ERECTION OF COFFERDAM TO DEFEND COLLECTOR WELL CONSTRUCTION—A CASE STUDY

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***Abstract*- This paper aims to assess the variation of progress flow in existing schedule of work and cost variation due to work delays in the execution of project and suggest the possible solutions to overcome them. An ongoing project in Tiruchirappalli district, a new drinking water scheme project includes a construction of collector well in Cauvery River which was posing a problem due to uncertain water flow in river not only but also in post monsoon season it is highly difficult to predict the flow in Cauvery river. This paper focuses on implementing a construction of cofferdam which would be optimum solution to overcome this hinders in construction of collector well. A quantitative research model is undertaken to find the work delays and cost. A case study was carried out in order to identify the favorable geological conditions for the collector well to select a suitable type of cofferdam. It also narrates the intricacy of the conventional work which lacks in management skills. The results proved that the constructing a cofferdam had improvements over traditional methods in terms of cost and progress flow. The results from these studies were compared with the existing project cost and progress flow to show the variance, since the estimation and also schedule were prepared to know the variance.**

Keywords : Coffer Dam, Collector Well. Construction Industry, Lack of Management, Variation of Progress Flow, Work Delays.

I. INTRODUCTION

In India, the Tiruchirappalli City Corporation has decided to execute a new drinking water scheme for the five new wards that have been added to it recently. The wards 61 to 65 are spread over Tiruverumbur Town Panchayat, and Pappakurichi, Ellakudi, KeezhaKalkandarkottai and Alathurpanchayats, all in the eastern suburbs of the city, and are merged with the corporation following delimitation. As per the norms of Central Public Health and Environmental Engineering Organization, the per capita water supply to the residents has been increased to 135 liters a day. At present, residents are getting about 70 to 100 liters a day, but the supply is said to be unequal [6] [14].

So, the corporation proposed to create a new water scheme project in Tiruchirappalli city. The Tiruchirappalli City Corporation hired a consultant not only to design and prepare detailed project estimates but also to look after the proposed new drinking water scheme for the five wards. The work "Construction of Collector well, Pipe Carrying Bridge, Control Room, Transformer Yard and Supply and Erection of Pump sets, Transformer etc. at Head Works for added areas covering wards 61 to 65" was awarded to contract, which was started in the month of July in 2016[12].

The river bed of Cauvery is filled with medium coarse sand which is highly pervious, and there will be no work on the construction of collector well unless the working area is rendered as dry. Due to unforeseen river flow, the construction of collector well will get delayed by 10 months approximately.

Moreover, in the monsoon period, the excavation for collector well was not possible due to the flow of water. The objective of this paper was to provide a watertight temporary structure during the construction of collector well which can divert and defend the unforeseen discharges of river surface water flow away from the working area. While implementing this structure, the cost should be contemplated so it would result in progress flow.

So, the best and most economical solution to achieve this objective was contrived as cofferdam construction which can handle the hydrology of this river during the construction as well as during the flood.

II. COFFER DAM

Cofferdams are basically retaining structures formed in a river in order to obtain a firm and create dry work areas below the water level for construction. Cofferdams are always temporary enclosures which are designed to support the ground, and the water is pumped out to enable dry work area for the construction to be carried out.

III. TYPES OF COFFER DAM

The selection of any type of cofferdam depends on the factors as below [9].

a. The velocity of water flow in river way

b. Type of soil
c. Water depth
d. Size and depth of excavation required
e. Accessibility of transport to the site

Generally, the selection of any type of cofferdam is based on the soil conditions and careful study of statistics of the flow and hydrographs of the river way

In the selection of types, the foundation of the subsoil conditions is the major factor [1] [10].

a. Generally, single-wall timber piling would be used in the deposit of soft clay soil. Use of timber for long periods in water is not recommended.
b. For low heads of water or slow moving water, Earth fill cofferdam is recommended. Sometimes, sand bags are also adopted on either side of single-sheet pile cofferdam.
c. Steel sheet coffer dams are used in alluvial reached in order to divert works on river valley project, and it is suitable for narrow excavation. Double-wall cofferdams or cellular sheet piling is suitable for wide excavations, but it requires cross-bracings to support them.
d. Rock- or earth-filled timber cribs would be suitable for a remote suite in undeveloped areas where heavy timber in log form is available and the cost of construction of the other types of cofferdams is relatively high.

IV. CASE STUDY

The geological survey of this water scheme project in the construction of collector well had been carried out elaborate geological studies at the site. . The data of this thesis were collected via descriptive, explanatory and quantitative methods. The descriptive methods consisted of collecting information about the current situation on the construction field. The quantitative works are carried out by gathering information from field or site through engineers, supervisor and managers [12].

The project area is dominated mostly by sandy soil and silt clay.The permeability rate varies from very high to medium, depending upon the soil texture. It was reported that the over-exploitation of ground water caused heavy decline in water level in the Trichy City corporation.

It has been indicated that the site is located in northern side of Cauvery River at Kambarasampettai 1500 m upstream of Kambarasampettai Head works and 2000 m downstream of Collector well No.1 of CWSS to Ramanathapuram. The intake structure of well, foot bridge and transformer site have been designed as a framed column structure abetting the south side of the river with a closed-wall structure to reduce the obstruction of water flow in the river. It will have negligible impact on the river flow characteristics, since the width of the river at the location is 1.10 km.

Moreover, the exact location of collector well was approximately 500m down from the average river bed level, and it was surrounded by water as shown in Figure 1[12].

Fig 1. Location of Collector Well

It may be observed that during pre-construction stages, to determine the detailed design parameters, is observed through boreholes work that the location was occupied by average of 3m depth of sand,6 m depth of black & red clay soil , 2m depth of coarse sand,3m depth of fine sand and the bore was stopped at the 20m depth of pebbles as shown in Table.1 and Figures 2 and 3.

Table 01. Classification Soil for Bore Hole Samples

Confirmatory Bore No : 34		
Date : 28.07.2016		
Depth	Soil Classification	Sample No.
0 – 2	Sand	1
2 – 6	Black clay	2
6 – 8	Red clay	3
8 – 12	Medium sand	4
12 – 14.75	Coare sand	5
14.75- 15	Sukka	6
	Bore terminated at 18m depth	

Confirmatory Bore No : 61		
Date : 27.08.2016		
Depth in Metre	Soil Classification	Sample No.
0 – 3	Sand	1
3 – 6	Brown clay	2
6 – 9	Red clay	3
9 – 10	Sukka	4
10 – 12	Red lay with sand	5
12 - 17	Coarse sand	6
17 -19.9	Coarse sand with big size pebble	7

Bore terminated at 19.9m depth

Confirmatory Bore No : 63		
Date : 30.08.2016		
Depth in Metre	Soil Classification	Sample No.
0 – 3	Sand	1
3 – 4	Black clay	2
4 – 5	Brown clay	3
5 – 6	Sukka	4
6 – 8	Red clay	5
8 - 9	Sandy clay	6
9 -12	Coarse Sand	7
12 – 14	Medium Sand	8
14 – 19.15	Coarse Sand with Pebbles	9

Bore terminated at 19.15 m depth

Confirmatory Bore No : 62		
Date : 29.08.2016		
Depth in Metre	Soil Classification	Sample No.
0 – 3	Sand	1
3 – 6	Brown clay	2
6 – 9	Red clay	3
9 – 10	Sandy Clay	4
10 – 12	Sand	5
12 - 14	Fine Sand	6
17 -19.9	Coarse Sand with Big Size Pebble	7

Bore Terminated at 19.9 m depth

Fig 2 Location of Bore Hole

(a)

(b) (c)

Fig 3 (a) Bore Hole work (b) and (c) Soil Samples

As per IS9795 (part 1) – 1981, it is recommended to use sheet steel pile because of the presence of alluvial soil [7].

A. COST OVERRUN

The actual cost of the project for construction of collector well is Rs.12,99,97,012.55 INR.The intended completion date for the whole of the Works is 24 months from the start date with the following milestones as shown in Table 2.

Table 2: Work Breakdown Structure

Sl. No.	Description of work	Mile Stone I (8 months)	Mile Stone II (16 months)	Mile Stone III (23 months)	Mile Stone IV (24 months)
1.	Construction of Collector well with radial arms	40% Civil works	80% Civil works	100% All works	
2.	Construction of pump house over collector well	-	40% Civil works	100% All works	
3.	Construction of Control panel room	30% Civil works	70% Civil works	100% Civil & Electrical works	
4	Construction of Foot bridge	-	70% Civil works	100% Civil works	
5.	Supply, delivery, erection, testing and commissioning of turbine pump sets	-	-	100% Civil & Electrical works	
6	Supply, delivery erection testing and commissioning of transformers including construction of transformer yard.	-	30%	100% Civil & Electrical works	
7.	Testing, Commissioning & Trial run	-	-	-	100%

But, as per the current site condition, this project would get delayed by 10 months. So, as per CPWD and contract agreement, the total project cost would be RS. 14,96,88,112.55 including the liquidate damage and delay cost which was Rs. 1,96,91,100.00.

The above situations caused the contractor and client a permanent diminution in value. To overcome this problem , as I stated earlier, constructing a watertight temporary structure would defend the collector well from river flow and also compensate for the loss and delay. An estimate of cofferdam to check whether it would be an economical solution is shown in Table 3[11] [13].

Table 3:Quantity for Construction Coffer dam

Sl No	Description	Nos.	Length	Breadth	Depth	Quantity
1	Earthwork excavation in sandy soil, other loose soil, etc., with an initial lead of 10m and lift of 2m. Etc complete for forming the cofferdam around the collector well.					
	southeastern side of well for forming Coffer dam	1 x 1	40.00	30.00	0.85	1020.00 m^3
2	Filling of sand inside the Cofferdam and consolidation etc. complete with required 2m depth from bed level					
	Around the collector well	1 x 1	24.00	24.00	2.00	1152.00 m^3
	Deduction collector well portion	1*∏/4	8.70	8.70	-2.00	-118.89 m^3
						1033.11 m^3

3	Driving M S Sheet pile PSA23/HS type400mm wide 10mm thick interlocking type and 4m long into the river bed 2.00m depth, etc.	1 x 4	24.00		6.00	576.00 m^2
4	Supply of M S Sheet pile ISPS2322 Z-type400mm wide 10mm thick interlocking type and 8m long including transporting charges etc. (assume the sheet pile can be used for 4 uses) For overlapping the sheet at edge row 10cm each side etc. Total Weight (1984 m x 0.4 m x 0.01m x 7850 kg/m^3)	1 x 4 x 60 1 x 4 x 2			8.00 8.00	1920.00 m 32.00 m 1984.00 m 62298 KG
5	Provisionfor Electrification arrangements with 2nos of tube light and 3 nos of 3pin plug and external HDV Lamp arrangements and EB wiring works etc complete					1 No.

Notes :

As per IS 2314 – 1986 specification for steel sheet piling sections, Z-type sheet pile were chosen according to the soil and site conditions.
Even the measurements and weights are taken as per IS 2314-1986

As per CPWD Rates, the cost for construction of cofferdam comes around Rs.8,69,165.80. So, if they were try to implement this solution to defend the water flow and also if the project goes without any obstacles, then it would be economical when compared to the procrastinated cost as shown in Figure 5.

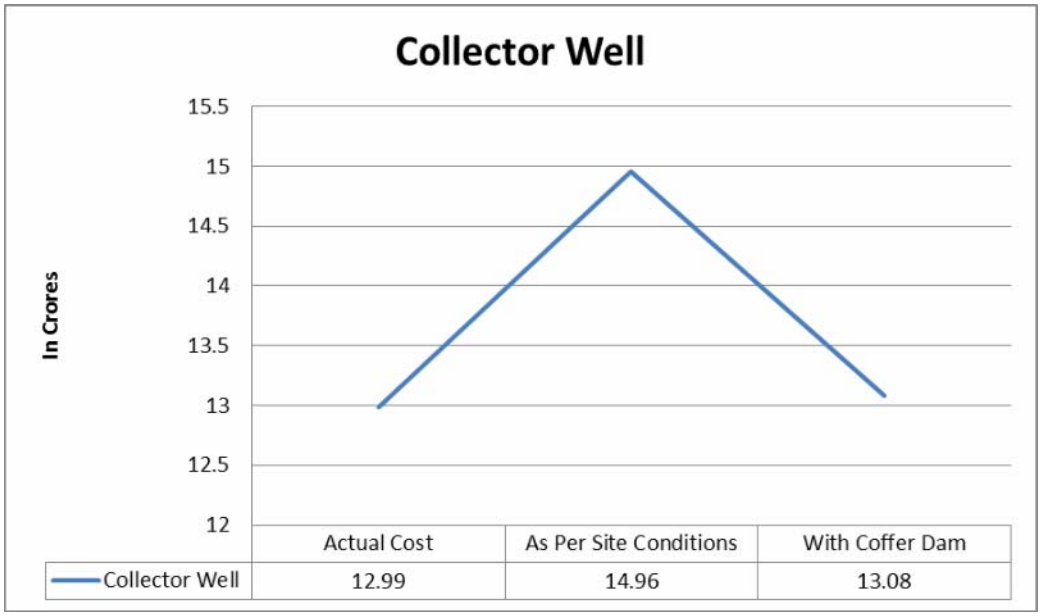


Fig 5. Cost comparison of the collector well.

B. PROGESS FLOW

As earlier I haven mentioned that intended completion date for the whole work was 24 months. But due to the river flow, the project was impeding which would slow down the project for 10 months as shown in Figure 6.

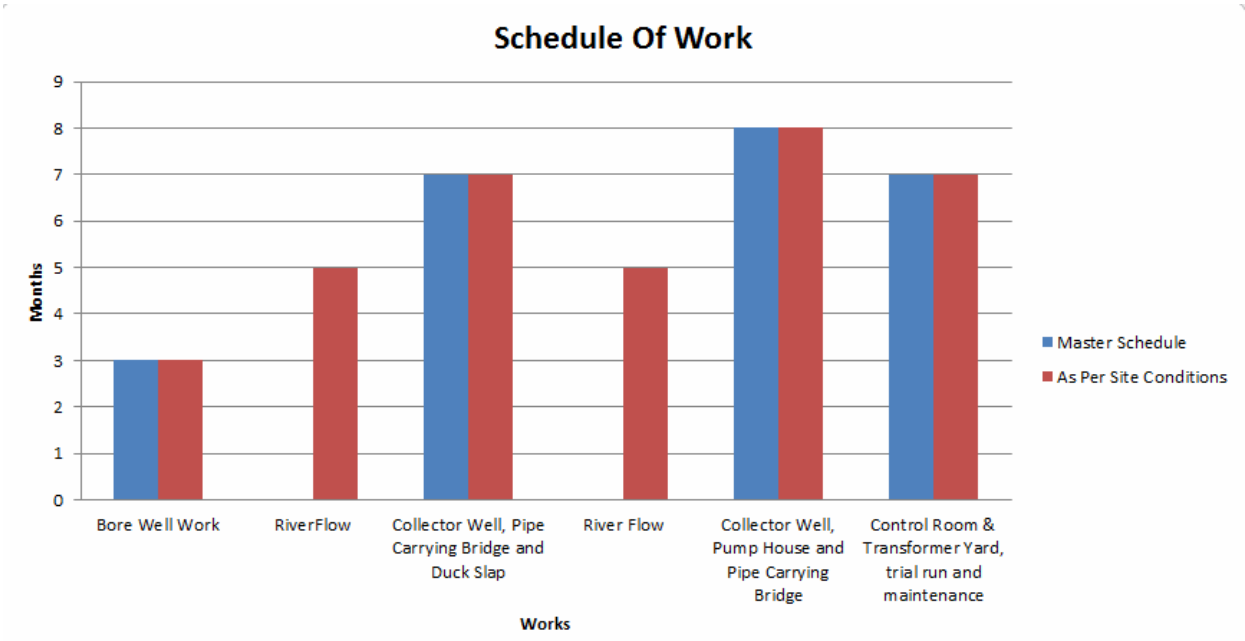
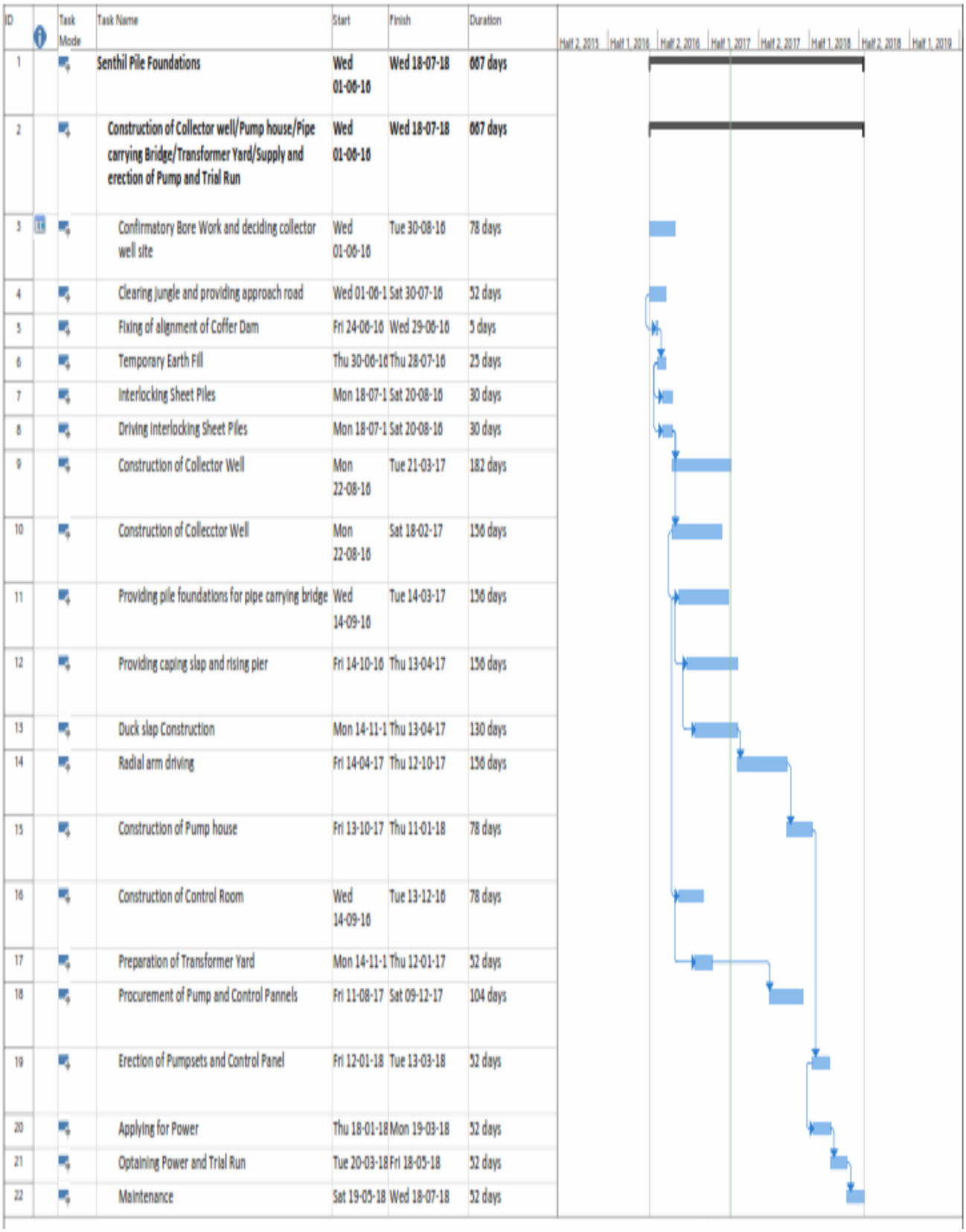


Fig 6. Schedule of Work

On the other hand, a schedule of work for construction of cofferdam made to determine the effects in delay which was caused by river flow.



ID	Task Mode	Task Name	Start	Finish	Duration
1		**Senthil Pile Foundations**	**Wed 01-06-16**	**Wed 18-07-18**	**667 days**
2		**Construction of Collector well/Pump house/Pipe carrying Bridge/Transformer Yard/Supply and erection of Pump and Trial Run**	**Wed 01-06-16**	**Wed 18-07-18**	**667 days**
3		Confirmatory Bore Work and deciding collector well site	Wed 01-06-16	Tue 30-08-16	78 days
4		Clearing jungle and providing approach road	Wed 01-06-1	Sat 30-07-16	52 days
5		Fixing of alignment of Coffer Dam	Fri 24-06-16	Wed 29-06-16	5 days
6		Temporary Earth Fill	Thu 30-06-16	Thu 28-07-16	25 days
7		Interlocking Sheet Piles	Mon 18-07-1	Sat 20-08-16	30 days
8		Driving interlocking Sheet Piles	Mon 18-07-1	Sat 20-08-16	30 days
9		Construction of Collector Well	Mon 22-08-16	Tue 21-03-17	182 days
10		Construction of Collecctor Well	Mon 22-08-16	Sat 18-02-17	156 days
11		Providing pile foundations for pipe carrying bridge	Wed 14-09-16	Tue 14-03-17	156 days
12		Providing caping slap and rising pier	Fri 14-10-16	Thu 13-04-17	156 days
13		Duck slap Construction	Mon 14-11-1	Thu 13-04-17	130 days
14		Radial arm driving	Fri 14-04-17	Thu 12-10-17	156 days
15		Construction of Pump house	Fri 13-10-17	Thu 11-01-18	78 days
16		Construction of Control Room	Wed 14-09-16	Tue 13-12-16	78 days
17		Preparation of Transformer Yard	Mon 14-11-1	Thu 12-01-17	52 days
18		Procurement of Pump and Control Pannels	Fri 11-08-17	Sat 09-12-17	104 days
19		Erection of Pumpsets and Control Panel	Fri 12-01-18	Tue 13-03-18	52 days
20		Applying for Power	Thu 18-01-18	Mon 19-03-18	52 days
21		Optaining Power and Trial Run	Tue 20-03-18	Fri 18-05-18	52 days
22		Maintenance	Sat 19-05-18	Wed 18-07-18	52 days

Fig 7. Coffer dam schedule of Work

The above schedule of work follows IS7272 for the productivity of work. From the above schedule of work, the total period for the construction of Collector Well would take 25 months as shown in Figure 7. So, this solution is not only economical but also time-saving one.

V. SAFETY PRECAUTIONS

In the construction of cofferdam, safety is the primary concern. As per IS 5121 - 1969, the safety precaution will be followed in the site. Since the workers will be exposed to hazardous working condition. Following that, the cofferdam should have adequate space for workers and supervisors and also attention to safe practices shall be maintained properly.

VI. CONCLUSIONS

This research explains the conflicts faced during the construction of collector well, and it suggested that to overcome this by construction of coffer dam around the collector well to defend the river flow. Similarly, it states that this solution would be economical and also would reduce the procrastinate cost. Following this, it also shows that there is improvement in progress flow which was caused due to river flow. Besides this, it described the high standards of safety for construction of cofferdam.

This project was good example for PMC which shows that the components of good management ability and effective planning are the most useful skills in construction industry.

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