Project Planning, Scheduling and Costing- A Case Study on Highway Project

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***Abstract*— Construction projects become complicated and fragmented so that many special contractors are involved. The most important aspect of the contractor's duties on any project is the effective management of materials, labour, time and safety. The management of project time is depending more and more on scheduling software. In such change environment, a proper planning, scheduling and costing are necessary for projects. This paper focuses on proper planning, scheduling, costing and critiques problems through interviews with professionals, data collection, and literature review. It proposes a new planning, scheduling and costing method, using different software applying (MS Project 2010, MS Excel).**

Index Terms— **Planning, Scheduling, Costing, MS Project, MS Excel**

I. INTRODUCTION

GENERAL

Construction is the second largest economic activity next to agriculture in India. It creates large-scale employment, so which by itself is a significant contribution to the nation's economy. It is also a good vehicle for distribution of wealth, which means the significant proportion of the money spent in construction moves directly from rich to poor people. The construction industry accounts for 7-8% of the GDP of many countries. The value of 11th 5 year plan (2012-2017) estimated by committee on infrastructure, 220000 crores for the modernization and up gradation of highway construction activity in world. Unfortunately, due to the secretive nature of construction business, knowledge gained in planning, scheduling and controlling of cost in construction process is rarely disseminated. Consequently, the cost of inefficiency is being incurred as a recurring cost. More over in various businesses, the rate of business failure of construction is one of the highest. One of the reasons for this high rate of business failures is the lack of knowledge and its application in preliminary state of construction management.

Construction industry is generally much fragment. It is here where proper management comes into picture. If proper management of work is done, the company could save from making loss. In construction industry there was a time when all project were labour intensive and management in those days meant proper utilization of labour to make optimum progress in construction in the most economical manner. But now-a-days technological advancement and scientific inventions have added in new dimensions to the construction industry. A project is now consider as a group of activity, having inter-relations, which may include the role of specialists and specialized work using latest knowledge, equipment and skill available, to be under taken in most systematic manner. The "most systematic manner" involves adaptation of techniques commonly known as Critical path method (CPM) or Program evaluation and review techniques (PERT) are being applied for the management of project. The use of plant, machinery and expert workers has improved the quality of construction and reduces the time for construction. The application of this construction management technique, the use of plants, machinery, specialized workers, finding alternative solutions and selecting the best possible solution with the aid of computer, have made the whole process so scientific that it is now difficult to think of going for large construction activities without these exercises.

Planning, Scheduling and costing are important part of the project. If we planned proper then we assures that project will completed within time and budget. This paper provides a proper method for planning, scheduling and Recourse utilization in construction projects and an application of activity-based computerized (MS Project and M S Excel) planning, scheduling. It is followed a study to exemplify the new method. The study is confined to the perspective of a general contractor.

PROJECT PLANNING

Planning is the very important technique of construction management. It is the process of formulating of time as a constraint factor and inter link the various activities, all types of resources to achieve specified project objectives. In simple words, it is a process of developing whole project plan. The project plan shows how the project is to be directed to achieve the assigned goals. It specified a pre-determined and a committed future course of action, based on discussions and decisions made on the available knowledge of future trends.

REQUEREMENTS OF PROJECT PLAN

- Estimation
- Resources Planning (men, material, machinery, money)
- organization
- time table of completion of the whole project
- budgeting of the project

PROJECT SCHEDULING

This phase follows the planning phase and concerns with time estimates of individual activities and the project as a whole. These time estimates represent normal duration, which would be expected to result if work was done at lowest direct cost for the activities. No unexpected delays or contingencies like fire, floods, strikes etc. are considered while making these estimates. The next step is to assign the activity times to the network and make computations for earliest and latest start and finish times of each activity. The earliest completion time of the last activity of the network gives the shortest completion time for the whole project. This time can be identified as the longest path of activities through the network from its start node to its finish node. This path is called critical path, and timely completion of project depends upon the timely completion each of the activities lying on this path. These activities are called as critical activities. An identification of critical activities helps management to pay due attention to the timely completion of these activities so that the project is completed in time.

PROJECT COSTING

There are two categories of project cost estimates: project planning cost estimates and project design cost estimates. Project planning cost estimates are used for project justification, programming, analysis of alternatives, and approval. Project design cost estimates are used to summarize the cost of a project's contract items of work and are used for the bid item list in the construction contract documents. Most of the government works are in BOQ Type of contract work for that rate will be fixed for each items using SR book rate of particular regain it include both planning and designing cost estimate.

II. REVIEW OF LITERATURE

MANY AUTHORS HAVE CONCENTRATED THEIR WORK ON AN OPTIMUM ALLOCATION OF RESOURCES FOR CONSTRUCTION WORKS, AND IMPORTANCE DEALT DETAIL.

- A work done by three authors viz., Mr. Jonathan A. N. Booth, Research student Mr. William H. askew, lecturer Dr. Michael J.Mawdesley, Lecturer University of Nottigham Department of Civil Engineering University park Nottingham NG7 2RD united kingdom (1991-92), introduces techniques for planning and control, and which concentrates on recommending appropriate practice for the practical problems which readers may come across when using both computerized planning methods. They discuss the whole of planning and control cycle as a function of Construction management. [1]
- Another classical work by Faniran O Fanirran, Peter E. D. Love and Heng Li (1999), suggested that optimum allocation of resources for construction jobs have not been taken seriously till now, they have also given some case studies where they had shown how resources are not used un optimal way. They have also shown in their work that if resourses are wasted, then in one day we will have to pay more to acquire the same thing. The importance of proper resource scheduling and proper implementation of it in actual construction is given prime importance. [2]
- Prof. Hera N ahuja and Mr.Mir Saif – uddin both faculties of engineering and applied science memorial university of new found land, St:Johns , Canada, has discussed about the role of computers in construction management and it various uses in different fields of civil engineering. They also illustrate how microcomputers have made an impact on computation work in civil engineering. [3]
- Another study done by Sanjay Bhayar, Dr. Dhanajay k. Parbat, International Journal of Emerging technology and Advanced Engineering (2014), a concept of optimum crew for each activity and its costing techniques were researched. Using different simulation techniques, they were able to find out a best crew for an activity and to see that the cost within the range. The entire study was done using algorithm and flow chart techniques. [4]
- In other study done Babatunde Omoniyi Odedairo, Oluwabununmi .A. Ogunsanya, berkly Ogagaoghene Anaro (2014), the need to reduce duration and minimize total while preserving the quality of the project cost in road construction project. The need to get the optimum number of segments a road project should be divided into and work to be carried out simultaneously using optimum crew sizes working at their natural rhythms is established. [5]

III. CASE STUDY

The selected site for case study is located in Padubidri to Karkala. The highway consisting of 27.8Km, Construction of work include, scarification, CD Works, protective work, embankment, sub grade (SG), granular sub base(GSB), wet mix macadam base course(WMM), dense bituminous macadam, bituminous mix surface or carpet (BC), emulsion spry, side drain, sidewalks, road marking & road furniture, traffic management & ENV protection measures.

Table 1 Project Details

Clint Name	KSHIP Karnataka
Consultant Name	SMEC Infrastructure Pty Ltd. Australia
Contractor Name	RNS infrastructure Ltd.
Duration of the project	18 Month
Total cost of the project	61.48 crore

As per the contract document the work should be completed in 18 month and within in the budgeted cost. For that a proper planning, scheduling is required and it is prepared using MS Project and MS Excel.

MAJOR MATIERAL QUANTITY

The major material quantity required for the project as per the BOQ is shown in below table

Table 2 major quantities

MATIREALS	QUANTITY
Aggregate	475678 MT
Sand	9133 MT
Cement	4064 MT
Bitumen	3117 MT
Admixture	29430 Kg
Emulsion	357761Kg
Steel	428 MT

PLANNING OF MATERIAL FOR THE PROJECT

Planning of materials for the project is done in MS Excel. As per the contract, the duration of the project is 18 month. So we should plan the material in a such a way that it should be available while execution.

Table 3 material statement

MATERIAL REQUIREMENT

Item Description	Constants	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
GSB										3000	11473	13240	13240	13240	13240	13240				3326
Aggregate	5% wastage with 2.115 MT									6662	25479	29403	29403	29403	29403	29403	0	0	0	7386
WMM										2500	13934	13934	13934	13934	13934	13934				3897
Aggregate	5% wastage with 2.20 MT									5775	32188	32188	32188	32188	32188	32188	0	0	0	9002
DBM											2691	2956	2956	2956	2956	2956				2480
Aggregate	5% wastage with 2.195 MT										6203	6813	6813	6813	6813	6813				5716
Bitumin	2% wastage with 0.105 MT										288	317	317	317	317	317	0	0	0	266
SDBC											1127	1238	1238	1238	1238	1238				1038
Aggregate	5% wastage with 2.30 MT										2721	2989	2989	2989	2989	2989	0	0	0	2507
Bitumin	2% wastage with 0.115 MT										132	145	145	145	145	145	0	0	0	122
CONCRETE ITEMS																				
M15 CC foundation									8	50	173	173	184	184	184	184	84	67	39	15
M15 CC foundation Bridge									0	0	0	4	8	7	0	0	0	0	0	0
M15 CC Levelling									8	51	174	174	186	186	186	186	85	68	40	15
Total									16	101	347	351	378	377	370	370	169	135	79	30
Aggregate	5%wastage with 1.294 MT								22	137	471	477	514	512	503	503	230	183	107	41
Sand	5% wastage with 0.680 MT								12	72	248	251	270	269	264	264	121	96	56	22
Cement	2% wastage with 0.27 MT								4	28	96	97	104	104	102	102	47	37	22	8

Total quantities of materials to be utilized in site for the duration of 18 month project, the requirements of material for each task have break down into monthly vise as shown in the above table.

PLANTS AND MACHINERIES

Plants and machinery chosen as per the output/capacity, from this we observed that how much machinery required for the completion of the project in estimated time.

Table 4 Machinery statement

MACHINERY AND EQUIPMENT REQUIRED MONTHWISE AS PER THEIR CAPACITY/OUTPUT

Item Of Work	Equipment Description	Output /Hrs	Unit	Monthly Output	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep
Clearing & Grubbing				40.00	2.00	3.00	4.00	5.00	5.00	5.00	4.00	4.00	4.00	3.00	1.00	0.00
	Dozer	0.13	Ha	39.00	1	1	1	1	1	1	1	1	1	1	1	1
	Loader	0.08	Ha	26.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Tipper 10MT	0.01	Ha	4.16	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00
Excavation for raodwork & structure				396843.00	14173.00	55998.00	55998.00	55998.00	55998.00	55998.00	55998.00	55998.00				
	Excavator 200	100.00	cum	33600.00	1.00	2	2	2	2	2	2	2				
	Tipper 20MT	35.00	cum	10920.00	2	6.00	6	6	6	6	6	6				
Embankment and Subgrade shoulder				434403.00	15510.00	50962.00	50962.00	62595.00	62595.00	62595.00	62595.00	62595.00	0.00	0.00	0.00	3994.00
	Excavator 220/300 h	125.00	cum	42000.00	1.00	2.00	2.00	2.0	2.00	2.00	2.00	2.000	0	0	0	1
	Tipper 20mt	30.00	cum	10080.00	2	6	6	7	7	7	7	7	0	0	0	1
	GRADER	200.00	cum	67200.00	0	1	1	1	1	1	1	1	0	0	0	1
	VIBRATORY ROLLER	150.00	cum	50400.00	1	2	2	2	2	2	2	2	0	0	0	1
	WATER TANKER	100.00	cum	33600.00	1	2	2	2	2	2	2	2	0	0	0	1
Granular Sub Base				83999.00	0.00	3000.00	11473.00	13240.00	13240.00	13240.00	13240.00	13240.00	0.00	0.00	0.00	3326.00
	Loader 1.5 cum	75.00	cum	15600.00	0	1.00	1	1.00	1.0	1.0	1.0	1	0	0	0	1
	Tipper 20 Mton	10.00	cum	2080.00	0	2	6	7	7	7	7	7	0	0	0	2
	GRADER	100.00	cum	20800.00	0	1	1	1	1	1	1	1	0	0	0	1
	VIBRATORY ROLLER	75.00	cum	15600.00	0	1	1	1	1	1	1	1	0	0	0	1
	WATER TANKER	75.00	cum	15600.00	0	1	1	1	1	1	1	1	0	0	0	1
Wet Mix Macadam+ WBM				90001.00	0.00	2500.00	13934.00	13934.00	13934.00	13934.00	13934.00	13934.00	0.00	0.00	0.00	3897.00
	Loader 1.5 cum	75.00	cum	15600.00	0	1	1	1	1	1	1	1	0	0	0	1

Table 5 plants statement

Sl No	Description	Item	Unit	Peak Requirement/Month	No of Days	Peak Requirement Per Day	Plant Capacity	Effecive Productivity (75%)	Considering plant run in	Productivity/day	Remarks
1	Aggregate Crushing Plant (250TPH)	Premix, GSB,WMM ,Concrete	Mton	72626.4	25	2905	250	187.5	12	2250	stock pile of Aggregate in ealrly period of the project, Hence (250 TPH *01) Plant is sufficient
2	Hot Mix Plant 140 TPH*01 no	Premix	Mton	4194* 2.4 =10066	22	457.55	140	105	8	840	Hence 140 TPH *01 no Plant is sufficient
3	WMM Plant 200TPH * 01 no	WMM	Mton	30654.8	26	1179	200	150	8	1200	Hence 200TPH * 01 no Plant is sufficient
4	Concrete Batching Plant 1)1 cum/Hr *4 No and 2) 4 cum/hr* 01 no Transit Mixer self Batching	Concrete	Cum	1644	30	54.8	8	6.00	9	54	Hence 1 cum/hr X 4 no & 4cum/hr Transit Mixer Self loading Plants are sufficient

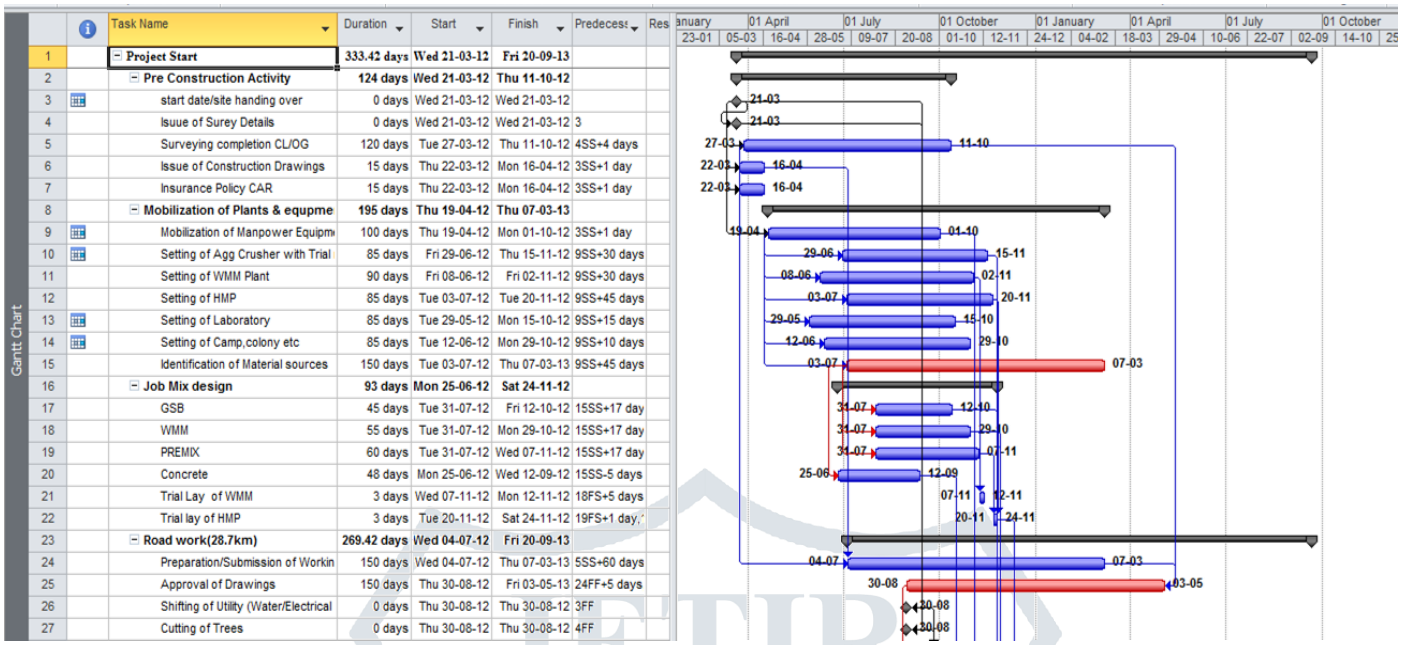
Peak Agg Requirement / Mon	Item	Qty	Agg Req				
	GSB	13240	13240				
	WMM	13934	13934				
	PREMIX	4194	4194				
	Concrete	1644	1644				
		G.Total	33012	x 2.2 =	72626.4	MT	

Total number of plants and machinery required for the project is depending on time constraint to finish the project, quantity of works in the project and output/capacity of the machineries as shown in the above table.

SCHEDULING OF THE PROJECT

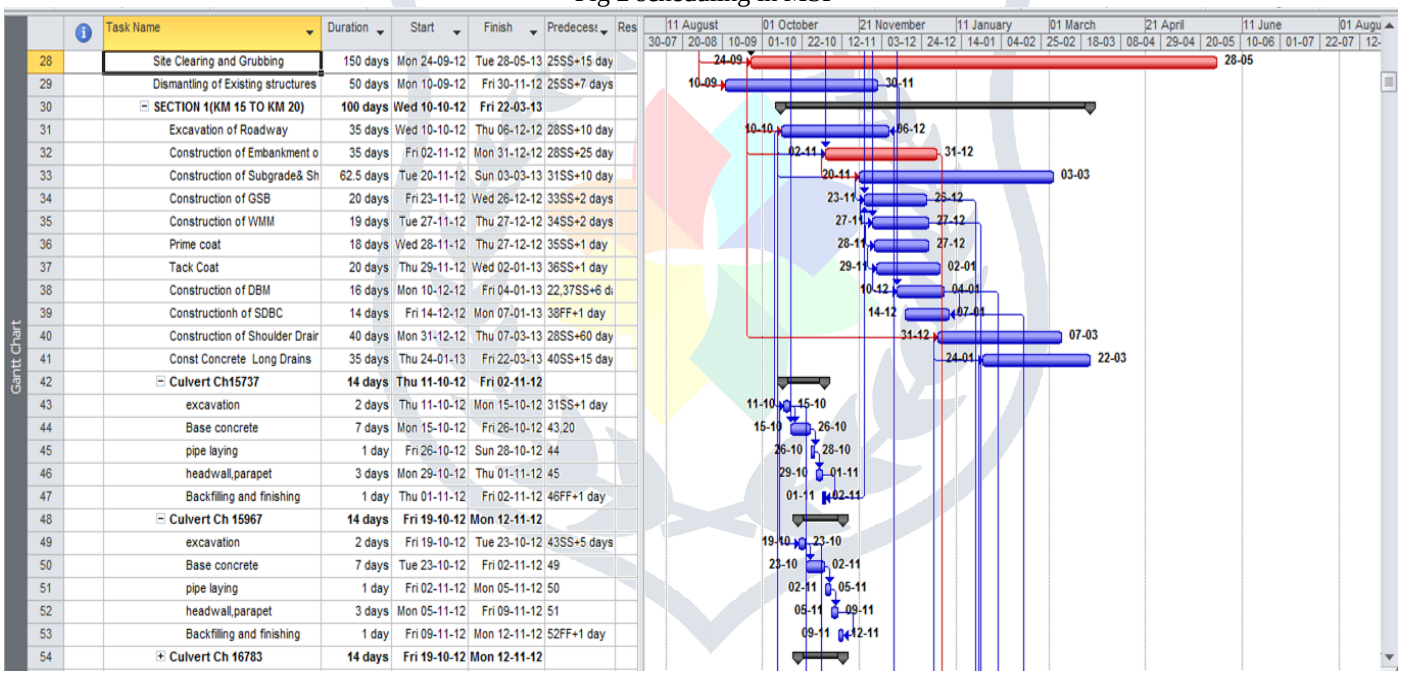
Scheduling of the project is done by using MS Project-2010 software. time is consider as a constraint because as per the contract document project will be completed within 18 month, For that planning and scheduling are done.

Fig 1 scheduling in MSP



	Task Name	Duration	Start	Finish	Predecess	Res
1	Project Start	333.42 days	Wed 21-03-12	Fri 20-09-13		
2	Pre Construction Activity	124 days	Wed 21-03-12	Thu 11-10-12		
3	start date/site handing over	0 days	Wed 21-03-12	Wed 21-03-12		
4	Isuue of Surey Details	0 days	Wed 21-03-12	Wed 21-03-12	3	
5	Surveying completion CL/OG	120 days	Tue 27-03-12	Thu 11-10-12	4SS+4 days	
6	Issue of Construction Drawings	15 days	Thu 22-03-12	Mon 16-04-12	3SS+1 day	
7	Insurance Policy CAR	15 days	Thu 22-03-12	Mon 16-04-12	3SS+1 day	
8	Mobilization of Plants & equpme	195 days	Thu 19-04-12	Thu 07-03-13		
9	Mobilization of Manpower Equipm	100 days	Thu 19-04-12	Mon 01-10-12	3SS+1 day	
10	Setting of Agg Crusher with Trial	85 days	Fri 29-06-12	Thu 15-11-12	9SS+30 days	
11	Setting of WMM Plant	90 days	Fri 08-06-12	Fri 02-11-12	9SS+30 days	
12	Setting of HMP	85 days	Tue 03-07-12	Tue 20-11-12	9SS+45 days	
13	Setting of Laboratory	85 days	Tue 29-05-12	Mon 15-10-12	9SS+15 days	
14	Setting of Camp,colony etc	85 days	Tue 12-06-12	Mon 29-10-12	9SS+10 days	
15	Identification of Material sources	150 days	Tue 03-07-12	Thu 07-03-13	9SS+45 days	
16	Job Mix design	93 days	Mon 25-06-12	Sat 24-11-12		
17	GSB	45 days	Tue 31-07-12	Fri 12-10-12	15SS+17 day	
18	WMM	55 days	Tue 31-07-12	Mon 29-10-12	15SS+17 day	
19	PREMIX	60 days	Tue 31-07-12	Wed 07-11-12	15SS+17 day	
20	Concrete	48 days	Mon 25-06-12	Wed 12-09-12	15SS-5 days	
21	Trial Lay of WMM	3 days	Wed 07-11-12	Mon 12-11-12	18FS+5 days	
22	Trial lay of HMP	3 days	Tue 20-11-12	Sat 24-11-12	19FS+1 day,	
23	Road work(28.7km)	269.42 days	Wed 04-07-12	Fri 20-09-13		
24	Preparation/Submission of Workin	150 days	Wed 04-07-12	Thu 07-03-13	5SS+60 days	
25	Approval of Drawings	150 days	Thu 30-08-12	Fri 03-05-13	24FF+5 days	
26	Shifting of Utility (Water/Electrical	0 days	Thu 30-08-12	Thu 30-08-12	3FF	
27	Cutting of Trees	0 days	Thu 30-08-12	Thu 30-08-12	4FF	

Fig 2 scheduling in MSP



	Task Name	Duration	Start	Finish	Predecess	Res
28	Site Clearing and Grubbing	150 days	Mon 24-09-12	Tue 28-05-13	25SS+15 day	
29	Dismantling of Existing structures	50 days	Mon 10-09-12	Fri 30-11-12	25SS+7 days	
30	SECTION 1(KM 15 TO KM 20)	100 days	Wed 10-10-12	Fri 22-03-13		
31	Excavation of Roadway	35 days	Wed 10-10-12	Thu 06-12-12	28SS+10 day	
32	Construction of Embankment o	35 days	Fri 02-11-12	Mon 31-12-12	28SS+25 day	
33	Construction of Subgrade& Sh	62.5 days	Tue 20-11-12	Sun 03-03-13	31SS+10 day	
34	Construction of GSB	20 days	Fri 23-11-12	Wed 26-12-12	33SS+2 days	
35	Construction of WMM	19 days	Tue 27-11-12	Thu 27-12-12	34SS+2 days	
36	Prime coat	18 days	Wed 28-11-12	Thu 27-12-12	35SS+1 day	
37	Tack Coat	20 days	Thu 29-11-12	Wed 02-01-13	36SS+1 day	
38	Construction of DBM	16 days	Mon 10-12-12	Fri 04-01-13	22,37SS+6 d	
39	Constructionh of SDBC	14 days	Fri 14-12-12	Mon 07-01-13	38FF+1 day	
40	Construction of Shoulder Drair	40 days	Mon 31-12-12	Thu 07-03-13	28SS+60 day	
41	Const Concrete Long Drains	35 days	Thu 24-01-13	Fri 22-03-13	40SS+15 day	
42	Culvert Ch15737	14 days	Thu 11-10-12	Fri 02-11-12		
43	excavation	2 days	Thu 11-10-12	Mon 15-10-12	31SS+1 day	
44	Base concrete	7 days	Mon 15-10-12	Fri 26-10-12	43,20	
45	pipe laying	1 day	Fri 26-10-12	Sun 28-10-12	44	
46	headwall,parapet	3 days	Mon 29-10-12	Thu 01-11-12	45	
47	Backfilling and finishing	1 day	Thu 01-11-12	Fri 02-11-12	46FF+1 day	
48	Culvert Ch 15967	14 days	Fri 19-10-12	Mon 12-11-12		
49	excavation	2 days	Fri 19-10-12	Tue 23-10-12	43SS+5 days	
50	Base concrete	7 days	Tue 23-10-12	Fri 02-11-12	49	
51	pipe laying	1 day	Fri 02-11-12	Mon 05-11-12	50	
52	headwall,parapet	3 days	Mon 05-11-12	Fri 09-11-12	51	
53	Backfilling and finishing	1 day	Fri 09-11-12	Mon 12-11-12	52FF+1 day	
54	Culvert Ch 16783	14 days	Fri 19-10-12	Mon 12-11-12		

Scheduling of the project is done in MSP and it gives the maximum duration of the project to complete with the help of the critical activities involved the project. And gives the completion date.

CASH FLOW OF THE PROJECT

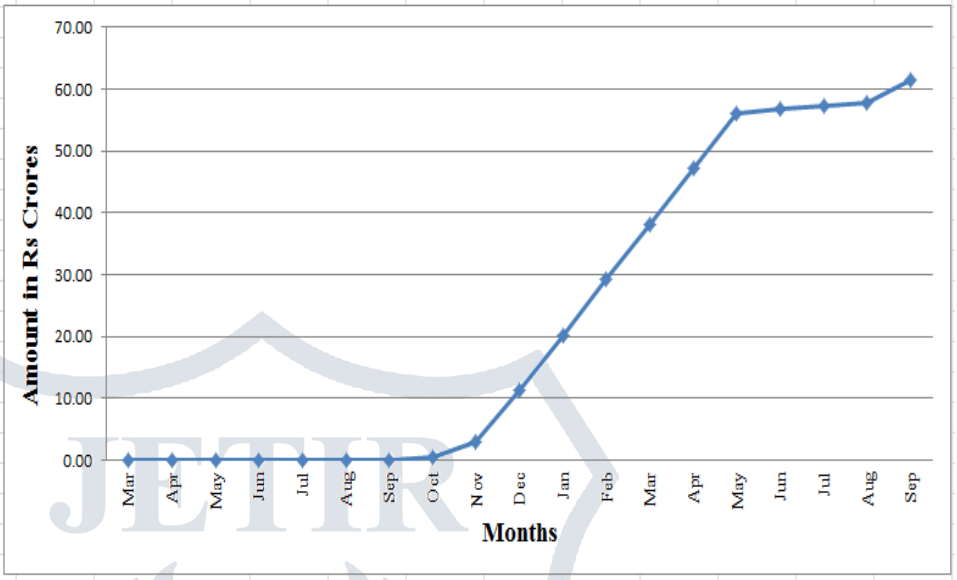
Following table shows the cash flow of the project.

Fig 3 S-Curve of the project

FINANCIAL CASH FLOW AND S-CURVE

Amount in Rs

Month	Monthly Casfolw	Cumulative Casfolw	Cumulative Casfolw Cr
Mar	0	0	0.00
Apr	0	0	0.00
May	0	0	0.00
Jun	0	0	0.00
Jul		0	0.00
Aug		0	0.00
Sep		0	0.00
Oct	61,02,568	61,02,568	0.61
Nov	238,24,153	299,26,721	2.99
Dec	829,00,403	1128,27,124	11.28
Jan	890,21,652	2018,48,776	20.18
Feb	897,85,557	2916,34,333	29.16
Mar	897,85,557	3814,19,891	38.14
Apr	902,85,557	4717,05,448	47.17
May	897,85,557	5614,91,005	56.15
Jun	67,22,299	5682,13,304	56.82
Jul	53,88,197	5736,01,501	57.36
Aug	31,23,668	5767,25,169	57.67
Sep	374,58,307	6141,83,476	61.42
Total	6141,83,476		



If the project goes as per the plan and schedule then the project is completed within the time and cost. The above S-curve shows the stability of the project.

IV. CONCLUSION

- It is very important to divide the project into segments so that we can allocate the crew in optimal manner.
- Planning, Scheduling and Resource allocation is taken as mission because many companies don't follow a proper plan and schedule, so that they face difficulty during execution of project. Due to improper management they are not able to complete the work with available time and cost. These were certain key factors which made to choose this planning, scheduling and resource allocation as the mission.
- This study mainly focuses on the planning, scheduling, costing and resource allocation using MS Project and MS Excel.
- The classifications of plants and machineries, manpower done according to their output/capacity of the plants and machineries.
- The study has provided immense knowledge in planning and scheduling of the mass project and what are all required for the preparation of schedule with using of software and also give knowledge about the resource planning. More than all, the project has created immense interest and confidence in taking up such projects.
- To conclude, if a mega projects is not planned, schedule and updated properly, the amount of money wasted would be enormous so at least in the future one hope that proper planning will take place in all departments of the company. Due to poor Planning, Scheduling and recourse allocation, construction organizations are finding it difficult to use available resources. The result of poor construction management means that money and recourses are wasted. These two important resource hold the key to successful completion of the project in time, hence due importance should be given.

V. ACKNOWLEDGMENT

I would like to express my sincere gratitude to RNS Infrastructure Ltd. for giving me an opportunity to take up my project at their site and for providing me all the required details about the project.

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