Earn Value Analysis for Project Performance in Precast Building Construction: A Study on The Application of Using Microsoft Project Software

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Abstract: Earned Value Analysis (EVA) is a project management technique that integrates project scope, time, and cost to provide a comprehensive assessment of a project's performance. By comparing the planned progress to actual progress and costs, EVA offers valuable insights into a project's health, allowing managers to identify issues early and take corrective action before they escalate. In the context of precast building construction, where complex processes such as manufacturing, transportation, and assembly of precast elements are involved, EVA becomes particularly crucial for managing performance and ensuring successful project delivery.

Precast construction involves the prefabrication of concrete components in a controlled environment, followed by their transportation and assembly at the construction site. The process provides several benefits, including faster construction times, enhanced quality control, and cost-effectiveness. However, the nature of precast construction presents challenges such as the coordination of materials, tight schedules, and managing the logistics of transporting large components. As a result, keeping projects on track requires effective monitoring of progress and cost efficiency. This is where Earned Value Analysis becomes an essential tool for project managers.

The implementation of EVA in precast building construction enables a clear understanding of how much work has been completed relative to the planned schedule and budget. By measuring both the Earned Value (EV) (the value of work actually performed) and comparing it to the Planned Value (PV) (the value of work planned to be performed) and Actual Cost (AC) (the actual cost incurred for the work performed), EVA provides a snapshot of project performance. Key performance indicators such as Cost Performance Index (CPI) and Schedule Performance Index (SPI) can be derived from EVA, helping project managers evaluate whether the project is ahead or delay in schedule and under budget.

This study aims to explore the role and application of Earned Value Analysis in precast building construction, emphasizing its utility in improving project outcomes. It will investigate how EVA can be applied to track and manage the unique elements of precast construction projects, including timelines for manufacturing, transportation, site assembly, and integration of different trades. By highlighting case studies and industry practices, the research seeks to demonstrate the effectiveness of EVA in enhancing decision-making, mitigating risks, and optimizing project performance in the precast sector.

Keywords: Earn Value Analysis, Precast Concrete Construction scheduling, Construction scheduling, Monitoring and Controlling project.

I. INTRODUCTION

In India, construction industry is one of the top revenues generating industry contributing large portion in National GDP. Construction industries faces a lot of challenges such as political intervention, Environmental condition, availability of raw materials, availability of labour, labour productivity, etc. In-spite of all this hurdles, construction companies can complete and deliver the project within the given time, cost & scope. It is possible only with the proper planning and scheduling.

In this paper, construction scheduling of two numbers of Precast staff Quarter is made in MS Project. Scheduling is done in such a way that one crane is used for the erection of elements of both buildings simultaneously. The scheduling part consists of activities in sequential order of work allocated with appropriate resources with its cost. All tasks are linked to each other with proper dependencies. Also, this estimated schedule is tracked against the actual progress of the work by earned value

analysis method. The results obtained are analysed and discussed. The construction of the building is done by precast concrete technology for better result in monitoring.

Precast building construction has gained significant traction in the construction industry due to its advantages in speed, quality control, and cost-effectiveness. However, managing the performance of precast projects presents unique challenges, particularly in terms of cost control, schedule management, and coordination across various stages of production and installation.

i) Earned Value Management (EVM):

It is a project management technique used to assess a project's performance in terms of cost, schedule, and scope. It integrates these elements to provide a clear, objective view of how a project is progressing and whether it is on track to meet its objectives. EVM combines measurements of work scope, schedule, and cost to provide early warnings of potential problems, helping managers make informed decisions to keep projects on course. Earned Value Management (EVM) is a project management tool that integrates scope, schedule, and cost controlling, providing a framework for monitoring, scheduling project performance. This paper explores the application of EVM in precast building construction, aiming to optimize project performance by improving decision-making, enhancing resource allocation, and identifying potential risks early. By examining how EVM can be applied to this sector, the study assesses its effectiveness in managing the complexities of precast projects, with a focus on cost performance, schedule adherence, and overall project efficiency. The research highlights the benefits of using EVM to ensure that precast construction projects are delivered on time and within budget, offering insights into best practices for implementation and future improvements.

ii) Key EVM Components:

- Planned Value = Budgeted work to be completed by a certain time.
- Earned Value = Value of the actual work completed.
- Actual Cost = Actual cost incurred for the work done.
- Cost Variance = Difference between EV and AC.
- Schedule Variance = Difference between EV and PV.
- Cost Performance Index = Efficiency of cost performance.
- Schedule Performance Index = Efficiency of schedule performance.
- Estimate at Completion = Forecasted total project cost.
- To-Complete Performance Index = Required efficiency to stay within budget.

ii) Precast Concrete Technology:

Precast Technology in construction offers various advantages over conventional way of construction such as speed, consistency in quality, Seismic resistant, quick turnover of money. After project initiation, the workflow of this technology is carried out by design & detailing of precast elements such as column, beam, slab, wall, and production of those elements in the controlled environment, Transportation of elements to site using vehicles and by using the cranes the element of the building is erected.

II. MICROSOFT PROJECT

MSP is the project management tool provided by Microsoft. It is very useful for project manager in developing a schedule, to assign appropriate resources to activities with its cost, tracking project, managing the project cost, preparation of reports and analysing the workloads. MS Project gives enormous facilities over other management tools such as MS Excel. The stages in planning of project such as defining the scope of the project, scheduling, execution of project, monitoring, and rescheduling of the project. Especially in tracking, MS Project provides us exact values and predictions in given time limits.

i) Site Details of the building is follows,

- Name of client :- SDC Infrastructure Pvt Ltd
- Contractor :- Gunjal Construction
- Project Type :- Residential Building
- Number :- Slits + 7
- No. of Blocks :- 2
- Total Area :- 5,895.68 Sqm

Fig 1. Architectural plan of the Building

In this study data is obtained from the working project. Before commencing the scheduling work, the process of planning, coordinating, monitoring, controlling the construction of the precast building is studied. Required data for Scheduling is collected from standard thesis & dissertations, project documents of the building, from authorities involved in construction. The Architecture diagram is converted to precast diagrams, which consists of Beam, Column, Wall, slab. Figure 5.1 shows the architectural diagram of the building. The number, quantity of concrete, and cost of precast elements is estimated. The architecture diagram of the residential building is converted into precast elements in Auto CAD software. And the quantity of those elements is derived by.

After the conversion of the architectural plan of the building into precast elements, we can able to know the number of elements of precast elements such as Wall, Solid slab, Beam, Column, etc. The reinforced concrete quantity is derived here is derived in the next title. Table 1shows the element details and its concrete quantity of the basement floor.

Table 1 Precast Element Details of Basement Floor

Items	No. of Items	Reinforced concrete quantity
Wall	69	31.58
Beam	14	7.22
Column	16	4.4

After the conversion of the architectural plan of the building into precast elements, we can be able to know the number of elements of precast elements such as Wall, Solid slab, Beam, Column, etc. The reinforced concrete quantity is derived here is derived in the next title. Table 2 gives the precast element details and the concrete quantity of the Stilt Floor.

Table 2 precast element details

Items	No. of Items	Reinforced concrete quantity
Wall	61	49.02
Solid Slab	11	5.81
Sun shade	1	0.28

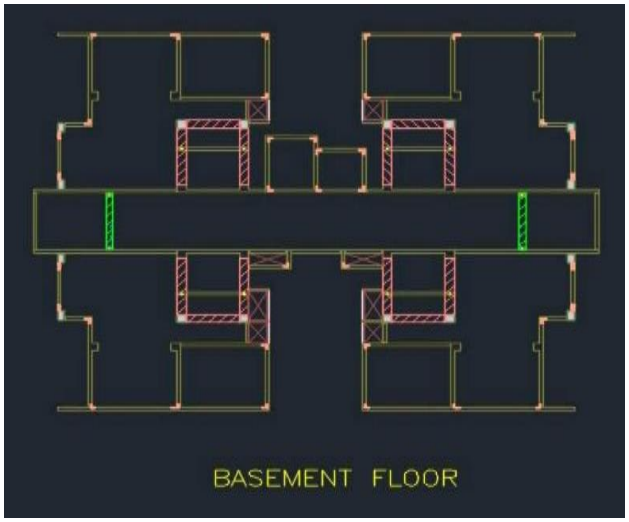


Fig.2 Basement Floor

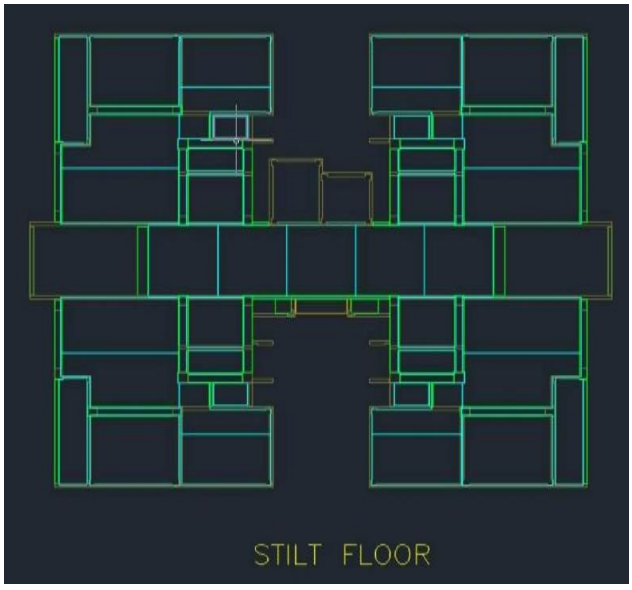


Fig.3 Slit Floor

The Estimated number of panels and the concrete quantity of Precast Building are as follows:

Table 3. Element Details

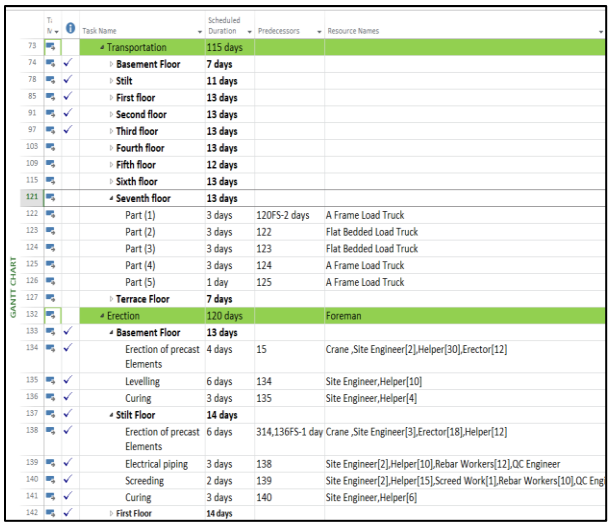
S.NO	ITEM	NOS	Cu.m
1	Wall Panel	787	1012.86
2	Column	32	17
3	Beam	154	53.35
4	Solid Slab	339	256.61
5	Staircase	32	13.506
6	Sun Shade	134	21.44

Step 2: Schedule Development: After collecting the required data for the project, Preliminary schedule is made listing the activities in the sequential order of work. Duration and labours needed for the activities is calculated from the similarly executed projects. Microsoft Project is used for the scheduling the two numbers of S+7 Staff Buidlimg.

In this project, there are 361 tasks defining various activities involving foundation works, Production, transportation, Erection of elements and development works as main activities. All the activities are in auto schedule mode so that the dates are assigned by itself.

Step 3: Assign Resources: The resources required for the running of project such as labours for executing the work, vehicles used for transportation and erection of precast elements, Precast elements, are listed and type of work is also defined.

After adding resources with its cost, the resources are assigned to the tasks. The costs for completing the tasks are derived automatically in the Cost column.



	Task Name	Scheduled Duration	Predecessors	Resource Names
73	Transportation	115 days		
74	Basement Floor	7 days		
78	Stilt	11 days		
85	First floor	13 days		
91	Second floor	13 days		
97	Third floor	13 days		
103	Fourth floor	13 days		
109	Fifth floor	12 days		
115	Sixth floor	13 days		
121	Seventh floor	13 days		
122	Part (1)	3 days	120FS-2 days	A Frame Load Truck
123	Part (2)	3 days	122	Flat Bedded Load Truck
124	Part (3)	3 days	123	Flat Bedded Load Truck
125	Part (4)	3 days	124	A Frame Load Truck
126	Part (5)	1 day	125	A Frame Load Truck
127	Terrace Floor	7 days		
132	Erection	120 days		Foreman
133	Basement Floor	13 days		
134	Erection of precast Elements	4 days	15	Crane ,Site Engineer[2],Helper[30],Erector[12]
135	Levelling	6 days	134	Site Engineer,Helper[10]
136	Curing	3 days	135	Site Engineer,Helper[4]
137	Stilt Floor	14 days		
138	Erection of precast Elements	6 days	314,136FS-1 day	Crane ,Site Engineer[3],Erector[18],Helper[12]
139	Electrical piping	3 days	138	Site Engineer[2],Helper[10],Rebar Workers[12],QC Engineer
140	Screeding	2 days	139	Site Engineer[2],Helper[15],Screed Work[1],Rebar Workers[10],QC Eng
141	Curing	3 days	140	Site Engineer,Helper[6]
142	First Floor	14 days		

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Fig 4 MSP Schedule

Step 4: Update Project Using Baselines: Best method to track and monitor the project is done by setting up of baselines. Baseline is the snapshot of the schedule which saves nearly 15 information of a particular activity. MSP allows to set 11 baselines and interim plans also. Baselines helps to know percentage of completion up-to date, assess the performance, Managing risks and future forecasting of project. To perform Earn value analysis, the project must be updated up to a certain date using baseline. Earned value analysis requires at least one baseline to get result of the performance of the project.

Step 5: Perform Earned Value Analysis:

Measuring the performance of all aspects such as cost, Time and Scope is crucial. Earn Value Analysis is one way which helps us to track and monitor progress of the project in all time, cost and scope aspects. The Key Components of EVM is used to measure the cost and schedule performance against the baseline. After updating the project to a specified date, the Earn Value Analysis is Performed. By the results we can compare the values of the planned and actual progress of the plan.

	Task Name	SV	CV	CPI	SPI	EAC	BAC	VAC
1	AAI-COIMBATORE	-₹ 4,362,591.00	-₹ 243,860.43	1	0.94	₹ 88,037,299.42	₹ 87,747,786.40	-₹ 289,513.02
2	TYPE B (TOWER 1)	-₹ 2,384,718.83	-₹ 130,817.37	1	0.94	₹ 44,010,921.89	₹ 43,855,733.20	-₹ 155,188.69
3	Foundation Works	₹ 0.00	-₹ 19,508.00	0.99	1	₹ 3,397,447.15	₹ 3,377,939.15	-₹ 19,508.00
4	site Clearance	₹ 0.00	-₹ 5,000.00	0.6	1	₹ 12,500.00	₹ 7,500.00	-₹ 5,000.00
5	Excavation	₹ 0.00	₹ 1,674.00	1.03	1	₹ 59,022.00	₹ 60,696.00	₹ 1,674.00
6	Marking & Levelling	₹ 0.00	₹ 1,674.00	1.21	1	₹ 8,022.00	₹ 9,696.00	₹ 1,674.00
7	PCC for Footing	₹ 0.00	-₹ 2,790.00	0.99	1	₹ 551,901.00	₹ 549,111.00	-₹ 2,790.00
11	Footing	₹ 0.00	-₹ 15,066.00	0.99	1	₹ 2,766,002.15	₹ 2,750,936.15	-₹ 15,066.00
16	Production	₹ 0.00	₹ 0.00	1	1	₹ 27,273,492.34	₹ 27,273,492.34	₹ 0.00
73	Transportation	-₹ 1,427,058.82	₹ 0.00	1	0.67	₹ 5,899,442.50	₹ 5,899,442.50	₹ 0.00
132	Erection	-₹ 957,660.01	-₹ 111,309.37	0.97	0.78	₹ 7,543,987.20	₹ 7,304,859.21	-₹ 239,127.99
133	Basement Floor	₹ 0.00	₹ 41,284.00	1.21	1	₹ 199,636.00	₹ 240,920.00	₹ 41,284.00
137	Stilt Floor	₹ 0.00	-₹ 58,823.00	0.93	1	₹ 812,640.69	₹ 753,817.69	-₹ 58,823.00
142	First Floor	₹ 0.00	-₹ 30,268.00	0.96	1	₹ 822,405.69	₹ 792,137.69	-₹ 30,268.00
147	Second Floor	₹ 0.00	-₹ 30,268.00	0.96	1	₹ 822,405.69	₹ 792,137.69	-₹ 30,268.00
152	Third Floor	₹ 0.00	-₹ 30,268.00	0.96	1	₹ 822,405.69	₹ 792,137.69	-₹ 30,268.00
157	Fourth Floor	-₹ 792,137.69	₹ 0.00	0	0	₹ 792,137.69	₹ 792,137.69	₹ 0.00
162	Fifth Floor	-₹ 161,007.27	₹ 0.00	0	0	₹ 792,137.69	₹ 792,137.69	₹ 0.00
167	Sixth Floor	₹ 0.00	₹ 0.00	0	0	₹ 792,137.69	₹ 792,137.69	₹ 0.00
172	Seventh floor	₹ 0.00	₹ 0.00	0	0	₹ 792,137.69	₹ 792,137.69	₹ 0.00
177	Above terrace	₹ 0.00	₹ 0.00	0	0	₹ 710,657.69	₹ 710,657.69	₹ 0.00
182	TYPE B (TOWER 2)	-₹ 1,977,872.17	-₹ 113,043.06	1	0.95	₹ 44,026,431.08	₹ 43,892,053.20	-₹ 134,377.88
183	Foundation Works	₹ 0.00	-₹ 19,508.00	0.99	1	₹ 3,397,447.15	₹ 3,377,939.15	-₹ 19,508.00
196	Production	₹ 0.00	₹ 0.00	1	1	₹ 27,273,492.34	₹ 27,273,492.34	₹ 0.00
253	Transportation	-₹ 1,119,261.82	₹ 0.00	1	0.72	₹ 5,899,442.50	₹ 5,899,442.50	₹ 0.00
312	Erection	-₹ 858,610.36	-₹ 93,535.06	0.97	0.8	₹ 7,545,198.12	₹ 7,341,179.21	-₹ 204,018.91

Fig 5 Earn Value Analysis

Step 6 :-Results & Discussion

The below results are obtained from the Earned Value Analysis Report which is generated by MS Project Software.

Table 4 EVA results

Parameters	Results
C.V	- 2,39,134
C.V%	0
CPI	0.99

S.V	- 45,27,220
S.V%	-6
SPI	0.94
BAC	8,77,47,786
EAC	8,80,33,375
VAC	- 2,85,588
TCPI	1.02

- CPI = 0.996 indicates that the project is slightly over the budget.
- SPI = 0.94 indicates that the project the behind the Schedule by 6%
- VAC = - ₹ 2, 85,588.93 indicates the difference between the Budgeted and Estimated at Cost (BAC & EAC)
- TCPI = 1.02 indicates that the remaining resources must be used at efficiency of 1.02 worth of every rupee spent.

Main reasons for delay in project schedule and over budget are as follows:

- Unavailability of Crane
- Delay in Transportation of Precast Elements
- Labors engaged in construction other blocks.

Measures to be taken by project managers to overcome this problem and to achieve the project scope are as follows:

- Use of highly skilled labours
- Modification of Work Plan

III. CONCLUSION

The construction scheduling and tracking of S+7 staff building using Microsoft Project is made successfully with respect to the objectives of this work. The results of analysis, shows that the construction of precast building is over the budget and behind the schedule. Variances and Indices evidently shows that the completion of the project will be delayed, and the project costs will slightly be over the budget. The reasons for delay and measures to be taken to complete the project on time are also mentioned. From this work, it is understanding the importance of the Construction Scheduling and Tracking by Earned Value analysis. Some of the guidelines are provided to project managers to keep the project in track on time and on budget as follows:

1) To complete project on time without decrease quality of construction
2) Proper Recourse Scheduling
3) To Give extra attention to CPM (Critical Path Method)

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