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"Optimizing Time and Cost of G+7 Residential Building"

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Abstract: In the construction industry, project time & project cost are given upmost priority. But since there are innumerable uncertainties involved in construction, delays in project completion are fairly common which lead to an increase in project's total cost. Thus project time crashing plays an important role in project management determining which activities duration to crash to complete the project in the stipulated time. But crashing the duration will mean adding more resources which will lead to an increased additional cost of the project. Thus, the paper deals with determining how to crash the project duration so as to complete the project at the earliest with minimum added cost obtaining a Time-Cost Trade-off for the project. Therefore for reducing total project time at the least added total cost and crashing the duration of an actual residential building construction by using primavera to schedule the project with CPM crashed using the Solver add-in of Microsoft Excel.

Keywords: Project management**,** project crashing, Excel Solver, Critical path method.

I. INTRODUCTION

According to the definition provided by the Project Management Institute the time and cost constitute two crucial elements of the project management (PM). The project is a temporary endeavour with a defined beginning and end undertaken to meet unique objectives, typically to bring about beneficial change or added value. Nowadays the project management is a very known and explored discipline of planning, organizing, securing, leading and controlling resources to achieve specific goals. This domain mainly serves to evaluate the impact of increasing or decreasing the level of resources on the project completion time and to find the cheapest or the shortest way of performing the whole project. Such a skill is very helpful in the project management. In the Analysis one might consider overtime, second shifts, or changing equipment to make some work proceed faster. The results of the Analysis show which activity durations should be changed to gain the intended outcomes. Crashing the activities of a project relates to the cost-evaluation of reducing the duration of those activities which are in the critical path. After this evaluation, the activities that correspond to the lowest cost for crashing should be worked on. This means that the addition of more financial resources, manpower (extra hours, for example), materials or equipment's, will cause an increase in the project budget. Construction of a real time structure involves thousands of activities including not only civil but also mechanical electrical & various other aspects. The project considered for this paper is that of a G+7 Residential Building which is located in Malad(w),Mumbai. Academic purposes, the scope of this paper limits to the planning & crashing of only RCC works of the G+7 Residential Building . The project is scheduled in Primavera and since manual crashing of the project of this scale will prove tedious and unnecessarily time consuming, the paper uses an adding of MS Excel called Excel Solver. The second section of this paper presents the problem statement formulated comprising of the complexities involved in crashing of the construction project. The third section presents the analysis of the crashing problem with a view to determine the least possible time for a projects completion; and to program the project crashing that would implicate.

Therefore it is recommended to use an optimization software which is able to find optimal solutions, to generate results needed in the sensitivity analysis and to allow the project manager to make quick time-cost simulations. The Solver, which is an Add-In of Microsoft Excel located under "Tools" of the main menu, is software which seems to meet all essential requirements.

II. METHODOLOGY OF WORK

The Methodology adopted to crash the project to answer the Problem Statement consequently solving the Time-Cost Trade-off is depicted in the following points:

i) Using Primavera to plan & schedule the project

A Myriad of Details Are Considered in Planning How to Coordinate All the RCC Activities, In Developing A Realistic Schedule. Of The Many Project Management Software's, Primavera Is The Most Commonly Used Software to Deal with All the Data Needed to Develop Schedule Information.

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The Various Activities Are Linked by the Software In Terms Of Their Predecessors and Successors .Once Completed, The Total Time Required to Complete the Project Is Displayed.

ii) Using Primavera doing Resource allocation and Defining Expenses

For defining cost and expenses resources should be added properly and proper resources allocation should be done to get the work done.

iii) Using Excel to reschedule the project with CPM and Excel Solver to crash the project and solve the Time-Cost Trade-Off

Each activity is scheduled by calculating its earliest & latest times (ES/EF/LS/LF) in MS Excel with the help of specific formulae.

The Problem Of Finding The Least Expensive Way Of Crashing Activities And The Consequent Time-Cost Trade-Off Can Be Rephrased In A Form More Familiar To MS Excel Sheet And Solved Using MS Excel Solver Add-In.

1. COLLECTED ALL ACTIVITIES WHICH IS INCLUDED IN RRC WORK ARE LISTED BELOW:

ID	Activity Name	Normal Duration	Normal Cost
1	**RCC (g+7)**	**235**	
2	**RCC.1 Substructure**	**87**	
3	**Sop**	**0**	
4	**RCC.1.1 Footings**	**21**	
5	Concreting	3	₹77,416.00
6	Deshuttering	4	₹9,500.00
7	PCC	7	₹64,400.00
8	Reinforcement Fixing	4	₹25,229.49
9	Shuttering	6	₹13,550.00
10	**RCC.1.2 Column upto plinth beam**	**41**	
11	**RCC.1.2.1 1st Step**	**13**	
12	Concreting	2	₹77,416.00
13	Deshuttering	3	₹9,500.00
14	Reinforcement fixing	3	₹25,229.49
15	Shuttering	5	₹13,550.00
16	**RCC.1.2.2 2nd Step**	**9**	
17	Concreting	2	₹77,416.00
18	Deshuttering	3	₹9,500.00
19	Reinforcement Fixing	3	₹25,229.49
20	Shuttering	5	₹13,550.00
21	**RCC.1.2.3 Plinth Beam**	**24**	
22	Concreting	2	₹77,416.00
23	Deshuttering	4	₹9,500.00
24	PCC Below Plinth beams	5	₹70,400.00
25	PCC for Plinth	5	₹68,000.00
26	Reinforcement fixing	3	₹25,229.49
27	Shuttering	5	₹13,550.00
28	**RCC.1.3 Construction of floor slab**	**25**	
29	**RCC.1.3.1 Pour 1**	**25**	
30	**RCC.1.3.1.1 Column and Retaining wall**	**14**	
31	Concreting	2	₹77,416.00
32	Deshuttering	4	₹9,500.00
33	Reinforcement Fixing	3	₹25,229.49
34	Shuttering	5	₹13,550.00
35	**RCC.1.3.1.2 Floor Slab**	**11**	
36	Concreting	2	₹77,416.00
37	Deshuttering	4	₹9,500.00
38	Reinforcement Fixing	3	₹25,229.49
39	Shuttering	5	₹13,550.00
40	RCC.1.3.3 Pour 2	25	
41	**RCC.1.3.3.1 Column and Retaining wall**	**14**	
42	Concreting	2	₹77,416.00
43	Deshuttering	4	₹9,500.00

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44	Reinforcement Fixing	3	₹25,229.49
45	Shuttering	5	₹13,550.00
46	**RCC.1.3.3.2 Floor slab**	**11**	
47	Concreting	2	₹77,416.00
48	Deshuttering	4	₹9,500.00
49	Reinforcement Fixing	3	₹25,229.49
50	Shuttering	5	₹13,550.00
51	**RCC.2 Superstructure**	**125**	
52	**RCC.2.1 RCC Slab Cycle**	**100**	
53	**RCC.2.1.1 1st Floor**	**25**	
54	**RCC.2.1.1.1 Slab**	**11**	
55	Concreting	3	₹77,416.00
56	Deshuttering	3	₹9,500.00
57	Reinforcement Fixing	4	₹25,229.49
58	Shuttering	5	₹13,550.00
59	**RCC.2.1.1.2 Column**	**23**	
60	Concreting	2	₹77,416.00
61	Deshuttering	3	₹9,500.00
62	Reinforcement Fixing	4	₹25,229.49
63	Shuttering	5	₹13,550.00
64	**RCC.2.1.2 2nd Floor**	**28**	
65	**RCC.2.1.2.1 Slab**	**14**	
66	Concreting	2	₹77,416.00
67	Deshuttering	3	₹9,500.00
68	Reinforcement Fixing	4	₹25,229.49
69	Shuttering	5	₹13,550.00
70	**RCC.2.1.2.2 Column**	**14**	
71	Concreting	2	₹77,416.00
72	Deshuttering	3	₹9,500.00
73	Reinforcement Fixing	4	₹25,229.49
74	Shuttering	5	₹13,550.00
75	**RCC.2.1.3 3rd Floor**	**28**	
76	**RCC.2.1.3.1 Slab**	**14**	
77	Concreting	2	₹77,416.00
78	Deshuttering	3	₹9,500.00
79	Reinforcement Fixing	4	₹25,229.49
80	Shuttering	5	₹13,550.00
81	**RCC.2.1.3.2 Column**	**14**	
82	Concreting	2	₹77,416.00
83	Deshuttering	3	₹9,500.00
84	Reinforcement Fixing	4	₹25,229.49
85	Shuttering	5	₹13,550.00
86	**RCC.2.1.4 4th Floor**	**28**	
87	**RCC.2.1.4.1 Slab**	**14**	
88	Concreting	2	₹77,416.00
89	Deshuttering	3	₹9,500.00
90	Reinforcement Fixing	4	₹25,229.49
91	Shuttering	5	₹13,550.00
92	**RCC.2.1.4.2 Column**	**14**	
93	Concreting	2	₹77,416.00
94	Deshuttering	3	₹9,500.00
95	Reinforcement Fixing	4	₹25,229.49
96	Shuttering	5	₹13,550.00
97	**RCC.2.1.5 5th Floor**	**28**	
98	**RCC.2.1.5.1 Slab**	**14**	
99	Concreting	2	₹77,416.00
100	Deshuttering	3	₹9,500.00
101	Reinforcement Fixing	4	₹25,229.49
102	Shuttering	5	₹13,550.00
103	**RCC.2.1.5.2 Column**	**24**	

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104	Concreting	2	₹77,416.00
105	Deshuttering	3	₹9,500.00
106	Reinforcement Fixing	4	₹25,229.49
107	Shuttering	5	₹13,550.00
108	**RCC.2.1.6 6th Floor**	**28**	
109	**RCC.2.1.6.1 Slab**	**14**	
110	Concreting	2	₹77,416.00
111	Deshuttering	3	₹9,500.00
112	Reinforcement Fixing	4	₹25,229.49
113	Shuttering	5	₹13,550.00
114	**RCC.2.1.6.2 Column**	**28**	
115	Concreting	2	₹77,416.00
116	Deshuttering	3	₹9,500.00
117	Reinforcement Fixing	4	₹25,229.49
118	Shuttering	5	₹13,550.00
119	**RCC.2.1.7 7th Floor**	**19**	
120	**RCC.2.1.7.1 Slab**	**14**	
121	Concreting	2	₹77,416.00
122	Deshuttering	3	₹9,500.00
123	Reinforcement Fixing	4	₹25,229.49
124	Shuttering	5	₹13,550.00
125	**RCC.2.1.7.2 Column**	**19**	
126	Concreting	2	₹77,416.00
127	Deshuttering	3	₹9,500.00
128	Reinforcement Fixing	4	₹25,229.49
129	Shuttering	5	₹13,550.00
130	**RCC.2.8 Terrace**	**5**	
131	Parapet Wall	5	₹28,709.00
132	**RCC.2.2 Over Head Tank**	**20**	
133	Bottom Slab	10	₹10,300.0
134	Top Slab	10	₹10,300.0
135	**RCC.3 finishing**	**110**	
136	**RCC.3.1 brickwork**	**90**	
137	fifth floor	6	₹183,818.00
138	first floor	6	₹273,248.00
139	fourth floor	6	₹243,560.00
140	ground floor	4	₹250,600.00
141	second floor	6	₹200,818.00
142	seventh floor	4	₹200,910.00
143	sixth floor	6	₹200,900.00
144	terrace level	4	₹193,800.00
145	third floor	6	₹210,800.00
146	**RCC.3.2 internal plastering**	**88**	
147	fifth floor	6	₹114,000.00
148	first floor	6	₹114,000.00
149	fourth floor	6	₹114,000.00
150	ground floor	4	₹114,000.00
151	second floor	6	₹114,000.00
152	seventh floor	6	₹114,000.00
153	sixth floor	6	₹114,000.00
154	Terrace level	2	₹114,000.00
155	third floor	6	₹114,000.00
156	**RCC.3.3 external plastering**	**88**	
157	fifth floor	6	₹180,050.00
158	first floor	6	₹180,050.00
159	fourth floor	6	₹180,050.00
160	ground floor	4	₹180,050.00
161	second floor	6	₹180,050.00
162	seventh floor	6	₹180,050.00
163	sixth floor	6	₹180,050.00

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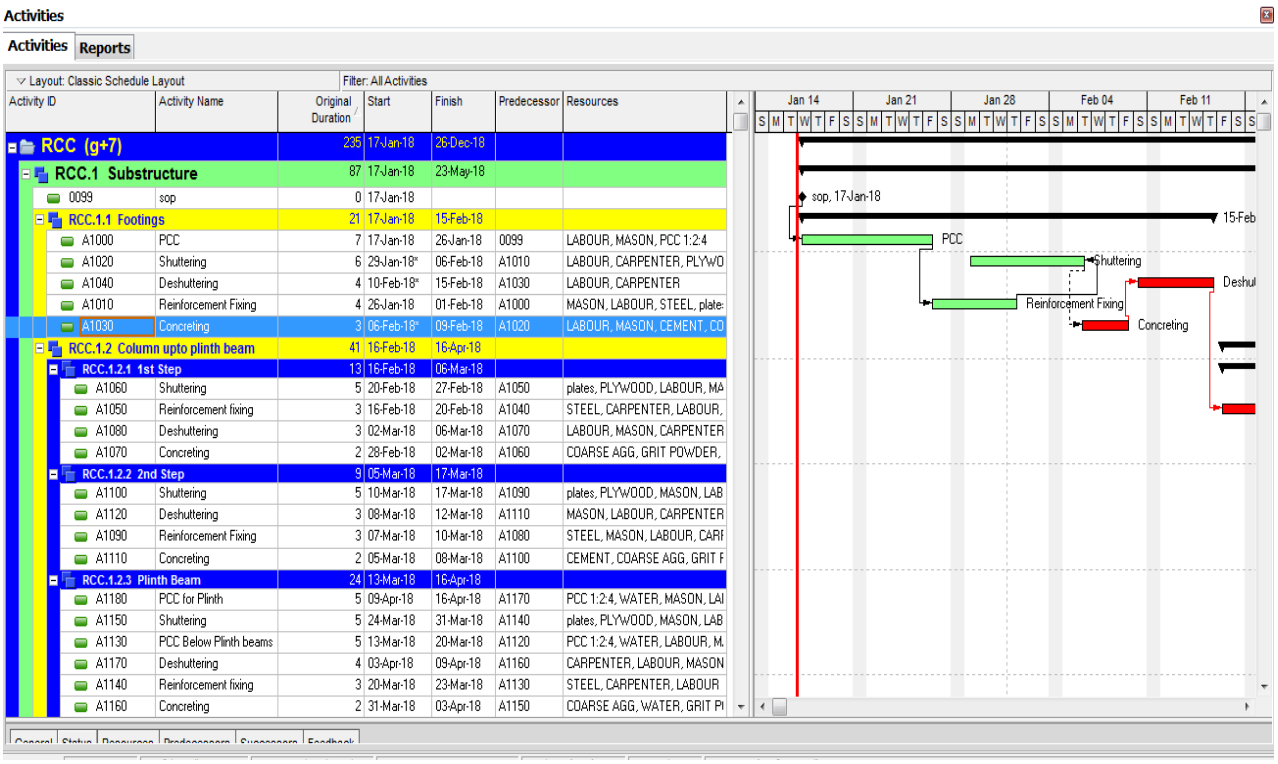
164	Terrace level	2	₹180,050.00
165	third floor	6	₹180,050.00
166	**RCC.3.4 flooring**	**88**	
167	fifth floor	5	₹90,160.00
168	first floor	5	₹90,160.00
169	fourth floor	5	₹90,160.00
170	ground floor	3	₹90,160.00
171	second floor	5	₹90,160.00
172	seventh floor	5	₹90,160.00
173	sixth floor	5	₹90,160.00
174	Terrace level	4	₹90,160.00
175	third floor	5	₹90,160.00
176	**RCC.3.5 painting**	**92**	
177	fifth floor	5	₹200,400.00
178	first floor	5	₹200,400.00
179	fourth floor	5	₹200,400.00
180	ground floor	5	₹200,400.00
181	second floor	5	₹200,400.00
182	seventh floor	5	₹200,400.00
183	sixth floor	5	₹200,400.00
184	Terrace level	4	₹200,400.00
185	third floor	5	₹200,400.00
186	**RCC.3.6 extra finishing work**	**10**	
187	doors and windows	10	₹297,000.00
188	railings	5	₹100,000.00
189	**eop**	**0**	

2. TO SCHEDULE THE PROJECT BY USING PRIMAWERA



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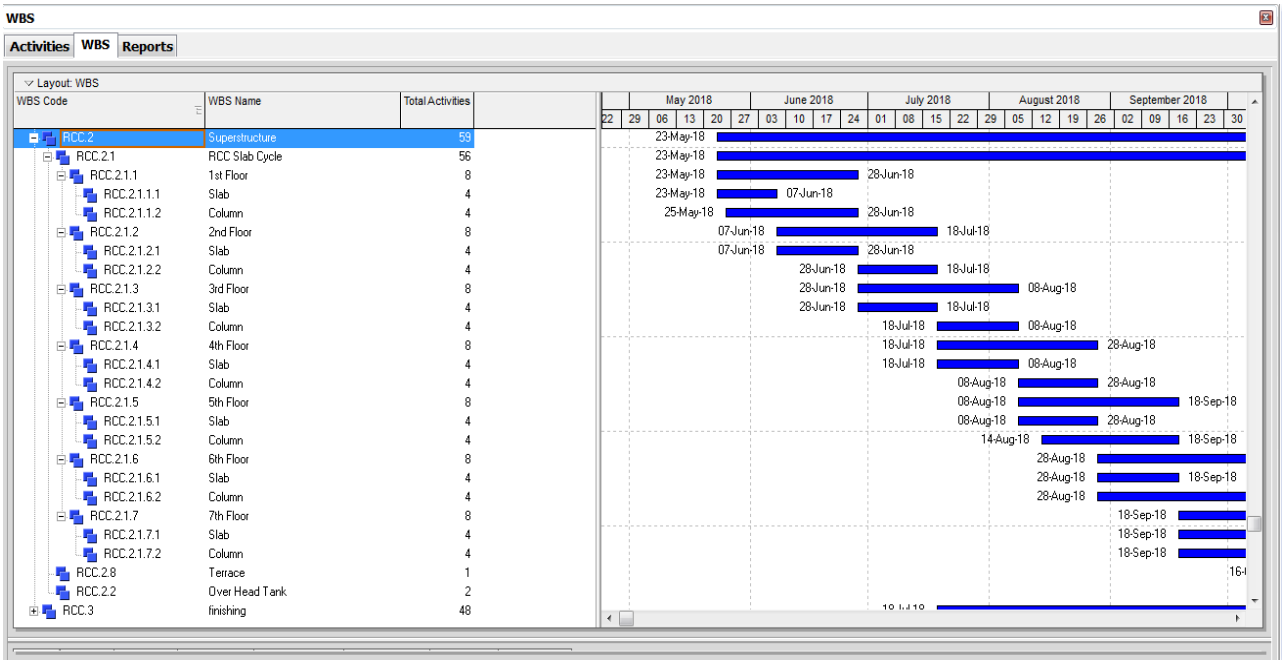

3. PROJECT CRASHING

Using Excel solver:
The calculations for scheduling (ES, LS, slack, etc.) are set up in MS Excel. They require use of the “min" and “max" functions and (to identify the critical path) the “if" function.
The following columns are imported to Primavera from MS Project:

- Activity ID
- Activity Description
- Normal Duration
- Normal Cost
- The Immediate Predecessors
- The Immediate Successors

Filling in the columns:
1. First five columns are just the imported information on the activities
2. Forward pass for “Early” times (ES; EF): In the column for ES the entry is always “= max (the EF entries for the immediate predecessors {separated by commas})”. The immediate predecessors are the nodes listed in the “Predecessors” column. In the EF column all entries are “= cell with ES + cell with Realised Time”. For the “Finish” node (if there is one) ES is “= max (all EF entries)”
3. Backward pass for “Late” times (LS; LF): In the LS column, the entry is “= cell containing LF - cell containing Realised Time” In the LF column, the entry is “= min(the LS entries for all the immediate successors { separated by commas})” The immediate successors of an activity are all the activities that have the activity in their “predecessors” list) [If you don’t have a “Finish” node you need to remember that for an activity that has no successors, the LF entry is “=max(all EF entries)”
4. Slack is “=cell for LF - cell for EF” (or = cell for LS - cell for ES)
5. Critical is “=IF (slack=0,”1”,”0”)”. This will put “1” in the cell if “slack = 0” is true and “0” if it is not. Finish time is “= EF of the “Finish” node” if there is a Finish node, or “= max (all EF entries)”. Use the mouse to select the range of all EF entries.
6. Finish-to-Start (F-S) is the most commonly used Task relationship and is by default used by MS Project to link the predecessors and successors unless specified otherwise. Complications may arise if there are different Task Relationships involved such as Start-to-Start (S-S), Start-to Finish (S-F) & Finish-to-Finish (F-F). For this project there are a number of activities linked with S-S relationship.
7. Activity Crash Time & Cost:
According to the site engineers, the regular working time of workers is 8 hours a day for 7 days a week from 9:00am to 6:00pm with 1 hr lunch. According to the project managers, the only way activities can be accelerated is through using overtime. Since the maximum overtime allowed is 6 hours on top of the regular 8-hour working day, (from 8:00am to 12:00am, 14hrs a day) activities may be crashed on average at a ratio of 4:7 (i.e. Regular 8/ Overtime 14). The results

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are the maximum crash durations used. Site managers also believed that when activities need to be crashed, the cost increase is mostly due to the double rate for overtime. As consequence, they had no problem in accepting the assumption of linear relationship between cost escalation and time crashed.

Maximum crash time for each activity has been calculated by the following formula:
1. Maximum crash duration = Normal Duration – Crash Duration
2. Cost of crashing per day = Crash cost/day = (Crash cost – Normal cost)/ Maximum crash duration
3. Realized time = Normal duration – Days to crash

CONCLUSION

The Existing Software Supporting The Project Management Does Not Have The Functionality Allowing The Manager To Optimize The Time And The Cost Of A Project On The Basis Of Different Time-Cost Variants For Particular Activities Belonging To The Project. This Paper Shows Excel Solver Can Be Applied In The Project Time And Cost Management.

- Excel Solver Allows the User to Find Very Quickly the Optimal Solutions, Which In The Project Time-Cost Management Means the Cheapest or the Shortest Schedule Meeting All the Customer's And Technical Requirements.
- Crashing Of Any Project Must Be Undertaken Only When The Benefits Received From Crashing Are More Than The Actual Cost Of Crashing.
- Productivity of Excel solver which can be used in Project management.

REFERENCES

[1] Bhushan V Tatar, Rahul S Patil, "optimization tools for time cost trade off applicable in construction project management" Department of Civil Engineering, Padmashree Dr. D.Y. Patil Institute of Engineering & Technology, Pune, (M.S), (India) International Journal of Science, Technology & Management,Volume No 04, Special Issue No. 01, March 2015
[2] Wenfa Hu and Xinhua He, "An Innovative Time-CostQuality Tradeoff Modeling of Building Construction Project Based on Resource Allocation", ScientificWorld Journal 2014.
[3] "Introduction to Operations Management" Hillier & Lieberman 8th-edition,chapter 22.
[4] Elazouni, A.M., and Metwally, F.G., (2007). Expanding finance based scheduling to derive overall optimized project schedules. Journal of Constitution Engineering and Management, 133(1), 86-90.
[1] Shahsavari Pour, N., Modarres, M. R., Tavakkoli- Moghaddam, R., (2012).Time-Cost-Quality Trade-off in Project Scheduling with Linguistic Variables. World Applied Sciences Journal 18 (3), 404-413.