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Analysis, Design and Estimation of G+4 Residential Building

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***Abstract*— The principal objective of this project is to analyze, design and make building estimation of a multistoried building [G + 4] using STAAD Pro and MS EXCEL. The design methods used in STAAD-Pro analysis are Limit State Design conforming to Indian Standard Code of Practice. The structure was subjected to self-weight, dead load, live load and seismic loads under the load case details of STAAD Pro. The supports at the base of the structure were also specified as fixed. Then STAAD Pro was used to analyze the structure and design the members. In the postprocessing mode, after completion of the design, we can work on the structure and study the bending moment and shear force values with the generated diagrams. The design of the building is dependent upon the minimum requirements as prescribed in the Indian Standard Codes. Strict conformity to loading standards recommended in this code, it is hoped, will ensure the structural safety of the buildings which are being designed.**

Keywords*— STAAD Pro, MS EXCEL, Analysis, Estimation, Design.

I.INTRODUCTION

The construction in this 21st century is becoming challenging day by day as in order to achieve more economy and efficiency. As in order to bring down these challenges and save time, computer-based software programs are used by engineers. In this project after having the theoretical knowledge about the analysis and design of building we have attempted to G+4 residential building using this software also estimation using MS Excel**.** Our project involves most popular software's like Auto Cad, Staad Pro and MS Excel.

I.Auto Cad: - One of the main benefits of AutoCAD is that it allows you to draw to scale and accurately, Easy Layout and Viewing, we can make changes easily and reduce risk of error, identify design problems, calculate material quantities for production store and transfer data safely save time and money. The ground and all floors plan were drawn using Auto Cad. Also, column, footing plan was constructed in it

II.The STAAD Pro CONNECT Edition: - It is used to generate the model, which can then be analysed using the STAAD engine. Design, including design for durability, construction and use in service should be considered as a whole. The design of the building is dependent upon the minimum requirements as prescribed in the Indian Standard Codes.

III.MS Excel: - It helps in maintaining bills, making graphs, S scheduling things for a project, calculating sizes of beams and columns, etc for a civil engineer, in times of executing, quantity estimating, planning, contracts, budgeting, designing, quality controlling, quantity estimating etc. As stated, everyone uses Excel. The required calculations are one by MS Excel. You can store, replicate, modify the data; however, one might want. In our Project we have done Building Estimation and Costing and prepared quantity measurement and abstract sheet using MS Excel.

II.AIM

The aim of the research is to study and analysis, design of g + 4 building using stand pro and cost estimation using MS excel

III.RESEARCH OBJECTIVES

1) To study analysis and design of G+4 building on STAAD PRO software.
2) To make building Estimation and costing using MS excel
3) To study the results of various parameters such as static and dynamic loads, displacement and deflection.

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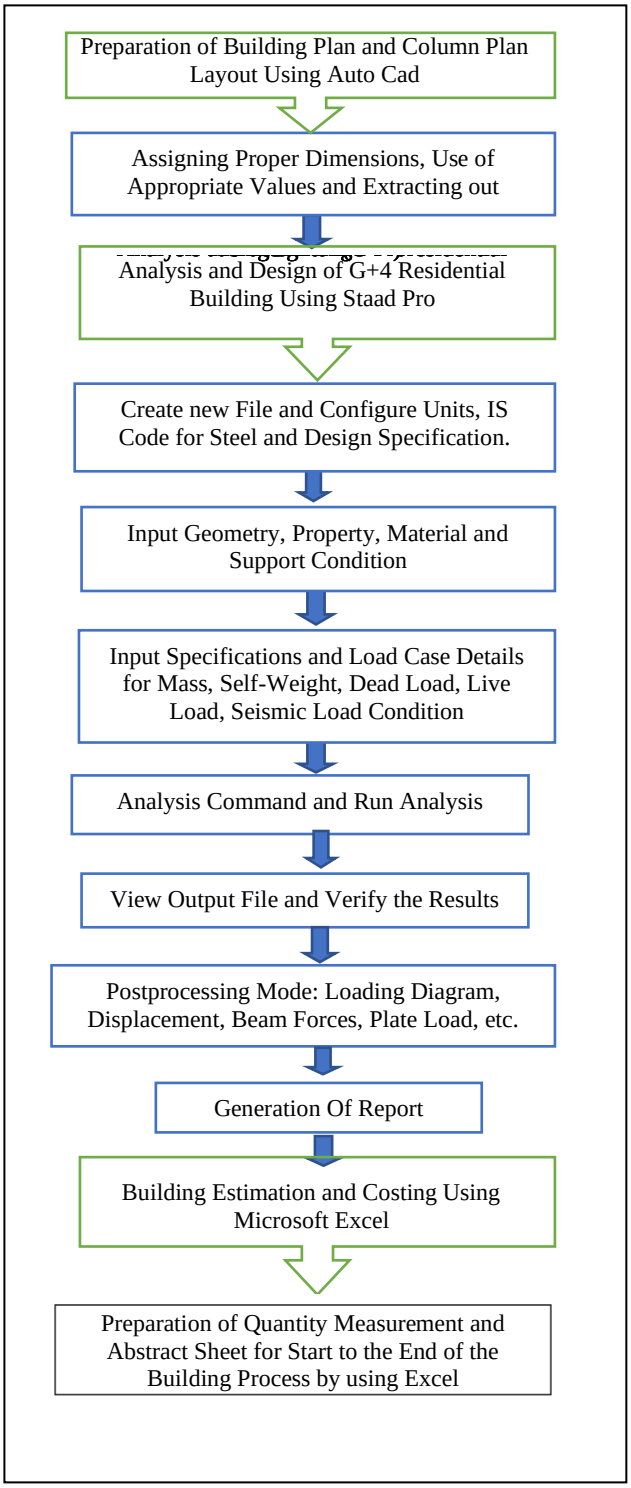
VI.METHODOLOGY



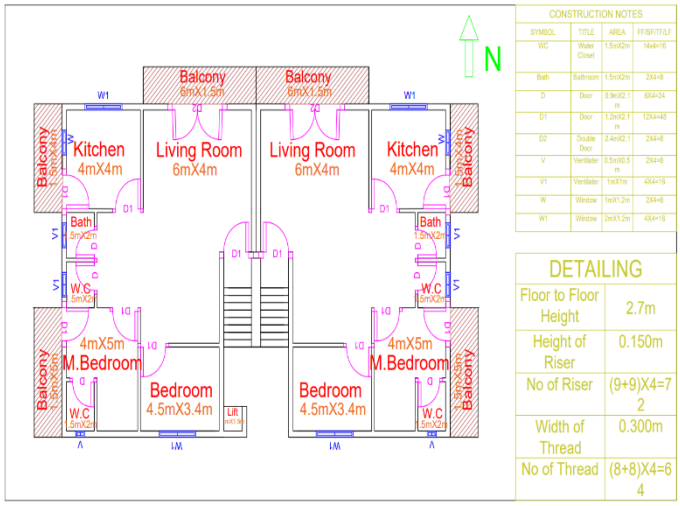
V.WORK PROGRESS

1. BASIC DATA

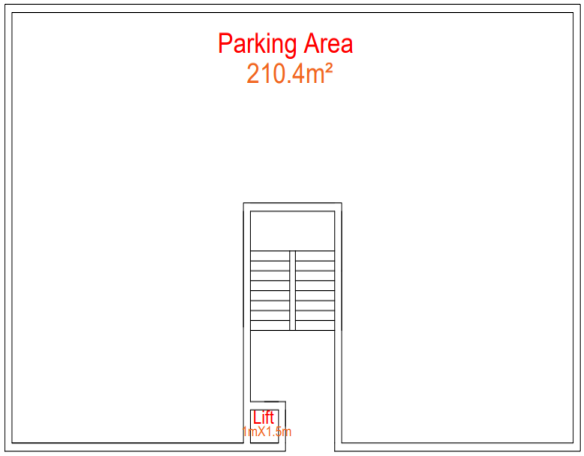
- Type of Structure: Residential building Mutli RCC Storey Frame
- Seismic Zone: v
- Type of soil: Medium
- No. of stories: 5 (G+4)
- Imposed load: 2.0 KN/m2
- Floor Finishes:1 KN/m2
- Depth of slab:150 mm
- Materials:M20 concrete and Fe415 steel
- Unit weight of RCC:25 KN/m2
- Beams: 350mmx250 mm
- Columns: 350mmx300mm
- External Wall thickness:250mm
- Internal Wall Thickness: 150mm
- Floor height: 2.7m
- Plinth height:0.9m
- Depth of footing: 1.5m

2. PLAN OF RESIDENTIAL BUILDING ON AUTOCAD

2.1 All Floors Plan



2.2 Ground Floor Plan



GROUND FLOOR PLAN

3.ANALYSIS AND DESING USING STAAD PRO:

3.1. LOAD CONSIDERATION

(a). DEAD LOAD: -

[IS 875(Part 1):1987 This is a Code of practice for design loads (other than earthquake) for buildings and structures Part 1 Dead loads – Unit weights of building material and stored materials (second revision)]

(c). SEISMIC LOAD: -

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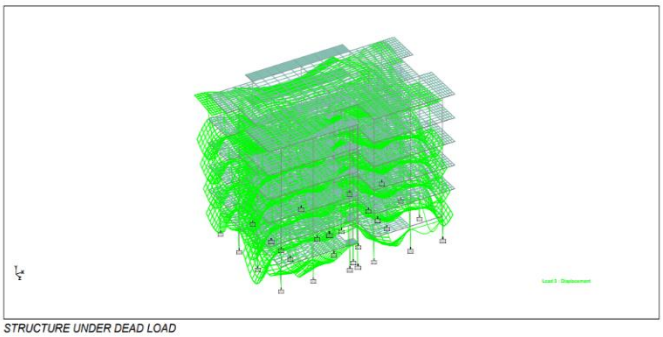
The dead load comprises of the weights of walls, partitions floor finishes, false ceilings, false floors and the other permanent constructions in the buildings.

- Dead load calculation

1) Self-weight= 1KN (Y axis).
2) Member load (ML)= wall thickness X (Floor Height-Beam Depth) X unit weight on masonry.

i. on External wall=5.875KN/m
ii. on Internal wall=3.675KN/m
iii. Parapet wall (1m Height) =1.25KN/m

3) Plate Load= 2KN/m.



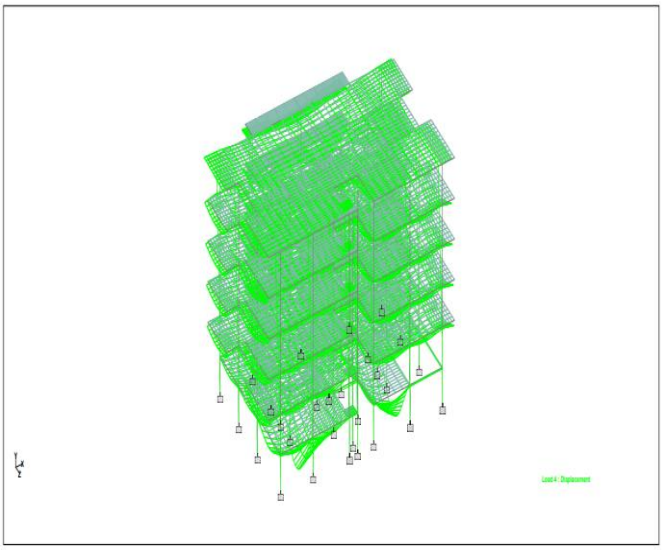
STRUCTURE UNDER DEAD LOAD

(b). LIVE LOAD: -

[IS 875(Part 2):1987 This is a Code of practice for design loads (other than earthquake) for buildings and structures: Part 2 Imposed loads (second revision)]

Imposed load is produced by the intended use or occupancy of a building including the weight of movable partitions, distributed and concentrated loads, load due to impact and vibration and dust loads.IS 875 part 2 is taken as reference. The live load is taken as <=3KN/m i.e., 2KN and Live load for terrace =-1.5K

Where, h = Height of building, in m. This excludes the basement storeys, where basement walls are connected with the ground floor deck or fitted between the building columns. But it includes the basement storeys, when they are not so connected. The approximate fundamental natural period of vibration (T,), in seconds, of all other buildings, including



STRUCTURE UNDER LIVE LOAD

[IS 1893: Part 1: 2016 Criteria for Earthquake Resistant Design of Structures - Part 1: General Provisions and Buildings]

1. Design Lateral Force

The design lateral force shall first be computed for the building as a whole. This design lateral force shall then be distributed to the various floor levels. The overall design seismic force thus obtained at each floor level shall then be distributed to individual lateral load resisting elements depending on the floor diaphragm action.

2. Design Seismic Base Shear

The total design lateral force or design seismic base shear (Vb) along any principal direction shall be determined by the following expression:

Vb = Ah W

Where,

Ah = horizontal acceleration spectrum

W = seismic weight of all the floors

3. Fundamental Natural Period

The approximate fundamental natural period of vibration (T,), in seconds, of a momentresisting frame building without brick in the panels may be estimated by the empirical expression:

Ta=0.075 h0.75 for RC frame building

Ta=0.085 h0.75 for steel frame building

moment-resisting frame buildings with brick lintel panels, may be estimated by the empirical Expression:

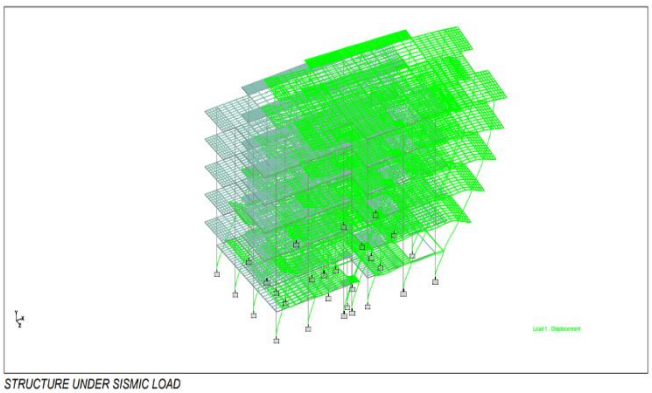
$T=.09H/\sqrt{D}$

Where, h= Height of building=15.9m

d= Base dimension of the building at the plinth level, in m,along the considered direction of the lateral force=20m,13m in X and Y direction respectively.

$(Ta)_x=0.3199$ sec and $(Ta)_z=0.3968$

4. Stiffness Reduction Factor for RC and Masonry Column= 75%, Beam=30%.
5. Scale Factor= ZI/2R=0.0432
   Z= Zone Factor= 0.36
   I= Impotent factor= 1.2
   R= Response reduce factor= 5
6. Seismic Live Load= 25%LL=0.5KN



STRUCTURE UNDER SISMIC LOAD

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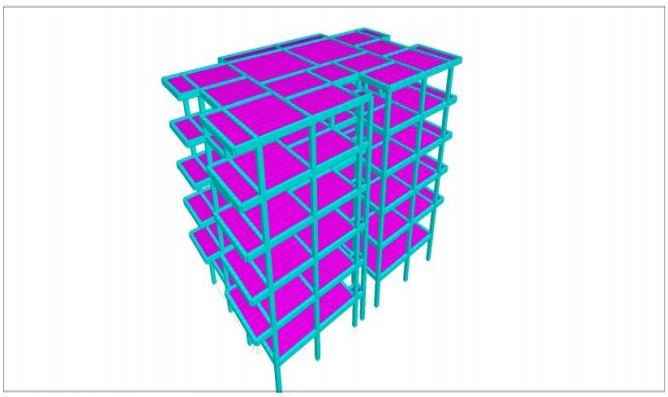
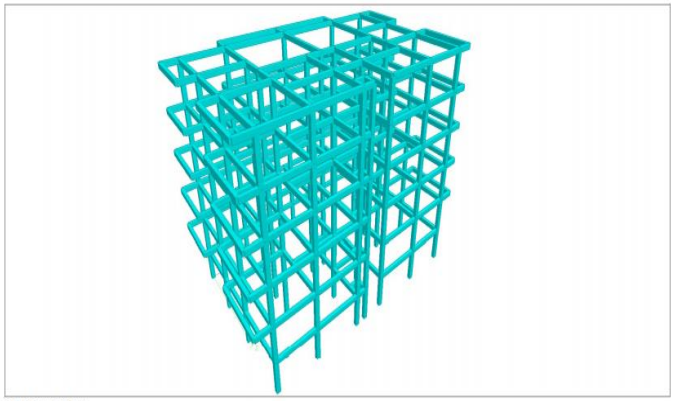
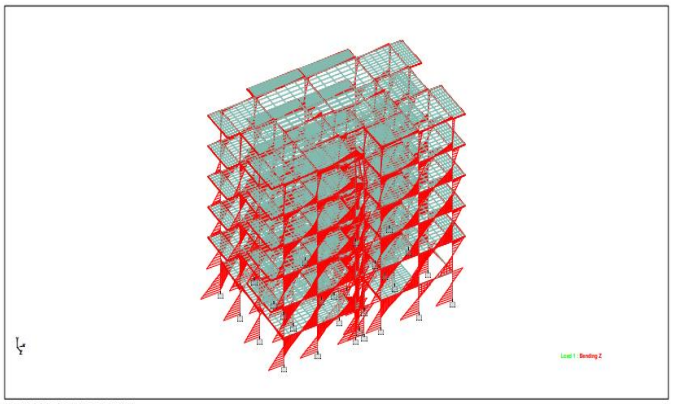
3.2. STAAD PRO OUTPUT



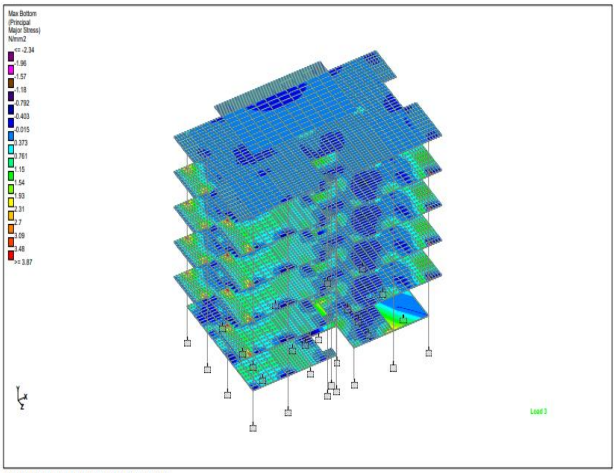
3D BUILDING VIEW WITH PLATE MESH



3D BEAM VIEW



BEAM MOMENT RESULT



STRUCTURE UNDER PLATE LOAD

3.3 RESULTS OF STAAD PRO

```
STAAD SPACE                                                    -- PAGE NO.  597

          CENTER OF FORCE BASED ON Z FORCES ONLY (METE).
       (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                        X =  0.996673603E+01
                        Y =  0.114452240E+02
                        Z =  0.615489663E+01
TOTAL APPLIED LOAD     2

   ***TOTAL APPLIED LOAD ( KN   METE ) SUMMARY (LOADING     2 )
        SUMMATION FORCE-X =           0.00
        SUMMATION FORCE-Y =           0.00
        SUMMATION FORCE-Z =        1114.80

      SUMMATION OF MOMENTS AROUND THE ORIGIN-
      MX=        12759.10  MY=       -11110.88  MZ=           0.00

TOTAL REACTION LOAD    2

   ***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING     2 )
        SUMMATION FORCE-X =           0.00
        SUMMATION FORCE-Y =           0.00
        SUMMATION FORCE-Z =       -1114.80

      SUMMATION OF MOMENTS AROUND THE ORIGIN-
      MX=       -12759.10  MY=       11110.88  MZ=          -0.00


   MAXIMUM DISPLACEMENTS (   CM   /RADIANS) (LOADING     2)
          MAXIMUMS     AT NODE
      X =   4.37777E-02      218
      Y =   2.98804E-01      116
      Z =   4.36867E+00     1203
      RX=   3.74438E-03       55
      RY=   5.44942E-05     6623
      RZ=  -1.01834E-03     6553
```

```
      ******************************************************
      * UNITS - KN    METE                                 *
      * TIME PERIOD FOR X 1893 LOADING =    0.31990 SEC    *
      * SA/G PER 1893=    2.500, LOAD FACTOR= 1.000        *
      * VB PER 1893=    0.1080 X    10322.20=    1114.80 KN *
      * VB Act Based on Clause 7.2.1 =     1114.80 KN      *
      * VB Min based on Clause 7.2.2 =      247.73 KN      *
      *                                                    *
      ******************************************************

   --WEIGHT AND BASE SHEAR SUMMERY

      Units:KN    METE
   |-------------------------------------------------------------------------|
   | Category |   Weight   |     Ah     | VB Calculated | VB Minimum |  VB Final  |
   |-------------------------------------------------------------------------|
   | Above GL | 10322.19531|   0.1080000|     1114.79712 |   247.73270|  1114.79712|
   |-------------------------------------------------------------------------|

      ***NOTE: Equivalent Static Analysis should preferably be performed for regular
   structures with approximate natural time period less than 0.4s and regular
   structures with height less than 15m in Seismic Zone II. Ref Cl.6.4.3 and 7.6
   BASE SHEAR AND TIME PERIOD IN Z
   --ABOVE GROUND LEVEL

      ******************************************************
      * UNITS - KN    METE                                 *
      * TIME PERIOD FOR Z 1893 LOADING =    0.39680 SEC    *
      * SA/G PER 1893=    2.500, LOAD FACTOR= 1.000        *
      * VB PER 1893=    0.1080 X    10322.20=    1114.80 KN *
      * VB Act Based on Clause 7.2.1 =     1114.80 KN      *
      * VB Min based on Clause 7.2.2 =      247.73 KN      *
      *                                                    *
      ******************************************************

   --WEIGHT AND BASE SHEAR SUMMERY

      Units:KN    METE
   |-------------------------------------------------------------------------|
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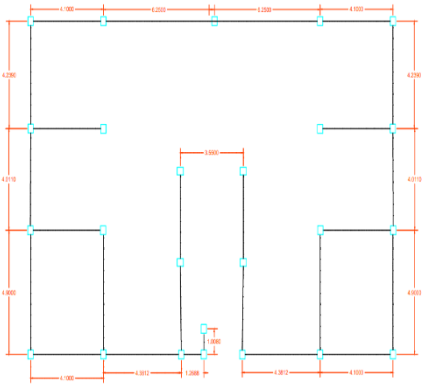
4. BUILDING ESTIMATION AND COSTING

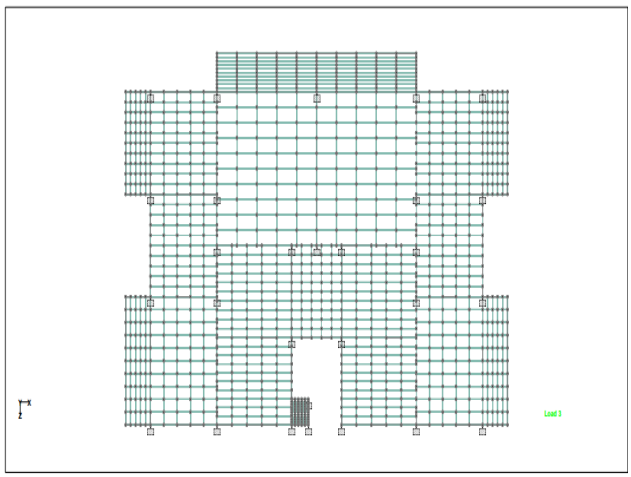
4.1 GENERAL

1.One of the key factors in construction industry is estimating and costing. Accurate estimation is very important as the success and quality of a construction or project depend on it.
2. The rate of each item was taken from Govt. Of Maharashtra Public Works Department (Schedule of Rates 2018-19) and Maharashtra Jeevan Pradhikaran Pune Region (Schedule of Rates for 2019-2020).
3. The quantity measurement and abstract sheet is prepared using MS Excel.
4. Long Wall and Short Wall method is used for Estimation.
5. Various Parameters like site cleaning, excavation, PCC, RCC, beam, column, painting, plastering etc., are calculated.

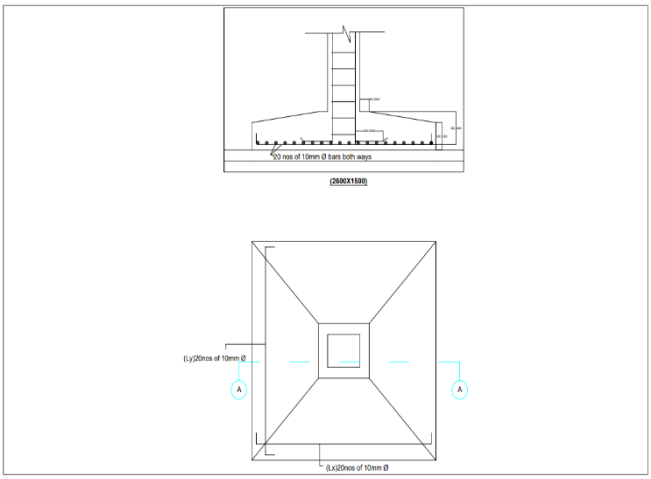


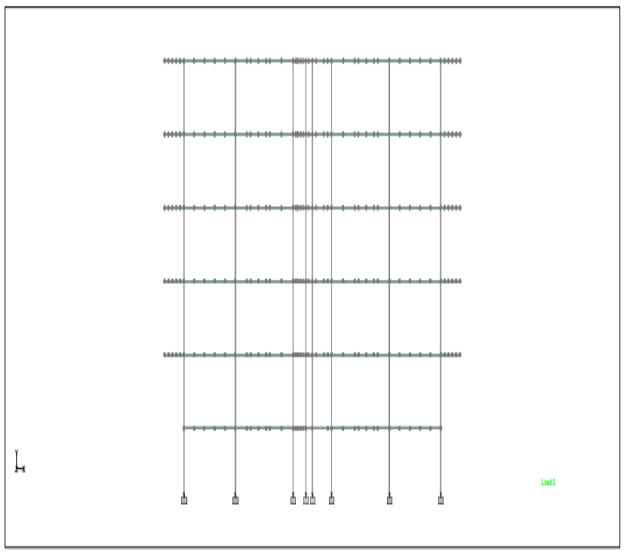
DETAILS	
External Wall Thickness	0.250m
Internal Wall Thickness	0.150m
size of Column	0.300m 0.350m
No of column	2

4.2. STRUCTURAL DRAWING



PLAN OF G+4 STOREY BUILDING





ELEVATION OF G+4 STOREY BUILDING

4.3. ESTIMATION SHEET

BUILDING ESTIMATION AND COSTING

QUANTITY MESUREMENT AND ABSTRACT SHEET

SR NO	DESCRIPTION/ITEM	NO OF ITEM	LENGTH	WIDTH	HEIGHT	TOTAL	UNIT	RATE	AMOUNT(in Rs)
1	SITE CLEANING	1	22	15		330	Sqm	200	66000
	L=1+20+1, W=1+13+1	Total qty. of Site Cleaning				330	Sqm		66000
2	EXCAVATION								
	Footing(L/W=0.3+2+0.3)	28	2.6	2.6	1.5	283.92	cum	574	162970.08
		Total qty. of Excavation				283.92	cum		162970
3	SAND FILLING								
	Footing	28	2.6	2.6	0.1	18.928	cum		
		Total qty. of Sand Filling				18.928	cum		
4	P.C.C IN FOUNDATION								
	Footing	28	2.6	2.6	0.1	18.928	cum	6437	121839.536
		Total qty. of P.C.C				18.928	cum		121840
5	FOOTING CONCRETE								
	Rectangular	28	2	2	0.25	28	cum		
	Trapezoidal(L=0.1+0.35+0.1,W=0.1+0.3+0.1)	28	0.55	0.5	0.1	4.968888	cum		
		Total qty. of Footing Concrete				32.96889	cum	4986	164382.8769
6	FOOTING SHUTTERING								
	Footing(L=2+2+2+2)	28	8		0.25	56	sqm		
		Total qty. of Footing Concrete				56	sqm		
7	PEDESTAL COLUMN								
	Column(H=1.5-0.1-0.1-0.25-0.1)	28	0.35	0.3	0.95	2.793	cum		
		Total qty. of Footing Concrete				2.793	cum	7544	21070.392
8	PEDESTAL COLUMN SHUTTERING								
	Column(L=0.35+0.35+0.3+0.3)	28	1.3		0.95	34.58	sqm		
9	BACKFILLING	Total qty. of Brickwork				210.3021	cum	200	42060.42235
	BF=EX-SF-P.C.C-FC-PC								
10	ONE LINE BRICK WORK								
	GB1	16	4	0.35	0.1	2.24	cum		
	GB2	4	4.5	0.35	0.1	0.63	cum		
	GB3	3	6	0.35	0.1	0.63	cum		
	GB4	4	5	0.35	0.1	0.7	cum		
	GB5	2	7	0.35	0.1	0.49	cum		
	GB6	2	1	0.35	0.1	0.07	cum		

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V.CONCLUSION

1.This project includes G +4 building with parking at ground floor and rest of the floors occupied with 2BHK flats. The response of a RCC high rise building under dead load, live load and seismic load is studied as per IS 875(Part 1):1987, IS 875(Part 2):1987and IS 1893: Part 1: 2016 respectively.
2.Reinforcement details for each member i.e., beams and columns can be obtained directly after the process of analysis is carried out.
3.Estimation and Costing is done using MS Excel to know the building Appropriate cost using Long Wall and Short Wall Method.
4. over all project helped us to understand the Building Process and use of different software for easy and timely completion of work.

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