PLANNING DESIGN AND COST ESTIMATION OF A G+4 RESIDENTIAL BUILDING

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Abstract - *Any construction project to begin with starts with the Layout of the building or structure followed by Design and Analysis of the structure which is succeeded by cost estimation and planning for the said project. This project involves the layout, design, analysis, planning and cost estimation of a G+4 residential building located in Aramgarh, Hyderabad. The layout of the proposed G+4 residential building is based on a plot of size 150' x 90 '.The ground floor of the building will be used as parking while the remaining 4 floors will be divided into 8 apartments each having an area of 246sq m. Each apartment is of 3BHK configuration. All the drafting was done using AutoCAD. Also these drawings made on AutoCAD also served as a base for transfer of the structure for analysis and design into STAAD Pro. The results include the various forces acting on various members as well various schedules for various members. Also using the software we got the concrete take-off as well as the weight of the various reinforcement bars thus easing the load of cost estimation. The foundation has been designed as an isolated footing using soil condition as medium. The foundation design values were calculated using STAAD Foundation. Primavera P6 has been used for planning the various activities that surround the construction of a building. The cost estimate for the project has been calculated using Centre Line Method in Microsoft Excel.*

1. OBJECTIVES OF THE PROJECT

The objectives of the project are mentioned below:
1. Draft the Layout of the proposed building using AutoCAD
2. Analyse and Design the building on STAAD Pro V8i
3. Plan the Project Schedule using Primavera P6.
4. Calculate the approximate cost of the building

2. METHODOLOGY OF PROJECT

2.1 Study of IS 875 1987
IS 875 deals with the various load cases that act upon a structure and ways to calculate them. There are various parts of the code that deal with the various load types such as dead load, live load, wind load, snow load and various special loads and load combinations. As the building is situated in Delhi and is not a high rise building, loads such as wind and snow were not considered in the design process. The Code gives the unit weights of various materials as well as the values of imposed loads that act in various types of structures and parts of these structures.

2.2 Preparation of Building Layout using AutoCAD
The layout for the proposed building was prepared, discussed and approved by an architect. The layout was then prepared using AutoCAD. The various layouts were prepared and then later discussed with the architect for error correction.

2.3 Analysis and Design using STAAD Pro
Once the layout of the building was approved by the architect the layout was transferred from AutoCAD to STAAD Pro using a DXF file format. Once the layout was transferred, multiple stories were created using the Translational Repeat Tool in Staad Pro. After this member properties were assigned. Next the load cases were generated and applied to the structure. Once the loads were applied the structure was analysed and corrections were made to the structure for the various errors that were generated while the structure was being analysed.

After the analysis, we started designing the structure by entering the DESIGN tab in STAAD Pro. All the design parameters were entered and load cases selected. This completes the design of the beam, columns and slabs.

For designing the foundation STAAD foundation program is opened and the structure along with the load cases is transferred. Once this is done the soil conditions and the type of foundation is entered. After this the program analyses and designs the foundation.

2.4 Project Planning using Primavera
For the purpose of planning the project Primavera P6 has been used. At first the project details are entered such as start and finish date, field related to the project. After the project has been created WBS is created and their related activity. Once this has been done the time schedule of each activity is entered and their related resources are assigned. After this the various activities are linked. As these things are carried out a gantt chart is created simultaneously which is the ultimate goal for using primavera.

2.5 Cost Estimation using Microsoft Excel
The total steel and concrete requirement is calculated by STAAD Pro reducing a lot of calculation. Remaining calculation left to be done is the calculation of walls, cement plaster, doors and windows, earthwork and foundation. The

calculations are based on the centreline method which is quite easy to do.

3. LAYOUT OF G+4 BUILDING USING AUTOCAD

The plot size for the project was 28x46 mts or 90'x150'. Accordingly the building has been laid in the centre of the plot leaving ample space on all the sides for landscaping and pathways for cars and for visitors parking.

Area of Plot	90'x150'
FAR	2.25(allowed)
Plot details	Front – service road followed a green belt from the main Mathura road Left & right side – private residential buildings Rear – service lane
Number of Floors	G+4
Number of Units	8 Ground Floor to be used as Car Parking
Type Apartment	3BHK
Area of Each Apartment	246 sq m

Table 1 General Layout Details

3.1 Salient Features of the Project:-

1. Vaastu compliant design.
2. Effective stepped planning for use of terraces at different levels.
3. Separate entrances for all units.
4. Combined lobby for all floors.

3.2 Beam and Column Layout

In the above picture the red lines signify the beam centre line while the green rectangular boxes signify the Columns. The beams have a cross section of .300x.400 m. The columns have a cross section of .400x.400 m. Slabs have a uniform thickness of 230mm while the staircase slab has a thickness of 200mm. The floor to floor to height is kept at 3.15 m.
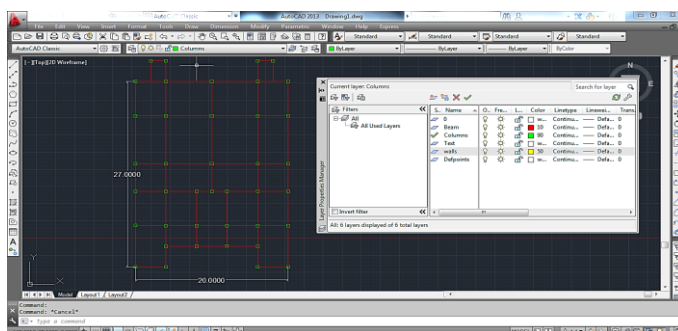

Fig 1. Beam and Column Layout using Layers

The plan for the proposed project has 2 apartments in each floor having a 3BHK layout along with a study and a family lounge. Each apartment has two master bedrooms with attached bath n toilet. The third bedroom shares a common bath and toilet with the rest of the apartment. There are a total of 8 apartments divided in 4 floors. The ground floor of the building will be used as parking.
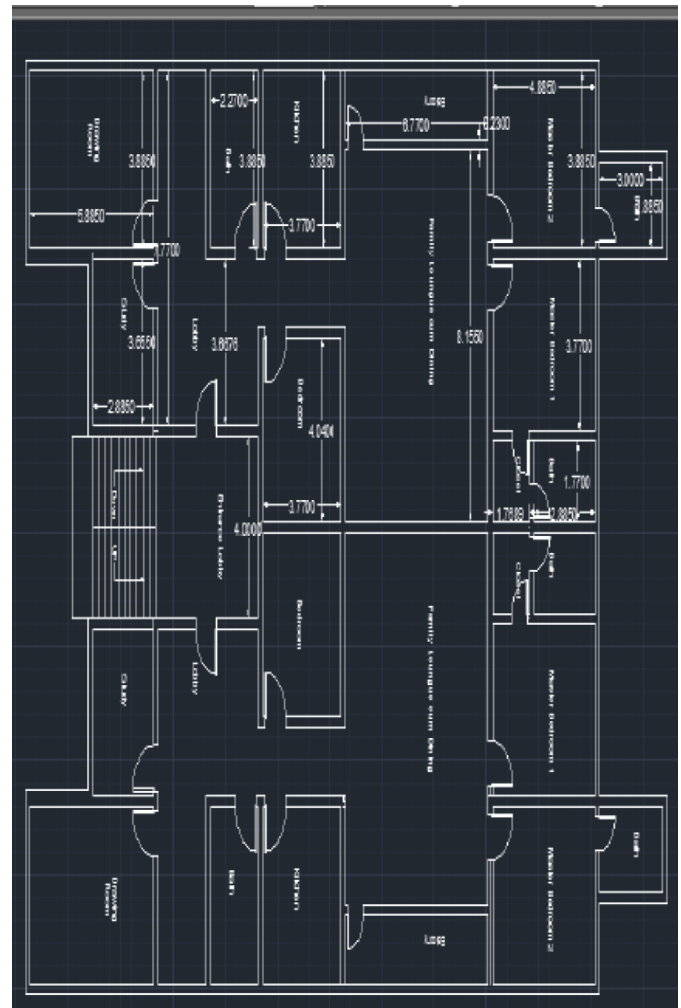

Fig 2. Plan Layout of 1st, 2nd 3rd & 4th Floor

The staircase has width of 2m, with riser of 157mm and a tread of 300mm. The landing is of size 4mx1m. All the walls have a thickness of 9" leaving a room of 1" for plaster and paint. There are two sizes of doors a) 1x2.1m & b) 0.75x2.1m. The smaller size door have been used in bathrooms and closets. There is also a provision for balcony with a width of 1.5m along the family cum dining longue.

4. ANALYSIS OF G+4 BUILDING USING STAAD PRO

The layout from AutoCAD is transferred to STAAD Pro using a DXF file. The elevation is then created by using Translational Repeat tool.

Length of Building	30.0m
Width of Building	20.0m
Height	3.15(Below GL)+G+4 @3.15m=18.9m
Live Load on the Floor	3.0 KN/m2
Grade of Concrete	M30
Steel	Fe 415
Column Size	0.5m x 0.5m
Beam Size	0.3m x 0.4m
Slab Thickness	230mm
Total No Columns	252
Total No Beams	581
No Of Footing	42

Table 2 Structural Details

- By using the Property Defining window we can generate the member property in STAAD Pro. The member section is selected and the dimensions are specified. The beams have a cross-section of 0.3 m x 0.4 m and the columns have a cross section of 0.4m x 0.4m.
- All the columns have been assigned fixed support using the STAAD pro Support creator and have been assigned accordingly. Fixed Supports have restricted movements in all directions as well there is restricted moment. This means FX FY FZ MX MZ MY all will have some values.
- The materials for the structure is selected as concrete with their property and constants as per IS Codes.
- The loading that have been considered on the structure are as follows
    1. Self-Weight
    2. Dead Load
    3. Live Load
    4. Seismic Load
    5. Load Combinations
- Self-Weight - It is the weight of the entire structure generated by STAAD Pro itself with the Self Weight Command.
- Dead Load from Slab - Dead load from the slab can be generated by STAAD Pro itself by specifying the Slab Thickness and the load on the floor per Sqm. This was found out to be 5.75KN/sq m
- Live Load - The live load acting on each floor was considered to be 3KN/ sqm. The live load are generated in the same way as dead load.

- Seismic Loads - The seismic loads were derived from IS 1893 2002 and these loads were generated by STAAD Pro Seismic Load generator in accordance with IS1893. The Seismic Load generator generates load in X and Z direction only. Y Direction only contains gravity loads.

- Load Combinations
  The structure has to be analysed for load combinations considering all the previous loads in proper ratio. These combinations are generated by the inbuilt auto- load generator for various load combinations as per IS Codes.

The Various Load Combinations used are as follows:
1. 1.5 DL 1.5 LL
2. 1.2 DL 1.2 LL
3. 1.2 DL 1.2 LL 1.2 EQ(X)
4. 1.2 DL 1.2 LL 1.2 EQ(Z)
5. 1.2 DL 1.2 LL -1.2 EQ(X)
6. 1.2 DL 1.2 LL -1.2 EQ(Z)
7. 1.5 DL
8. 1.5 DL 1.5 EQ(X)
9. 1.5 DL 1.5 EQ(Z)
10. 1.5 DL -1.5 EQ(X)
11. 1.5 DL -1.5EQ(Z)
12. 0.9 DL 1.5 EQ(X)
13. 0.9 DL 1.5 EQ(Z)
14. 0.9 DL -1.5 EQ(X)
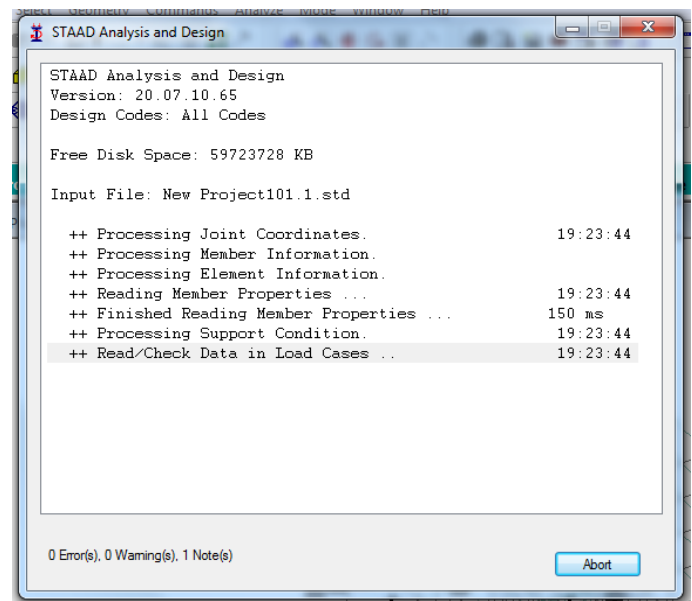15. 0.9 DL -1.5 EQ(Z)

4.1 Analysis of the Structure

Fig 3.GUI showing the analysing and design window

The STAAD Pro Engine analyses the structure based on the loads and member property defined. This engine has the capacity to analyse each and every member of the structure and let the designer know if any changes are required in the structure for a safe and efficient design.

5. DESIGN OF G+4 STRUCTURE USING STAAD PRO

After the STAAD Pro has completed analysing the whole structure, we can now proceed to the design part of the structure. After the completion of the analysis we get the design values for the various members in the form of a written data. to get the entire schedule of a member we have to just click the member and we will get the schedule for that particular member.
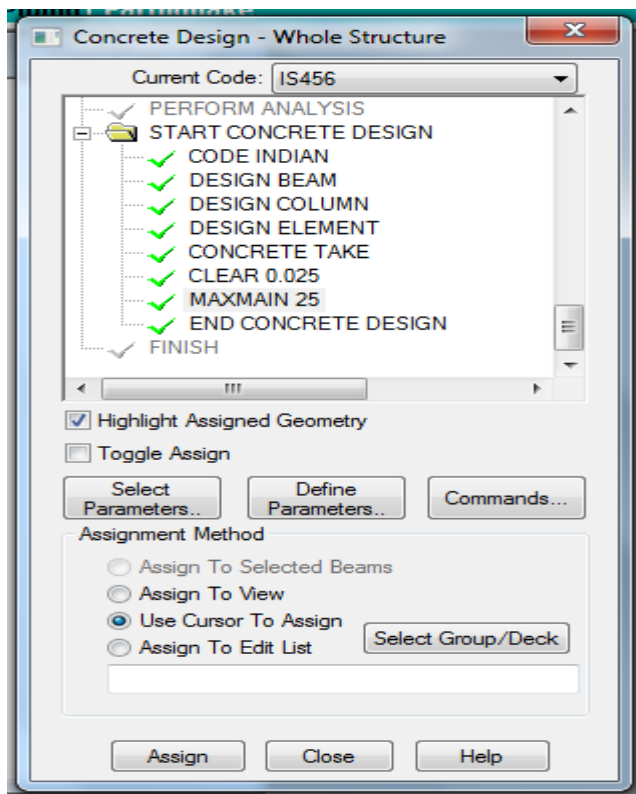
Fig 4.Assigning Design Parameters to the whole structure

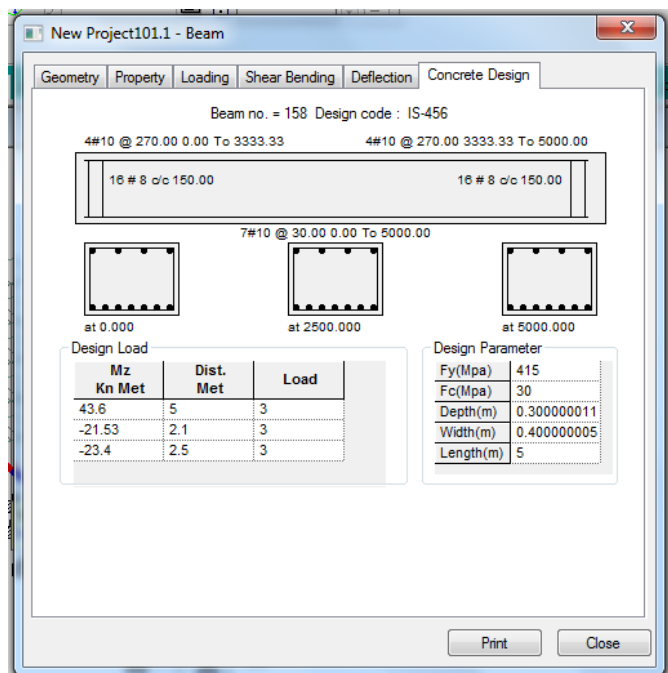## 6. ANALYSIS & DESIGN RESULTS
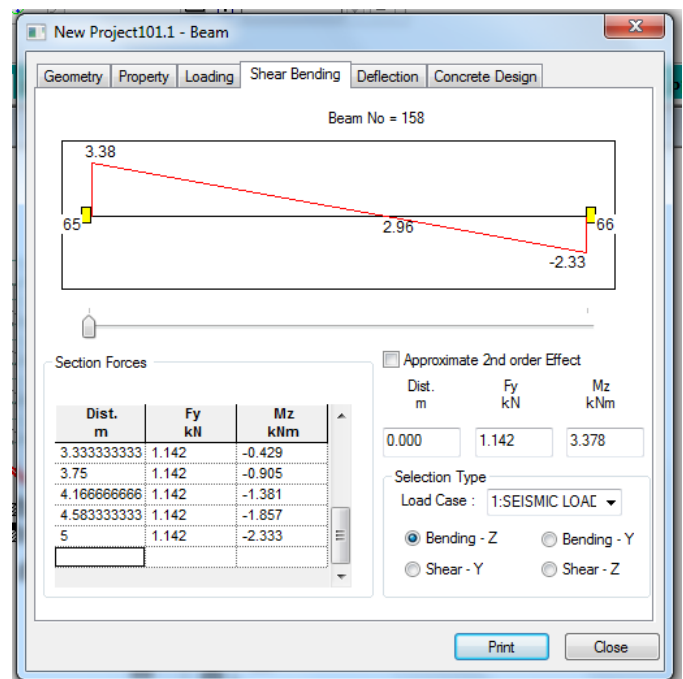
Beam Design Results

Fig 5. Beam 158 Schedule

Fig 6.Beam 158 Shear Bending

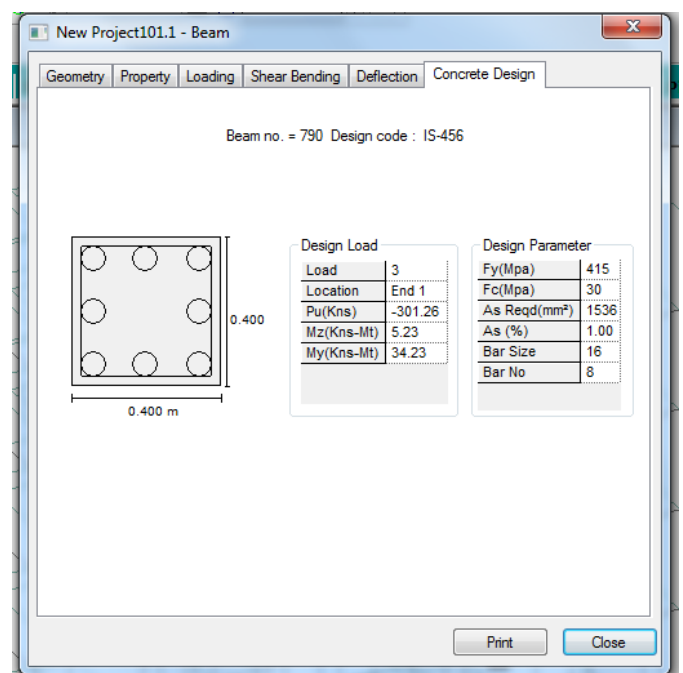### 6.1 Column Design Results

Fig 7.Column 790 Schedule

6.2 Foundation Design

The foundation for the structure has been designed using STAAD Foundation. The structure and load cases can be transferred to STAAD Foundation using in-built program. The Foundation is designed as per IS specifications an in

accordance to the soil conditions where the structure is to be built.

To design the foundation firstly the structure is to be transferred to STAAD foundation along with the selected load cases. After that the type of the foundation has to selected, whether it is an isolated, combined or mat foundation. Finally the job is to be created and the foundation analysed and designed.
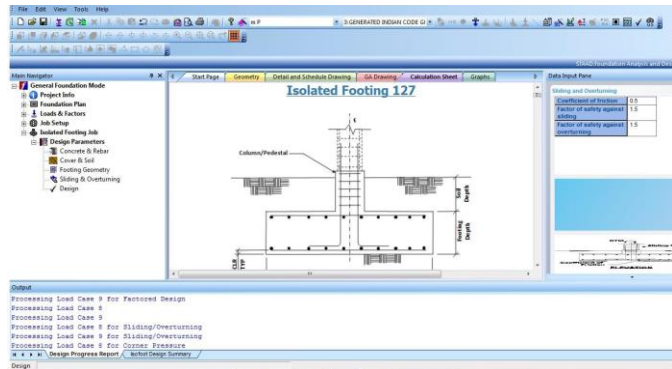

Fig 8.Design Window of STAAD Foundation

The Foundation Design Details for Footing no 127 are as follows
1. Cover : 50mm
2. Length: 3.75 m
3. Width: 3.75m
4. Thickness of Slab: 300mm
5. Reinforcement Top (X): 6mm @75mm
6. Reinforcement Top (Y): 6mm @75mm
7. Reinforcement Bottom (X): 6mm @75mm
8. Reinforcement Bottom (Y): 6mm @75mm

7. PROJECT PLANNING USING PRIMAVERA P6

Primavera is better than conventional planning in the way that the user knows the status of the work in real time which provides a lot of flexibility to the user to keep the project under control.

The various activities are and there time schedules are shown using an animated Gantt chart. The chart also shows the relationships between various activities and these activities are linked to the various resources for easy monitoring.
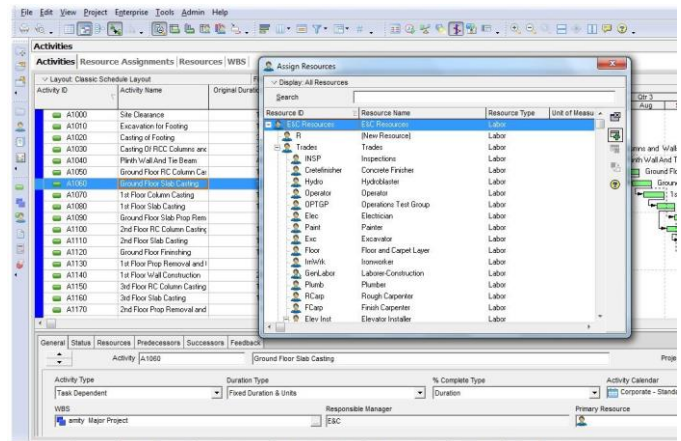

Fig 9.Entry of all the Activities in Primavera

Fig 10.Assigning Resources to the various activities

Primavera gives the user a lot of preferences when assigning resources. Primavera includes almost all of the various resources that may be used while doing such a project starting from the earthwork labour, the field engineer, electrician, plumber etc. And if any resource is missing from the database, it can be added manually. This gives the user a lot of flexibility in operating the management of such a vast and detailed project.

Fig 11. Yellow Highlight Showing completed activities

The Bars shown in blue have been completed and are marked by the yellow highlighted portion. Activities which have not been completed are shown in green.

By default each day has an 8 hour working shift per labourer which can be adjusted accordingly. All the activities are monitored in real time by the project manager and any delays are adjusted accordingly such that it does not affect the schedule of the work.

8. COST ESTIMATE OF G+4 RESIDENTIAL BUILDING

The cost estimate includes the Abstract Cost of the building floor wise. The rates used in the abstract have been taken from the CPWD Schedule of Rates for Hyderabad.

Below is the Complete Cost Estimate including the quantity estimate and abstract cost of the proposed G+4 Residential building in Aramgarh, Hyderabad.

Carpet Area per flat-246sqm

Carpet Area per floor – 4*246sqm = 984sqm

Total Carpet Area 4 floors - 4*984 sqm = 3936 sqm

Total Built up area = CA + Wall area + Circulation area

=3936 + 10%(3936) + 15%(3936)

=4920m2

Cost of Super Structure	Assume Cost of Super Structure @ 10000 Rs per m^2	4920*10000 =4,92,00,000/-
Cost of Foundation	20% of 4,92,00,000	98,40,000/-
Building Cost (4,92,00,000+98,40,000**)**		**5,90,40,000/-**
Assume cost of WS	5% of 5,90,40,000	29,52,000/-
Cost of Sanitation	5% of 5,90,40,000	29,52,000/-
Cost of Electrification	7% of 5,90,40,000	41,32,800/-
Overall Cost (5,90,40,000+29,52,000+29,52,000 +41,32,800)		**6,90,76,800/-**
Contingencies	5% of 6,90,76,800	34,53,840/-
Work Charges Establishment	2.5% of 6,90,76,800	17,26,920/-
Final Cost (6,90,76,800+34,53,840 + 17,26,920)		**7,42,57,560/- Rs**

Table 3 Cost Estimation

9. CONCLUSION

This project includes the layout of G+4 residential building using AutoCAD, Analysis and Design using STAAD Pro, Planning using Primavera P6 and concludes with the cost estimate for the entire project.

The layout of the proposed G+4 residential building is based on a plot of size 150' x 90 ' located at Aramgarh, Hyderabad. Previously the plot was being used as a commercial complex, but according to the new plan it will be used as a multi-storeyed residential building. The ground floor of the building will be used as parking while the remaing 4 floors will be divided into 8 apartments each having an area of 246sq m. Each apartment is of 3BHK configuration. All the drafting was done using AutoCAD. Also these drawings made on AutoCAD also served as a base for transfer of the structure for analysis and design into STAAD Pro.

The analysis and design of the entire structure has been completed using STAAD pro. The results include the various forces acting on various members as well various schedules for various members. Also using the software we got the concrete take-off as well as the weight of the various reinforcement bars thus easing the load of cost estimation. The foundation has been designed as an isolated footing using soil condition as medium. The foundation design values were calculated using STAAD Foundation.

Primavera P6 has been used for planning the various activities that surround the construction of a building. Using primavera we were able to formulate a working schedule and also a progress bar for constant monitoring of the project. Using primavera we were able to assign various resources as well as responsibilities on various people related to the various stages of the project there by increasing accountability. The duration of the project using primavera has been calculated to be around 374 days which also includes holidays. The progress and the relationship between various activities has also been shown in the form of an animated Gantt Chart. This chart also helps the Project manager to explain to his clients the various aspects as well as progress of the project.

The cost estimate for the project has been calculated using Abstract cost CPWD Schedule of rates has been followed and a total cost of Rs 7,42,57,560/- has been calculated.

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