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Research paper

Sequence of residential building construction in 99 days

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Abstract

Time management is one of the vital key factor in the project management of any construction project. Effective planning, scheduling & control of construction project resulted in the reduction of construction time, cost overrun and disputes. Not only effective planning, but also proper organization & sufficient flow of resources to a project can automatically achieve a good result when preliminary works has been done for each & every activity. The study area mainly focuses on the execution of work as it is scheduled before the commencement of construction. This paper describes the sequence of residential building construction (G+2) in 99 days has been executed as a real time project and achieved the completion in 99 days. For normal construction of (G+2) may be completed in 180days, but this project completed in 99 days by using the technique called Task Based Activity Execution (TBAE) to the labours. During execution, delays are observed and overcome by using the preliminary works for the next activity. The sequence of construction discussed here will definitely enhance the project planning skills for the forthcoming project.

Keywords: *Residential building, sequence, TBAE, effective planning, scheduling, execution*.

1. Introduction

Global construction 2030 is the fourth in a series of major global studies of construction & engineering industry to be published by Global construction perspectives and Oxford economics. Global construction costs are expected to rise overall by 2.9% in 2016 and projected global growth in 2017 will be 3.6%. The construction market in India will grow almost twice as far as china to 2030, providing a new engine of global growth in emerging markets. The construction industry is the second largest industry in India after agriculture. It accounts for about for about 11% of India as GDP.

The successful completion of construction projects leads to careful planning, executive & established techniques such as Gantt Bar Chart, CPM, PERT, Simulation etc., Proper planning & execution of sequence in construction leads to avoid project overrun cost and to be done in a systematic path. Effective time management is very important and crucial to achieve the successful completion of the large scale and mega projects. But it is highly applicable for the small scale projects to minimize the delays.

2. Project management

Project management is the process of achieving set goals within the constraints of time, budget and staffing restrictions.

Process of project management is guided by 3 major principles such as

1. Planning.
2. Controlling.
3. Managing.

The project planners faces the critical problems in the planning schedule is as follows

(i) Limited storage area.
(ii) Limited working space.
(iii) Lack of preliminary planning.

As you control the project process, it is project manager's job to keep the team aware of changes made in the schedule & their possible consequences. A good project manager wears many hats, acting at various times as a motivator, communicator, coordinator and advisor. It definitely leads to the successful completion of the project without any disputes.

3. Literature review

Jacob Je-Chian Lin et al [2] proposed an innovative approach for evaluating accessibility during pre-construction site layout planning. It can present an intuitive and easily understood visualization result which clearly indicated the unsafe parts of the site layout plan.

Srikanth .R et al [3] focused on the consistent view of project status and issues, is to ensure that the project is completed within the allocated and approved budget; Work Break Down structure will be prepared, duration and predecessors for each activity will be assigned, Critical Path will be determined, Resource analyzing and leveling will be done for entire,. Estimating is to assign resources to each activity in the activity list. Total duration and cost will come to know by using Microsoft Project.

Unmesh. Y. Polekar et al [6] explained to plan, schedule, and track a residential project with help of primavera software, study the results generated, it is possible to suggest which method is suitable for the selected residential project. Also to recommend measures to the organization for enhancing their project planning skills for similar projects in future.

Wallace Agyei [5] collected data on the cost and duration of activities involved were obtained Angel Estates and Construction Ltd., a construction company based in Ashanti region, Ghana. Both critical path method (CPM) and project evaluation and review technique (PERT) were used for the analysis. The

activities underwent crashing of both the time and cost using linear programming, this paved way for the determination of critical path. Further analysis revealed that the shortest possible time for the completion of the analyzed building project is 40 days instead of the expected duration of 79 days. This means that through proper scheduling of activities, the expected completion time was reduced by 39 days.

1. Objectives of the study

The main aim of this study is to achieve the execution of real time project of a residential building (G+2) in 99 days. To achieve the goal, the following objectives are identified.

1. Effective planning, scheduling & execution methods
2. Formation of construction sequence
3. Preparation of material delivery schedule
4. Task allocation to the labours
5. Identification of delays by comparing the prepared & executed time chart

4. Methodology

The following methodology has been observed to achieve the objective and completion of this project.

1. Data collection
2. Literature review
3. Site identification
4. Planning & Designing
5. Drawing preparation (Layout & Structural)
6. BOQ preparation
7. Cost estimation
8. Sequence of construction
9. Material Supply schedule
10. Preparation of bar chart
11. Identification of subcontractors &Labour
12. Execution of each task

5. Project details

The executed residential building (G+2) is located at Plot No: B35, Police Station Street, MMDA Colony, Chennai – 600106.
Ground floor is constructed as a stilt floor for the purpose of car parking and pet animals area. First and Second floor is a residence having an area of 1200 Sqft each. The 2BHK house faces the north direction and having the following area details.

1. Plot area (30'x50') = 1500 Sqft
2. Plinth area (25'x48') = 1200 Sqft
3. First Floor area = 1200 Sqft
4. Second Floor area = 1200 Sqft

This project has been started on 21st April 2016 and completed on 28th July 2016 (99 Days). Before starting this work, all the resources availability are ensured and they are given below:

1. Men
2. Material
3. Money
4. Machinery
5. Information
6. Facilities

The estimated cost for this building is Rs.87,62,748/- (Rupees Eighty Seven Lakhs Sixty Two Thousand Seven Hundred and Forty Eight Only)
For completing this project in time, is mainly due to the technique adopted is **"Task Based Activity Execution" (TBAE).** In this technique, the labour allotted with their task and the rate has been finalised for their activity. And also, the labour is maintained upto the completion of the project and they will be shifted to the other site.

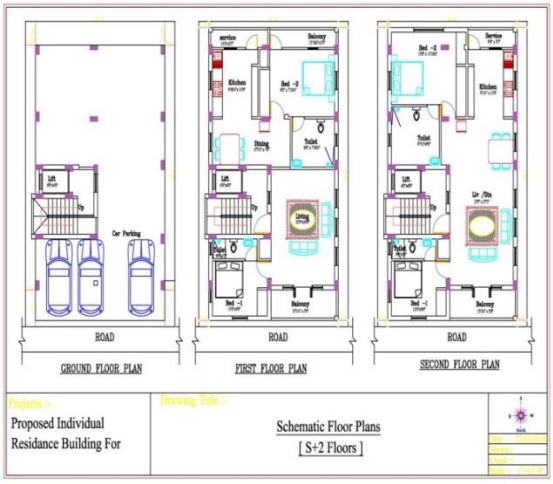

Figure. 1: Plan of Residential Building (G+2)

The following criterion has been followed and achieved the successful completion of this project in 99 days.

1. Rate fixation for each task
2. Bulk booking of materials and rate fixation
3. Material delivery schedule to the site in time without delay
4. Allotment of labours and to be maintained till the completion of project
5. Sequence of work follow-up
6. Preliminary work for each activity
7. Payment done for the labours only on task basis, not for daily activity

Rate fixation

Before the commencement of the project, the labour has to be fixed and their work will be allotted. For example, the labour will be allotted for their task upto the ground level (GL) and the rate will be fixed for each column.

Table I: Rate fixation

Sl No	Task	Labour Requirement	Rate
1	Marking Excavation Dressing Sand filling PCC Marking Column erection Footing concrete Backfilling Column concrete till GL	1 Male Coolie (MC) 1 Female Coolie (FC)	Rs.1500/- per column (Excluding Barbending & Brick Work)

In this project, number of labours required to complete the task (18 columns) till the ground level in 3 days is 15MC, 15 FC and 5 Mason. Normally it takes 7-8 days.

Bulk booking

The material requirement for completing the project has to be finalized before the commencement of the work. Because of this bulk booking, the material rate will be fixed and rate variation will be minimized.

Material supply

The material delivery schedule has been given to the material contractor to ensure the supply without delay. Once the material reached the site in time, the activity will not be delayed.

Allotment of labours

The task will be allotted to the labours properly with sufficient resources. For example, number of labours required to complete the task from basement level to first floor level in 6 days is 3mason, 10 MC, 10 FC, 6 fitter & 6 helper and 6 carpenter & 6 helper. Normally it takes 12 – 15 days.

Sequence of work

The sequence of construction is prepared before and after the commencement of the work. Herewith attached the sequence is prepared during the work progress. **(Refer Table II).** During the execution of work, day 39 has not been able to complete because of heavy rain as scheduled. But the work progress completed within two days and regular scheduled work started.

Preliminary work

The preliminary work for each activity should be performed to avoid delays. Before the commencement of each activity, the site supervisor has to check the availability of material, labours and other accessories to perform the activity. If the preliminary work performed well, then there will be no delay in any cases except natural calamities.

Payments

The payment to the labours and material contractor should be done in time without any delay. Because once the delay happens in payment, the delivery of materials and labour work will also be delayed. It reflects in the delay of completion of work.

6. Recommendations

The following points has been identified and recommended for the project completion in a scheduled time

1. Effective Planning, Scheduling and Execution
2. Checking the availability of all resources before execution
3. Planned preliminary work, before starting the next day activity
4. Properly executing the scheduled sequence of work
5. Creation of healthy environment and motivation of workers.
6. Application of TBAE and rate fixation for the activity leads to regulate the work and increase the productivity
7. Normal construction of same building shall be done by 180days. After the implementation of TBAE, the construction time reduced to 99 days and also executed in a real time manner.

7. Conclusion

This project investigation compared the sequence of work before and after the execution of real time construction. This is the first and foremost study gives the sequence of construction for 99 days and this will surely help the researchers to put forth their views in effective planning and execution.

Table II: Sequence of Building Construction

Day	Date	Description	Work Done
1	21-04-2016	Marking, Leveling & earth work excavation	Earth work - 2376 cft
2	22-04-2016	Footing mat steel fabrication, erection and concreting	Footing concrete - 377 cft
3	23-04-2016	Brick wall , footing column concrete upto ground level and soil back filling	column concrete - 91 cft
4	24-04-2016	Plinth beam marking, P.C.C laying, steel fabrication and plinth beam concreting	P.C.C - 64 cft, Plinth beam - 287cft
5	25-04-2016	Basement brick work upto 2 feet height over the plinth beam	Brick work - 383 cft
6	26-04-2016	Soil back filling and consolidation.	Back filling soil - 1617cft
7	27-04-2016	Dry the soil, Sump work in progress	Sump - 10000 Litres capacity
8	28-04-2016	P.C.C for the basement, column starter marking & concreting	P.C.C - 450 cft
9	29-04-2016	Ground floor column steel reinforcement work.	18 columns
10	30-04-2016	18 columns concreting at ground floor.	R.C.C - 152cft
11	01-05-2016	Curing for column	
12	02-05-2016	Ground floor roof shuttering work.	Shuttering - 1200 sft
13	03-05-2016	Barbending work and electrical work.	Steel - 1200kg
14	04-05-2016	Ground floor roof slab concrete work.	R.C.C - 500 cft
15	05-05-2016	Roof slab curing and first floor column starter concreting	
16	06-05-2016	Ground floor step brick work and first floor columns steel reinforcement work.	18 step brick work, barbending work - 9 columns
17	07-05-2016	First floor 9 columns concreting work and remaining 9 columns steel reinforcement work	R.C.C - 76 cft, Barbending work - 9 columns
18	08-05-2016	First floor remaining 9 columns concrete work	R.C.C - 76 cft
19	09-05-2016	First floor roof shuttering work.	Shuttering - 1200 sft
20	10-05-2016	Roof slab barbending and electrical work.	Steel - 1200kg
21	11-05-2016	First floor roof slab concreting work.	R.C.C - 500 cft
22	12-05-2016	Roof slab curing and second floor column starter concreting and step brick work.	
23	13-05-2016	Second floor 6 columns Steel reinforcement, shuttering and concrete work	R.C.C - 38 cft
24	14-05-2016	Second floor 6 columns Steel reinforcement, shuttering and concrete work	R.C.C - 38 cft
25	15-05-2016	Second floor 6 columns Steel reinforcement, shuttering and concrete work	R.C.C - 38 cft
26	16-05-2016	Curing work carried out.	
27	17-05-2016	Second floor roof Shuttering work	Shuttering - 1200 sft
28	18-05-2016	Roof slab barbending and electrical work.	Steel - 1200kg
29	19-05-2016	Second floor roof slab concrete work.	R.C.C - 500 cft
30	20-05-2016	Second floor roof slab curing work and ground floor roof	

		deshuttering work	
31	21-05-2016	Head room and machine room column steel and concreting work. Ground floor brick work upto sill level. Parapet wall brick work in terrace floor.	column concrete - 22.5 cft, Ground Floor 9" B.W - 207.5 cft 4.5" B.W - 87 sqft, Terrace 4.5" B.W 475sqft.
32	22-05-2016	Ground floor brick work upto lintel level. Inner parapet wall plastering work. Machine room Roof slab, water tank shuttering and bar bending work	Ground Floor 9" B.W - 207.5 cft 4.5" B.W - 87 sqft. Terrace Plastering 475sqft
33	23-05-2016	Machine room slab concrete work. Ground floor lintel concrete work.	Slab concrete - 63 cft, Lintel beam 95 cft.
34	24-05-2016	Ground floor button mark work for ceiling and wall plastering.	
35	25-05-2016	Ceiling plastering in ground floor car parking area.	Plastering - 800 sqft
36	26-05-2016	Ground floor brick work above lintel level. Door frame work for all doors and windows.	Ground Floor 9" B.W - 207.5 cft 4.5" B.W - 87 sqft. Door frame - 1 M.D, 2 Bed Door, 3 Window frames
37	27-05-2016	Ground floor ceiling inner plastering work.	Plastering - 400 sqft
38	28-05-2016	First floor roof slab De-shuttering. Ground floor electrical work, wall chasing and pipe laying work	
39	29-05-2016	Work stopped due to heavy rain	
40	30-05-2016	First floor 9" brick work upto lintel level. 4.5 " brick work upto sill level. Ground floor internal plastering work.	First Floor 9" B.W - 415 cft 4.5" B.W - 87 sqft. Plastering - 2745 sqft
41	31-05-2016	4.5 " brick work upto lintel level.Lintel concrete in first floor and plumbing line cutting work in Ground floor.	4.5" B.W - 87 sqft. Lintel beam 72 cft.
42	01-06-2016	First floor 9" brick work above lintel level. Lintel beam above 4.5 " B.W. Second floor roof slab deshuttering work. Ground floor Plumbing pipe line work.	Lintel beam 23 cft. First Floor 9" B.W - 207.5 cft
43	02-06-2016	First floor 4.5" brick work above lintel level. First floor electrical pipeline chasing and laying work.	4.5" B.W - 87 sqft.
44	03-06-2016	First floor button mark work for plastering.	
45	04-06-2016	First floor door frame work for all doors.	Door frame - 1 M.D, 2 Bed Door
46	05-06-2016	First floor door frame work for windows.	3 Window frames
47	06-06-2016	First floor ceiling plastering work and second floor Brick work upto sill level.	Plastering - 1046 sqft. Second Floor 9" B.W - 207.5 cft 4.5" B.W - 87 sqft.
48	07-06-2016	First floor inner walls plastering work. Second floor Brick work upto lintel level.	Plastering - 2000 sqft. Second Floor 9" B.W - 207.5 cft 4.5" B.W - 87 sqft.
49	08-06-2016	Second floor lintel concrete work. First floor inner walls plastering work and scaffolding work at outer north side for plastering.	Plastering - 2010 sqft. Lintel beam 95 cft.
50	09-06-2016	Second floor brick work above lintel level and scaffolding work at south side	Second Floor 9" B.W - 207.5 cft 4.5" B.W - 87 sqft.
51	10-06-2016	Second floor electrical work and steps inner plastering work.	
52	11-06-2016	Second floor wood frame work for all doors	Door frame - 1 M.D, 2 Bed Door
53	12-06-2016	Second floor wood frame work for windows and button mark work for plastering	3 Window frames
54	13-06-2016	Second floor button mark work for plastering.	
55	14-06-2016	Second floor internal ceiling plastering and south side external plastering work from parapet to second floor sill level.	Ceiling Plastering - 1012 sqft. External plastering- 325 sqft
56	15-06-2016	Second floor internal wall plastering and south side outer wall plastering work completed.	Inner Plastering - 1700 sqft. External Plastering- 475sqft
57	16-06-2016	Ground floor tile laying work and second floor inner plastering work.	Inner Plastering - 1715 sqft. Tile laying - 200sqft.
58	17-06-2016	East and west side scaffolding work and north side external wall button mark work for plastering.	
59	18-06-2016	North side external plastering work and ground floor tile laying work.	External Plastering - 325 sqft. Tile laying - 200sqft.
60	19-06-2016	North side external plastering work completed and first floor bathroom tile laying work.	External Plastering- 475sqft. Tile laying - 182 sqft.
61	20-06-2016	Button mark work at east and west side for external wall plastering. First floor tile laying work.	Floor tile laying- 500sqft.
62	21-06-2016	Outer plastering button mark work and second floor electrical wiring work.	
63	22-06-2016	External plastering work at east and west side of the building. First floor tile laying work completed.	Floor tile laying- 546sqft External Plastering - 1248sqft
64	23-06-2016	External plastering work at east and west side. Plumbing line work at outer area and second floor bathroom tile laying work.	External Plastering - 960sqft. Tile laying - 280sqft
65	24-06-2016	Plumbing line work and second floor tile laying work.	Floor tile laying- 500sqft.
66	25-06-2016	Second floor tile laying work.	Floor tile laying- 512sqft.
67	26-06-2016	Electrical wiring for ground floor and tile laying work in first floor balcony area	
68	27-06-2016	First floor electrical wiring work and tiles work in sump	Sump Tile - 227.5sqft
69	28-06-2016	Lift wall inner button mark work for plastering from machine room to ground floor.	
70	29-06-2016	Lift wall plastering work from machine room to second floor.	Plastering - 400sqft
71	30-06-2016	Lift wall plastering work at first floor and ground floor.	Plastering - 400sqft
72	01-07-2016	Weathering coarse screeding work at terrace.	Screeding concrete - 500 sqft
73	02-07-2016	Weathering coarse screeding work at terrace.	Screeding concrete - 700 sqft
74	03-07-2016	Ground floor inner ceiling painting work and car parking tile	Painting work - 400sqft Parking tiles - 550sqft

		laying work.	
75	04-07-2016	Ground floor parking area ceiling painting work.	Painting work - 800sqft
76	05-07-2016	Ground floor inner wall painting work and terrace floor tile laying work.	Wall putty 2 coat - 2745sqft, Weathering tile work- 300sqft
77	06-07-2016	Ground floor inner wall painting work and terrace floor tile laying work.	1st coat painting - 2745sqft, Weathering tile work- 550sqft
78	07-07-2016	Ground floor inner wall painting work and terrace floor tile laying work.	2nd coat painting - 2745sqft, Weathering tile work- 350sqft
79	08-07-2016	First floor ceiling painting work and compound wall brick work.	1st coat painting - 1046sqft, Brick work - 210sqft
80	09-07-2016	First floor ceiling painting work and compound wall brick work.	2nd coat painting - 1046sqft, Brick work - 350sqft
81	10-07-2016	First floor wall painting work and compound wall brick work.	Wall putty 2 coat - 4010sqft, Brick work - 350sqft
82	11-07-2016	First floor wall painting work and compound wall plastering work.	1st coat painting - 4010sqft, Plastering - 910sqft.
83	12-07-2016	First floor wall and second floor ceiling painting work. Compound wall plastering work.	2nd coat painting - 4010sqft, ceiling 1st coat - 1012sqft, Plastering - 910sqft.
84	13-07-2016	Ground floor door fixing work. Second floor ceiling painting work.	ceiling 2nd coat - 1012sqft
85	14-07-2016	Ground floor doors, windows and second floor wall painting work.	Wall putty 2 coat - 3415sqft, Door - 2Nos, Window- 3nos
86	15-07-2016	First floor door fixing work. Second floor wall painting work.	1st coat painting - 3415sqft
87	16-07-2016	Lift installation work. First floor doors, windows and second floor wall painting work.	2nd coat painting - 3415sqft, Door - 3Nos, Window- 8nos
88	17-07-2016	Lift installation work. External south side wall painting work.	Wall primer - 800sqft
89	18-07-2016	Lift installation work. External south side wall painting work.	Painting - 800sqft
90	19-07-2016	External east side wall painting work.	Wall Primer - 1104sqft
91	20-07-2016	Second floor doors, windows and external east side wall painting work.	Painting - 1104sqft, Door - 3Nos, Window- 8nos
92	21-07-2016	External wall west side painting work	Wall Primer - 1104sqft
93	22-07-2016	External wall west side painting work. South side scaffolding removing work.	Painting - 1104sqft
94	23-07-2016	External wall north side painting work. East side and west side scaffolding removing work.	Wall primer - 975 - sqft
95	24-07-2016	External wall north side painting work. Compound wall painting work.	Painting - 975sqft, Compound wall Painting - 910sqft
96	25-07-2016	Compound wall painting work. North side scaffolding removing work.	Compound wall Painting - 910sqft
97	26-07-2016	Outer gate fixing work. Electrical and plumbing fittings work at all floors	
98	27-07-2016	Grill gate painting work and other necessary touch up painting works.	
99	28-07-2016	All the scaffolding materials and construction materials clearing from the site. (hand over key to client)	

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