Solid State Technology
Volume: 63 Issue: 6
Publication Year: 2020

Optimisation of Scheduling and Resource Leveling of High Rise Structures by using Primavera

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***Abstract*—** Scheduling of a project is a complex process involving inputs from experts from various fields. Resource scheduling, optimization and leveling of resources are the vital ingredients in making a successful project. Utilization of endemically available resources, their effective utilization and structuring has been done in this work using Primavera. The construction industry's performance depends upon two things scheduling & resource management. Controlling of both of these will affect the total budget of the project. Management of scheduling and resource lies in the hands of organisation only but due to many complexities and vastness in the industry it becomes slightly haphazard and chaotic.

Scheduling and resource management is difficult task due to its inherent complexities of construction projects. The present study deals with the scheduling and resource management of high rise structures. The study was carried out in two phases.

In the first phase scheduling and resource controlling of a residential building are prepared by considering the concrete was casted at site. The required data was collected from the detail drawings and prevailing site conditions of Ramky One North project.

***Keywords*—** *Scheduling, Resource Leveling, High Rise Structures, Primavera*

I. INTRODUCTION

A project may be defined as an endeavor to create a unique and useful product beneficial to masses. It is of either temporary or permanent nature. Repetition of components in a project does not alter the fundamentals and deliverables of the script.

PROJECT MANAGEMENT

Application of knowledge tools, skills and techniques in an optimized manner is called project management. Its main objective is to regulate the time, cost and quality of the project. The triangular relationship of these components is shown in Fig-1.1.

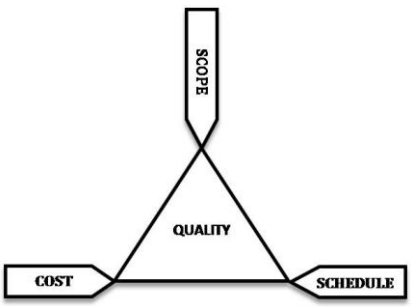

Fig.1.1 Project management triangle

II. LITERATURE REVIEW:

According to AnilSawhney et al (2013), the key factors that contribute to the delay in execution of a project are improper planning and lack in the clearity of scope and boundaries of the project. They have selected an inventory of 45 attributes which cause a delay in execution of the project and have formulated the interrelationship between those attributes.

AnkurVerma1 , K.K. Pathak, R K DixitHere (2014)

Management of a project involves, The project P6 or Primavera carries out the functions of monitoring, planning and construction of projects. Undertaking the board system is honestly trustworthy on successful organizing, checking and controlling of improvement adventure with usage of errand the chiefs programming Primavera P6. The assessment on "Obtained Value Analysis of Construction Project at Rashtriya Sanskrit Sansthan, Bhopal" shows importance, use and remarkable features of procured worth organization that points of interest adventure boss and finally results in adventure accomplishment. The associations which don't use PM programming mechanical assemblies gainfully need to fabricate their inclinations in getting ready and educating their used undertaking gatherings, similarly as in setting up information development systems that will support and help PM gatherings. The usage of such programming's helps with completing the endeavor on schedule and cost.

Unmesh. Y. Polekar and Rohit. R. Salgude (2015)

Appropriate arranging and booking is basic being created predicts for lessening and controlling delays of the undertaking. Amazing extents of time, cash, assets are squandered every year in an improvement industry considering inappropriate organizing and booking. With globalization the headway undertakings have gotten tremendous and complex. Putting together of such tasks requires colossal extent of definitive work, which can be decreased with the assistance of undertaking arranging programming. Giving phenomenal engineering, legitimate connection, palatable development of assets for an undertaking can't hence accomplish required outcome. A counsel structure must be available which can caution the relationship about its conceivable achievement and dissatisfactions all through the undertaking. The fundamental complaints of his appraisal are to plan, timetable, and track a private task with assistance of primavera programming, study the outcomes made, it is conceivable to propose which system is fitting for the picked private undertaking. Moreover to prescribe measures to the relationship for improving their undertaking organizing aptitudes for comparable undertakings in future.Appropriate engineering and booking is enormous being created anticipates for lessening and controlling delays of the undertaking. Huge extents of time, cash, assets are squandered every year in a progression industry because of inappropriate arranging and booking. With globalization the headway undertakings have gotten massive and complex. Coordinating of such tasks requires gigantic extent of administrative work, which can be decreased with the assistance of undertaking putting together programming. Giving mind boggling arranging, real connection, agreeable development of assets for an undertaking can't hence accomplish required outcome. An exhortation structure must be available which can caution the relationship about its conceivable achievement and dissatisfactions all through the undertaking. The main complaints of his appraisal are to plan, timetable, and track a private task with assistance of primavera programming, study the outcomes made, it is conceivable to propose

which technique is fitting for the picked private undertaking. Moreover to support measures to the relationship for improving their undertaking arranging aptitudes for comparable undertakings in future.

AnujDubey (2015)

Resources are required to carry out specific tasks in a project, but the availability of resources within a given firm is always limited. While preparing the schedule structure, the Project Manager might schedule certain tasks in parallel. In such cases it might be possible that the same resource is being used in both the parallel tasks, while its availability is limited. This paper emphasises how the Project Manager could resolve suchh conflicts by using Resource levelling in modern softwares such as Microsoft Project and Oracle Primavera. Resource levelling as defined by PMBOK is a "technique in which start and finish dates are adjusted based on resource constraints with the goall of balancing demand for resources with the available supply." It basically refers to solving over-allocation of resources for the given project. A resource is over allocated when scheduled to perform more work than possible within the resource's schedule. Resource levelling may be simple in which the given tasks are delayed until the given resources are available or they can be complex where the given resource might be deployed on multiple projects throughout the company, thus requiring levelling to be done at the company level instead of the individual project. If levelling is done on tasks which are not present on the critical path, the given project will not be delayed, but if the given tasks are critical then the project would be delayed. Hence, Resource levelling is a complex issue which needs to be resolved in order to avoid delays in the project.

T.Subraman, Kurian Jacob (2016)

Essentially adventure the board cycle incorporates five cycle social occasions (PMBOK, 2008). They are beginning, orchestrating, executing, noticing and controlling, and closing. Screen and control of assignment work is the path toward following, investigating and guiding the progression to meet the introduction targets described in adventure the board plan. Noticing is a piece of undertaking the chiefs played out all through the endeavor. It joins assembling, assessing, and passing on execution information, and reviewing assessments and examples to impact measure updates (PMBOK, 2008).

III. PRIMAVERA PROJECT MANAGEMENT

Task devours a few assets in the course of its life to accomplish the ideal objective. The assets have time subordinate, chief aberrant costs identified with them. For huge Construction ventures with enormous spending it turns out to be extremely hard for theproject group to deal with the errands in this way, it turns out to be exceptionally important to give an instrument in the hand of undertaking group that helpskeep a track of exercises in the task. Primavera Project Planner P6 adaptation 8.2, an item from Oracle is a verypowerful instrument present in the possession of venture group. The product helps in arranging, booking and controlling of projectsvery effectively.

Temporary workers in India are hesitant to utilize venture arranging and booking strategies, which are being utilized world overand effectively demonstrated as benchmark for in time culmination of tasks. The nature of timetable created from thesoftware regularly needs detail and the motivation behind the product in enhancing the venture is by and large not met by the usersin India. Notwithstanding give knowledge on different undertaking assignments, their entomb relationship, conditions to foresee totalproject span during arranging stage. The timetable should be extensive enough to let the client comprehend in detailthe reason for different exercises in the timetable.

PROJECT DATA

Project Name	: Ramky One North
Location	: Avalhalli, yelahanka, Banglore.
Area of the Project	: 42000Sft
Project Type	: Residential Building
Name of the Block	: B-Block
No of Floors	: B+S+G+12
No of Flats	: 312
No of Blocks	: 6Blocks (B1,B2,B3,B4,B5&B6)
Ground Floor Area	: 27555Sft
Project Cost	: 62cr
Project Manager	: Mr. Ravi Shankara Reddy

The stages involved in collecting data are as follows:

A. Progress Records (PR)

B. labour record

C. Activities and their schedule

A. Progress records:

The PR describes the work done by labor and also the its details maintained on a daily basis. The resources to be provided can also be traced and provided as and when essential. A sample PR is given in Appendix A.

B. Labour record:

Work output is the amount of work done by one person (Labor) in 1 day. It is used to calculate durations required for activity based on the available manpower on site.

C. Activities and their schedule:

The time required for the project is evaluated using primavera. Absolute exercises for development of the private task with their arranged length (in light of work yield and labor accessible on location) are entered in primavera for additional working.

IV. MEN POWER CALCULATION

Table 4.1 Labour required for different works

Activity	Per Unit	Mason	Bhisti	Beldar	Mazdoor
Excavation	28.3CUM			5	4
Refilling	28.3CUM		0.5	3	2
PCC laying	2.83CUM	0.25	0.75	2	3
RCC laying	2.83CUM	0.5	1.333	3	3
Shuttering	9.6SQM	4(Carpenters)		4	
Reinforcement	1Quintal	1(Fitter)		1	
Brick work	2.83CUM	2.25	0.5		4.5
Doors work	.18CUM	2(Carpenters)		1	
Tiles laying	10SQM	1			2
Plastering	40SQM	3	1		3
White wash	180SQM	1White washer			1
Painting	56SQM	1(Painter)			1
granite	5	1			2

In 1stphase,based on the total quantities obtained from the drawings and output constants, manpower required have been computed for various activities as shown in Table 4.1. According to the site timings the work hours are 9 by interpolating NBO timings and site timings, the quantities and menpower required are calculated and shown in Table 4.2.

Table 4.2 phase-1 men power calculation

Name of Activity	As per NBO					As per Actuals				
	Qty	Mason	Bhisti	Beldar	Mazdoor	Actual Qty	Mason	Bhisti	Beldar	Mazdoor
Excavation	31.84 Cum			5	4	1600			251.28	201
Refilling	31.84 Cum		0.5	3	2	1666.67		26.17	157.05	104.7
PCC laying	3.18 Cum	0.25	0.75	2	3	101.04	7.93	23.8	63.47	95.21
RCC laying	3.18Sqm	0.5	1.33	3	3	74.05	11.63	31	69.77	69.77
Shuttering	10.8Sqm	4		4		182.33	67.53		67.53	
Reinforcement	1.13Sqm	1		1		29.54	26.25		26.25	
Brick work	3.18 Cum	2.25	0.5		4.5	28.26	19.97	4.44		39.94
Doors work	0.2Sqm	2		1		5.35	52.83		26.41	
Tiles laying	11.25Sqm	1			2	192.77	17.14			34.27
Plastering	45Sqm	3	1		3	550.76	36.72	12.24		36.72
White wash	202.5Sqm	1			1	1728	8.53			8.53
Painting	63Sqm	1			1	1722.83	27.35			27.35
Granit	5.63Sqm	1			2	56.79	10.1			20.19

In 2ndphase,Pre cast construction method is adopted. According to NBO and some details collected from the Preca company quantities, the menpower required are calculated and shown in Table 4.3.

Setting up enterprise project structure (EPS)

EPS mentions the project body. One can create up to 50 levels in primavera. EPS can create by project name or project location. The following figure shows that EPS name of the project is Ramky One North and EPS ID is RON.

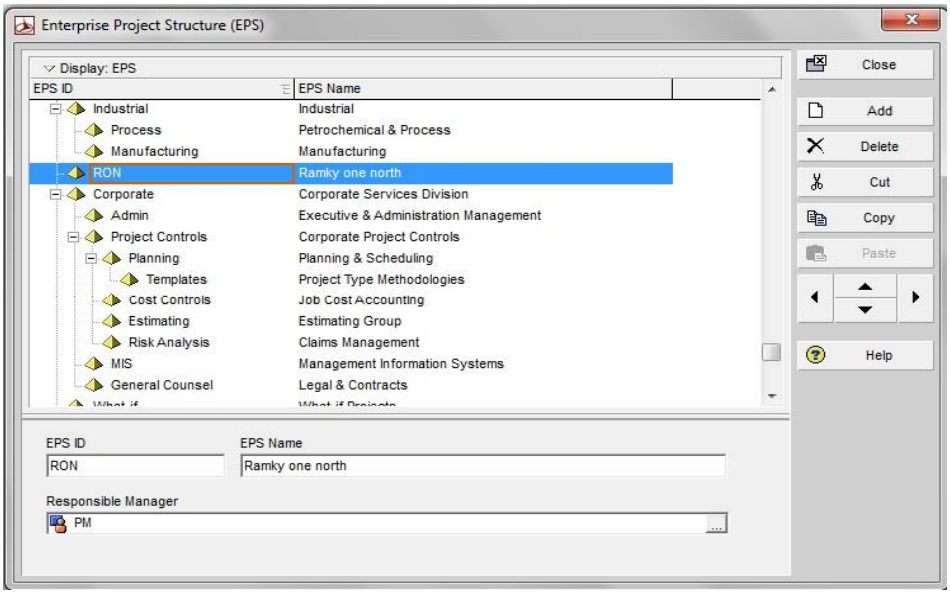

Fig.5.1 EPS

Fig.5.1 Enterprise Project Structure of the project.

Name of Activity	As per NBO& Site obseravation					As per Actuals				
	Qty	Mason	Bhisti	Beldar	Mazdoor	Actual Qty	Mason	Bhisti	Beldar	Mazdoor
Excavation	31.84Cum			5	4	1600			251.3	201
Refilling	31.84Cum		0.5	3	2	1666.67		26.2	157	104.7
PCC laying	3.18 Cum	0.25	0.75	2	3	101.04	7.9	23.8	63.5	95.2
RCC laying	3.18 Ton	0.5	1.333	3	3	74.05	11.6	31.0	69.8	69.8
Shuttering	10Sqm	2		3		182.33	36.5		54.7	
Reinforcement	1.13 Ton	1		1		29.54	26.3		26.3	
Brick work	3.18 Cum	2.25	0.5		4.5	28.26	20	4.4		39.9
Doors work	0.2Sqm	2		1		5.35	52.8	0.0	26.4	
Tiles laying	11.25Sqm	1			2	192.77	17.1	0.0		34.3
Plastering	45Sqm	3	1		3	550.76	36.7	12.2		36.7
White wash	202.5Sqm	1			1	1728.00	8.5			8.5
Painting	63Sqm	1			1	1722.84	27.3			27.3
granite	5.63Sqm	1			2	56.8	10.1			20.2

SETTING UP ORGANISATION BREAKDOWN STRUCTURE (OBS)

An Organizational Breakdown Structure is a moderate degree of an alternate graphs. The OBS shows hierarchical connections and afterward utilizes them for relegating work to assets in an undertaking. The Fig.5.2 shows that the dependable supervisor of the venture is venture chief (PM) and the excess staff go under PM.

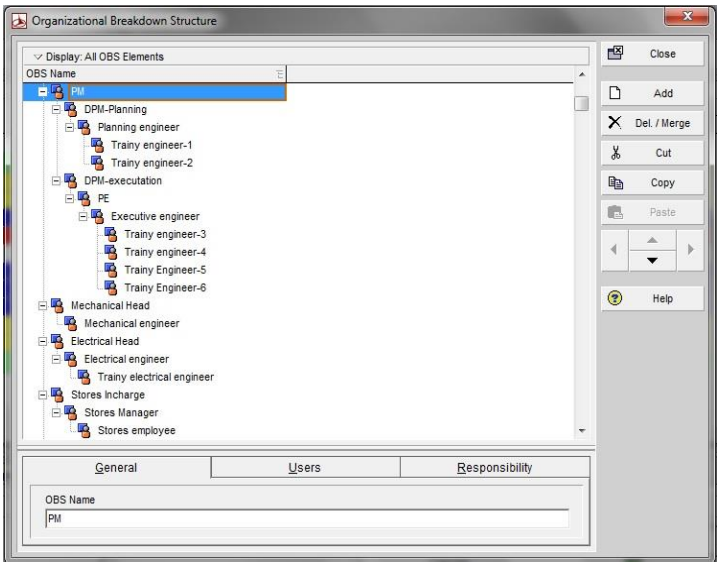

Fig.5.2 OBS

CREATING A PROJECT

Project is simply known as set of works. Projects can be added by selecting the required EPS. In the following figure "Ramky One North"represents the Enterprise Project Structure (EPS), name of the projects are“B-block” and “B-block PC”. Responsible manager of the project is Project manager (PM).

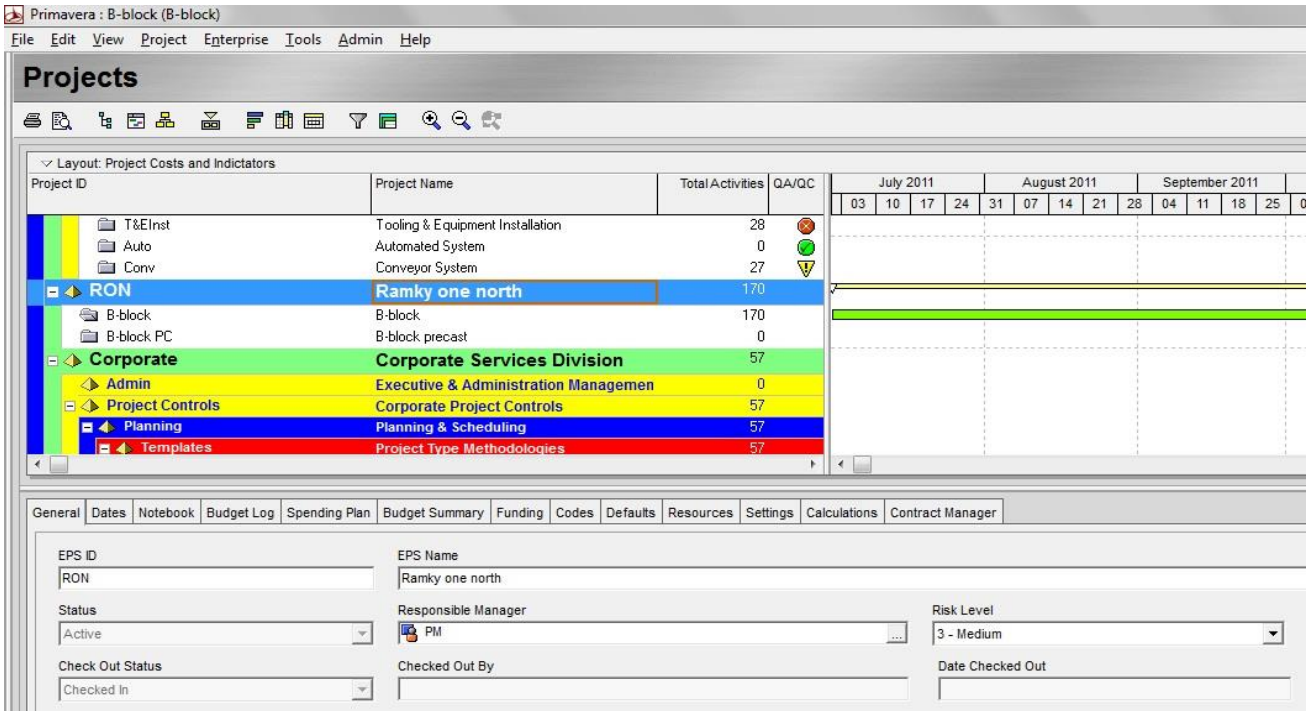

Fig.5.3 Creation of Project

CREATING WORK BREAKDOWN STRUCTURE (WBS)

A work breakdown structure (WBS), in adventure the heads is a deliverable-organized crumbling of an endeavor into more unobtrusive parts. A work breakdown structure is a key endeavor deliverable that sorts out the participation into reasonable portions. According to the PMBOK the work breakdown structure is a "deliverable arranged reformist disintegration of the work to be executed by the endeavor gathering."

The going with figures shows that the WBS of the endeavor from Sub Structure to Finishing Works.Fig.5.4 Work Breakdown Structure of the project from Sub Structure to Finishing Works.

ASSIGNING CALENDAR

Every organisation has their own calendar which includes the list of regular holidays, special holidays and work timings. The calendar design depends on environment, location, festivals etc. For each project in an organisation, there is aseparate calendar. The Fig.5.4 shows the calendar of present project. 9 working hours per day is prepared based on the calendar.

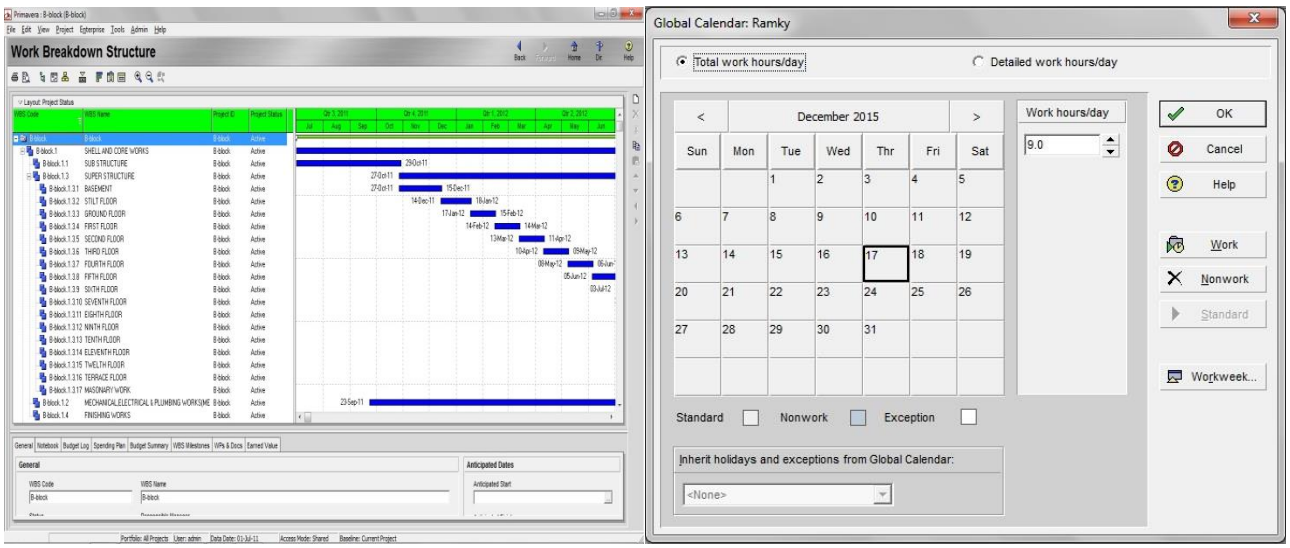

Fig.5.4 Calendar of the project

BASIC DETAILS OF SCHEDULING

For any scheduling, activities and sequencing are most important. So after creating the project, open the project and assign the responsible manager of the project, assign the calendar which is suitable for the particular project and work breakdown structure. Then activities should be listed as required WBS as shown in the Fig.6.1 through Fig.6.11. For the current project the responsible manager of the project is “Project Manager” calendar is “Ramky” calendar which is designed as per site conditions. WBS are “Shell And Core Works, Sub Structure, Super Structure, Basement, Stilt floor, Ground Floor, Fist Floor etc as shown in the Fig.5.4

In scheduling the general items are as follows

Activity ID : for every activity thereis an individual activity id for easyreorganisation.

Activity name : the name of the particular activity is shown.

Original Duration : it shows the duration of the activity to complete the work.

Start Date : it shows the start date of the activity.

End Date : it shows the end date of an activity.

On the right side of each figure, a chart showing the duration of each activity and the red colour bar indicates critical path work with no float and green colour bar indicates the remaining work which has float.

PHASE-1 SCHEDULING

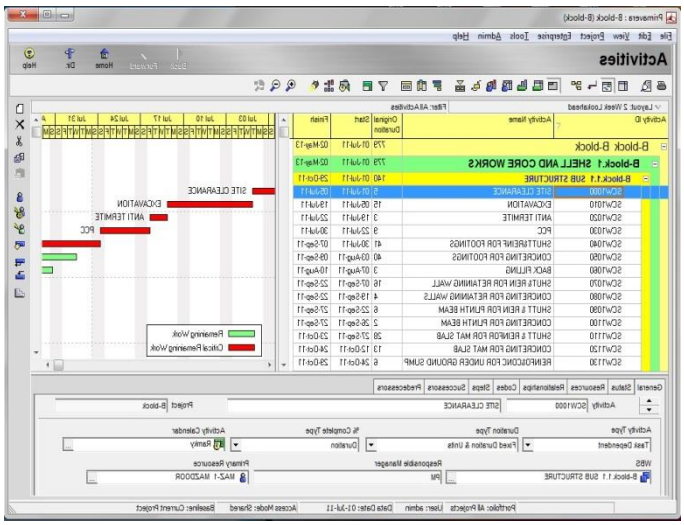

Fig.6.1 shows the schedule details of sub structure

In the Fig.6.1 Sub Structure works are shown i.e from site clearance to construction of footings of the building.

RESOURCE LEVELING

In current project the project was scheduled at the beginning without resource leveling. Resource leveling was made in primavera without effecting the total project duration by using float constrains.

The Fig.8.1 and Fig.8.2 shows the details of highest labour requirement without resource leveling in both normal method and precastmethod respectively.

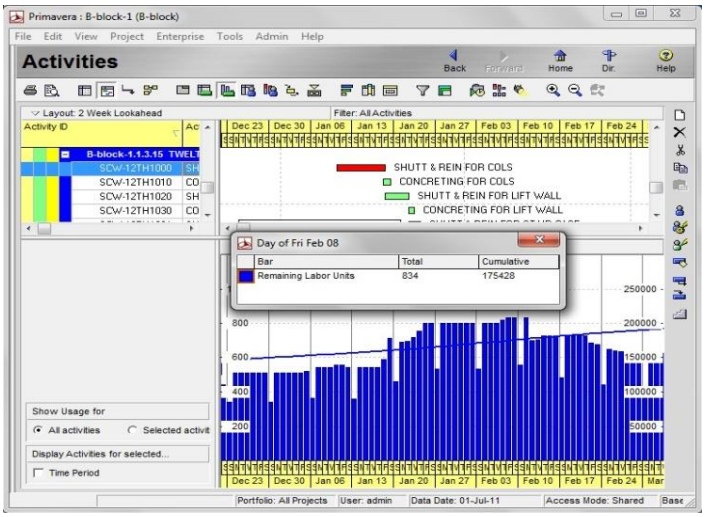

Fig.8.1 highest labour requirement in phase-1 without resource levelling

V. RESULTS AND DISCUSSIONS

GENERAL

Two phases of scheduling are prepared. One is by traditional method of casting (phase-1) and other is precast method of casting (phase-2). In both cases the variation of the manpower and schedule is observed.

EFFECT OF SCHEDULE

Table 9.1 Schedule comparison between phase-1& phase-2

Name	Start Date	End Date	Total Duration (days)
Phase-1 Schedule	1st June 2011	2nd May 2013	671
Phase-2 Schedule	1st June 2011	1st March 2013	609
	Total Variance		**62**

From the Table 9.1, the variation of scheduling in phase-1 and phase-2 is 62days.

S-Curve

A S Curve is described as "a feature of absolute costs, work hours or various sums plotted against time. The name gets from the S-like condition of the twist, praise around the beginning and end and more extraordinary in the middle, which is ordinary for by far most of the exercises. The beginning addresses a moderate, deliberate yet animating beginning, while the end addresses a deceleration as the work runs out.The S-curves of the men power in phase-1 is shown in Fig.9.1.

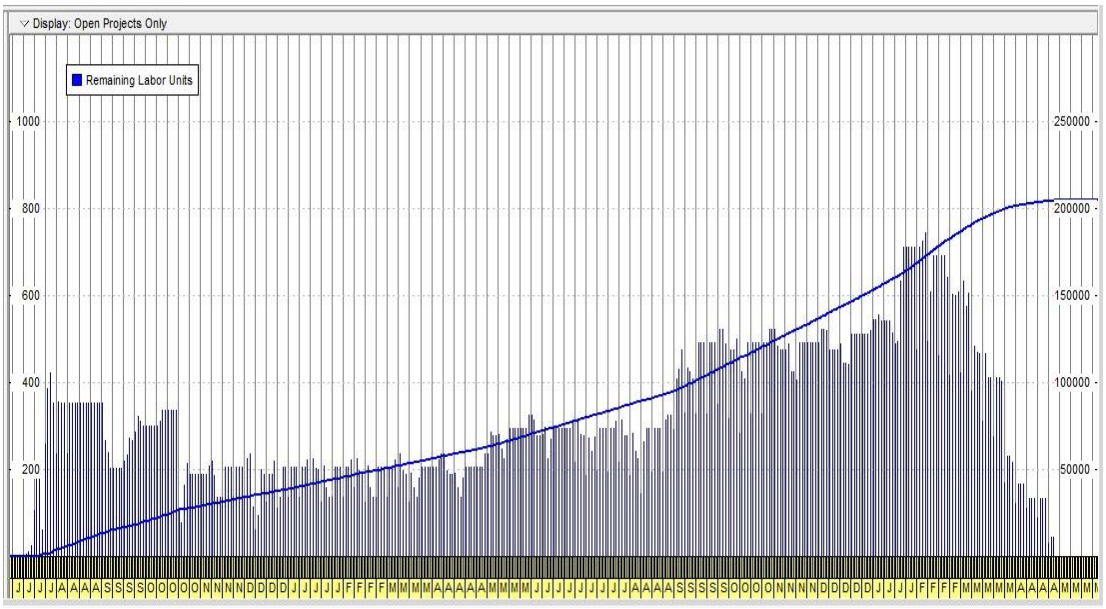

Fig.9.1S-curve for phase-1

The S-curves of the men power in phase-2 is shown in Fig.9.2.

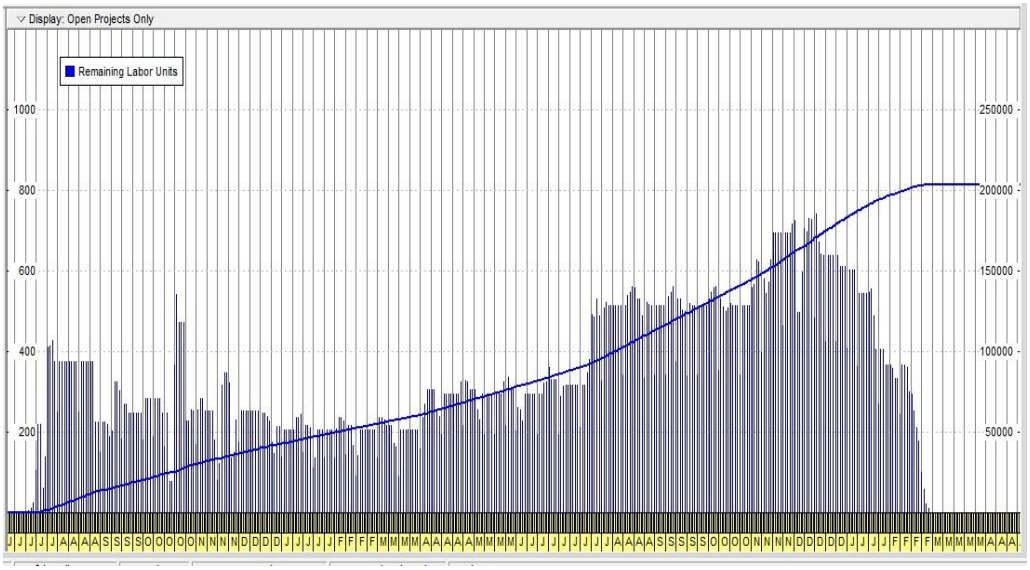

Fig.9.2 S-curve for phase-2

The total man power reduced by adopting the precast construction method is 1172 members.

RESOURCE LEVELING

Table 9.1 Schedule comparison between phase-1 and phase-2

Name of item	Without resource leveling	With resource leveling	% of variance
Normal scheduling	834	744	10.79
Precast scheduling	848	742	12.5

From the Table 9.2 in Phase-1 scheduling, the variation of highest labour requirement by leveling is 10.79%, i.e. 90 members are reduced. And in Phase-2 scheduling, the variation of highest labour requirement by leveling is 12.5 %, i.e, 106 members are reduced.

VI. CONCLUSIONS

From the above results of scheduling of phase-1 and phase-2 the following conclusions are drawn.

[1] The normal construction method scheduling requires 671 mandays, whereas precast method requires 609 mandayswhich shows a reduction of 62 mandays with about 9.23 % indicates precast method as more optimized for construction.

[2] The over-allocation of the labour resource is reduced by 10.79% of total labour required in phase-1 (normal construction method)by resource leveling.

[3] The over-allocation of the labourresource is reduced by 12.5% of total labourrequiredin phase-2 (precast method)by resource leveling.Hence more reduction in labour is observed for Precast method than normal construction method.

[4] The labour requirement is reduced by 1175 between both the methods of construction from S - Curve comparison after resource leveling.

[5] Hence precast method is more optimized and cost effective method than normal construction methodwith less mandays and manpower.

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