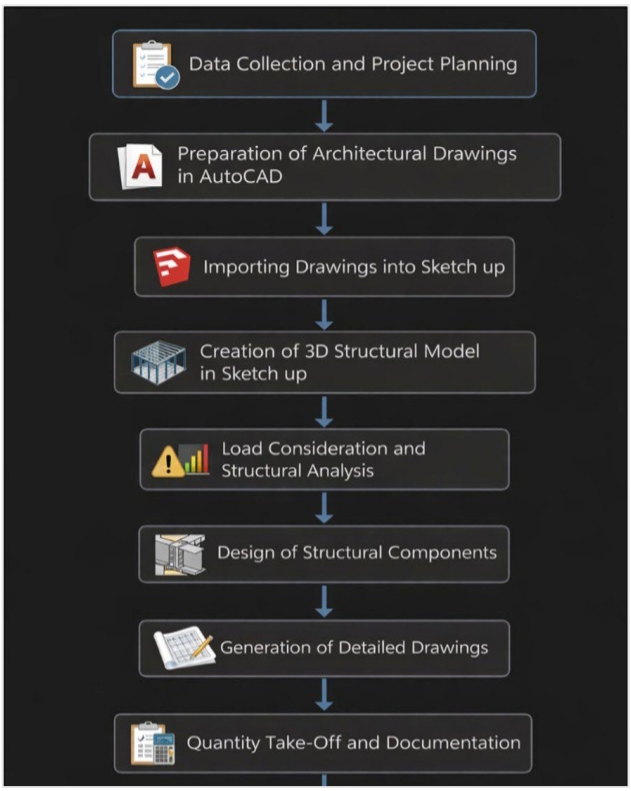

Fig. 1. Flow chart of the complete process of the project

1) Planning and Data Collection

Data collection and project planning is the first step in a multi-storey building project. collection data in civil engineering. In this phase all the necessary details like building

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specifications, building materials, labor, codes like IS 456:2000 and is 875, etc. are collected. Project planning refers to preparing the work in advance. The process of estimating cost and time, preparing drawings the work in advance. The process of estimating cost and labor. Affected personally by the fraud you may be eligible for compensation.

2) Preparation of architectural drawings in AutoCAD:

Architectural drawings in AutoCAD are basic two-dimensional drawings of the floor plans, elevation and section of building. The diagrams display the layout of the rooms, walls, doors and windows with their relative actual sizes. AutoCAD is the software that enables the development of clear and accurate drawing. The drawings provide guidance on accurate construction of the building.

Specifications:

plot area = 4000 Sq ft

built up area = 2235 Sq ft per one floor, for 3 floors=6705 Sq ft

living room = 12'x11'6" Sq ft
master bed room=11'8"x11'6" sq ft
guest bed room= 11'8"x11'2" Sq ft
kids bed room= 11'8"x10'2" sq ft
puja = 5'2"x4' Sq ft
Kitchen=9'2"x10'2" Sq ft
Toilet=5'9"x3'8" Sq ft
Dining=12'x10'2" Sq ft
Main door = 4'x7' Sq ft
Windows = 4'x3' Sq ft
Toilet doors=3'x7'ft
Compound wall thickness=9" inch
Outer wall = 6" inch
Inner wall=4" inch
Floor height = 10' ft

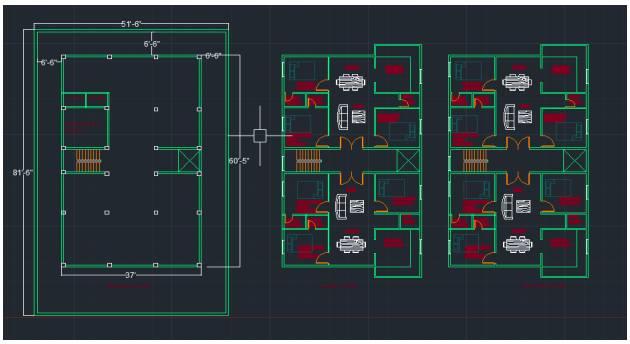

Fig. 2. AutoCAD floor plan

3) Importing drawings into SketchUp

The process of transferring 2D drawings from AutoCAD to Sketchup for 3D modelling is known as importing drawing into SketchUp. Uploaded AutoCAD file (usually in .dwg format or primitive 3D formats) is imported into SketchUp, which is used to create a 3d model. This makes it easy to convert 2D plans of building to 3D for easy understanding of the design.

4) Creation of 3D structural models in Sketchup

3D modelling developing a three-dimensional view of the building using an imported 2D drawing which helps in visualization. The 3D modelling of various elements like columns, beams, slabs, walls, doors and windows is done. One of essential benefits of using Sketch UP is that it gives a clear visual representation of the structure. Thus, one can easily understand the design and view the dimensions. Moreover, it also helps that you may have in identifying mistakes made.

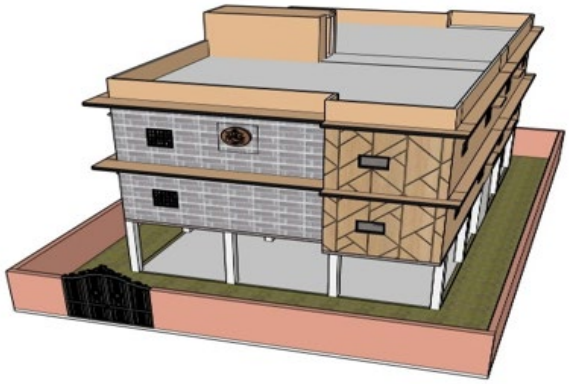

Fig. 3. Front elevation

Fig. 4. Sectional elevation

5) Design of structural components

The design of structural components means working out the sizes and strength of columns and beams, slabs and footings. This is done for safety and to ensure the building can withstand all stresses. They have made use of the standard codes like IS 456:2000 and IS 875 during the design. The proper design of a structure will help in making the structure strong and stable. It will help in the durability of the structure as well.

6) Generation of detailed drawings

Preparing clear and complete drawings of all structural components of building is called generation of detailed drawings. The structural drawings contain dimensions and reinforcement details of columns, beams, slabs and footings. Usually, their preparation is done with AutoCAD. These drawings aid engineers and workers in comprehending the design accurately and executing construction correctly.

7) Quantity take-off

The process of quantity take-off means estimating the total material requirement of the work. This is about getting quantities of cement, steel, sand, aggregates, bricks, etc. from the drawings. This is made using detailed drawings in AutoCAD. Quantity take-off aids in making cost evaluation and establishes adequate scheduling of materials for the work.

Plot area= 4000sqft

Built- up area= 2235 sq. ft. (3 floors x 2235= 6705 sq. ft.)

Table 1
Quantity and cost estimation

	Description	Unit	Quantity	Rate	Amount
A. Earthwork, PCC & Site Preparation					
01	Excavation for foundation (avg depth 1.5m)	Cum	87.9	516/-	45356/-
02	Anti-termite soil treatment (IS 6313 complaint)	Sqm	371.6	150/-	55740/-
03	PCC M10- 75mm bed below footings	Cum	6.4	5200/-	33280/-
04	PCC M10- 100mm slab on grade (GF)	Cum	27.5	5500/-	151250/-
B. RCC Foundation- M20 Concrete+ Fe 500 Steel					
05	RCC M20-Isolated footings (1.2x1.2x0.45, 20no's)	Cum	12.96	7500/-	97200/-
06	RCC M20-Plinth beam (0.3mx0.45m)	Cum	21.6	8000/-	172800/-
07	Reinforcement Fe500 HYSD- Foundation zone(~100kg/cum)	Kg	5539	273000/-	273000/-
C. RCC Columns (0.3mx0.3m, H=3.04m per floor)					
08	RCC M20- Ground floor column (20 no's)	cum	5.47	8500/-	46495/-
09	RCC M20- First floor (20 no's)	Cum	5.47	8500/-	46495/-
10	RCC M20 – Second floor (20 no's)	Cum	5.47	8500/-	46495/-
11	Reinforcement Fe500 HYSD ~ columns (~280kg/cum)	Kg	3836.2	78/-	299223.60/-
D. RCC Beams 0.3mx0.45m					
12	RCC M20-First floor beams	Cum	17.28	8200/-	141696/-
13	RCC M20- Second floor beams	Cum	17.28	8200/-	141696/-
14	RCC M20- Roof level beams	Cum	14.85	8200/-	121770/-
15	Reinforcement Fe500 HYSD-beams (~220kg/cum)	kg	5660.6	78/-	441526.80/-
E. RCC Slabs – 125mm thick, M20					
16	RCC M20- Ground floor slab on grade (275sqm)	Cum	34.4	6500/-	223600/-
17	RCC M20- First floor slab(550sqm)	Cum	68.75	7800/-	536250/-
18	RCC M20- Second floor slab (559sqm)	Cum	68.75	7800/-	536250/-
19	RCC M20- Terrace/ Roof slab(550sqm)	Cum	68.75	7800/-	536250/-
20	Reinforcement Fe500 HYSD` slabs (~180kg/cum)	kg	16257	78/-	1268046/-
F. Staircase					
21	RCC Dog-leg staircase- 2 flights x 2 floors (waist slab, step, landing)	Ls	1	145000/-	145000/-
G. Brick Masonry					
22	External brick wall 230mm thick– Ground floor	Cum	34.5	5800/-	200100/-
23	External brick wall 230mm thick- First floor	Cum	32	5800/-	185600/-
24	External brick wall 230mm thick- Second floor	Cum	30	5800/-	174000/-
25	Internal brick wall 115mm thick- all floors	cum	62	5200/-	322400/-
26	Parapet wall 115mm x 1 m ht- terrace perimeter	Cum	11.5	5400/-	62100/-
H. Plastering					
27	Internal wall plastering 12mm (CM 1:6) all rooms	Sqm	1850	95/-	175750/-
28	External wall plastering 15mm (CM 1:5)	Sqm	600	135/-	81000/-
29	Ceiling plastering (CM 1:4 + putty ready finish)	Sqm	920	75/-	69000/-
I. Flooring & Dado					
30	Virtified tiles 600x600mm – bedrooms, hall, dining	Sqm	650	720/-	468000/-
31	Anti-skid ceramic tiles- toilets, kitchen	Sqm	140	580/-	81200/-
32	Granite flooring- main entrance, puja room	Sqm	45	1800/-	81000/-
33	IPS Flooring- parking area, watchman room	Sqm	120	280/-	33600/-
34	Dado tiles in toilets (2.1m ht)	Sqm	180	520/-	93600/-
35	Dado tiles in kitchen (0.6m above slab)	Sqm	40	480/-	19200/-
J. Doors & Windows					
36	Main door-teak frame, decorative panel 1.2x2.1m	No's	2	35000/-	70000/-
37	Unit entry door- teak frame, flush 0.9x2.1m	No's	4	18000/-	72000/-
38	Internal flush door 0.9x2.1m (HDF both faces)	No's	24	6500/-	156000/-
39	Toilet doors- FRP flush 0.75x2.1m	No's	14	4500/-	63000/-
40	Aluminium 2- track sliding window 1.2x1.2m	No's	16	7200/-	115200/-
41	Aluminium 2- track sliding window 1.5x1.2m	No's	12	9000/-	108000/-
42	Ventilators aluminium louvre 0.6x0.6m	No's	14	2800/-	39200/-
K. Painting					
43	Internal walls- 2 coats + 2 coats emulsion	Sqm	2100	65/-	136500/-
44	External walls- weather-shield paint 2 coats	Sqm	560	95/-	53200/-
45	Ceiling- white distemper 2 coats	Sqm	920	35/-	32200/-
46	Enamel paint- doors/window frames & MS Grill	Sqm	380	120/-	45600/-
L. Waterproofing					
47	Terrace- 2 coats crystalline waterproofing (370sqm)	Sqm	370	320/-	118400/-
48	Toilets- polymer waterproofing 2 coats	Sqm	180	380/-	68400/-
49	External wall plastering- integral waterproofing additive	Sqm	600	55/-	33000/-
M. Electrical Works					
50	Main service connection, LT panel & earthing system	Ls	1	65000/-	65000/-
51	Internal wiring FR-LSH cable (6/4/2.5sqm)- 280points	Pts	280	850/-	238000/-
52	Conduit, MCB distribution board, circuit breakers94 units)	Ls	4	28000/-	112000/-
53	Modular switches & sockets- Legrand/ Havells (280 points)	Pts	280	350/-	98000/-
54	LED light fixtures- basic provision (90no's)	No's	90	550/-	49500/-

	Description	Unit	Quantity	Rate	Amount
55	CCTV system-8ch DVR +6 cameras+ full cabling	Ls	1	45000/-	45000/-
56	DG backup cabling provision (generator ready)	Ls	1	18000/-	18000/-
N. Plumbing & Sanitary					
57	CPVC hot & cold supply piping- all floors complete	Ls	1	85000/-	85000/-
58	UPVC drainage, soil stack & waste piping- all floors	Ls	1	65000/-	65000/-
59	Sanitary ware- EWC, wash basin, shower per unit x 4 sets	Sets	4	22000/-	88000/-
60	CP fittings, taps, mixers, showers (mid range) x 4 sets	Sets	4	18000/-	72000/-
61	Overhead HDPE tanks 10000L x 2 no's + connection piping	Ls	1	55000/-	55000/-
62	Underground RCC sump 10000L	Ls	1	45000/-	45000/-
63	STP/ 3- chamber septic tank (as per local norm)	Ls	1	55000/-	55000/-
O. External & Site Works					
64	Compound wall 230mm x 2m ht – 3 sides	Rm	170	1800/-	306000/-
65	Main MS fabricated gate- 3m clear opening	No's	1	35000/-	35000/-
66	Dry way- interlocking paver blocks	Sqm	85	650/-	55250/-
67	Landscaping / Garden area (basic)	Ls	1	45000/-	45000/-
68	Sunshades/ chajjas- RCC 0.6m projection	Rm	80	1200/-	96000/-
69	Watchman room- internal finishing works	Ls	1	35000/-	35000/-
P. Miscellaneous & Special Works					
70	MS grill for windows + MS balcony/ staircase railing (1200kg)	Kg	120	85/-	102000/-
71	Staircase MS handrail with enamel paint	Rm	32	1800/-	57600/-
72	Lift shaft provision- RCC only (2- floor, machine room above)	Ls	1	95000/-	95000/-
Q. Contingency & Unforeseen Items (2.5%)					
73	Contingency & unforeseen items @ 2.5% of base estimate	Ls	1	324856/-	324856/-

Total estimated cost excluding GST = 1,07,59,055.80/-

Grand total (rounded to nearest lakh) = 1,10,00,000/-

(Total built up area =6705 Sq ft), cost per Sq. ft. = 1605/- per Sq. ft.

5. Conclusion

Drawing, evaluation, and rough estimation of G+2 multi-storied residential building using AutoCAD and SketchUp assists in managing and controlling planning and costing. The software AutoCAD is used successfully to prepare 2D architectural and structural drawings, which included the floor plans, elevation drawings, detailed layouts etc. These drawings were subsequently imported into SketchUp to create realistic three-dimensional models, allowing for enhanced visualization of the building, early detection of design problems, and presenting the project in a more refined manner. The structural components have been designed on the basis of standard engineering practices using appropriate codes like IS 456:2000, IS 875, and IS 1893, etc. The comprehensive estimate presented in the project reveals an overall cost of construction of around ₹1.10 crore. The combination of AutoCAD and SketchUp has improved the precision of technical drawings as well as the quality of the 3D visualisation making the designing process more accurate and easier to understand. As a whole, the project successfully proves that contemporary software tools and standard design practices result in a structurally safe, economic, and aesthetic multi-storied building that could be used for residential purposes.

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