"DELAY ANALYSIS IN CONSTRUCTION PROJECTS"

A Thesis

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY

IN

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With specialization in

CONSTRUCTION MANAGEMENT

Under the supervision of

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CERTIFICATE

This is to certify that the work which is being presented in the thesis titled **"DELAY ANALYSIS IN CONSTRUCTION PROJECTS"** in partial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering with specialization in **"Construction Management"** and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by Rekha Thakur (Enrollment No. 142607) M. Tech. Construction Management during a period from July 2015 to June 2016 under the supervision of **Mr. Santu Kar** Assistant Professor, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of my knowledge.

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Date: **Rekha Thakur**

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ABSTRACT

In India, construction is the second largest economic industry next to agriculture. The delay problem in construction industry is a worldwide phenomenon. Delays occur in most construction projects are either simple or complex. To avoid the project delay different factors causing delay should be analyzed and managed properly. This report discussed the delay in construction projects; hence various factors were considered which are responsible for delay in many projects. A questionnaire was prepared by considering the various factors that causes delay in the construction industry. The collected list contained 63 causes for delay which were categorized into seven different groups. This questionnaire was sent to different owners, consultants and contractors for the ranking of the various factors. This data was used to analyze "Frequency index, Severity index and Importance index" of different delay factors. The study aimed to provide the compilation of different views of researchers and results clearly showed that every group of researchers gave different ratings for various factors causing delay. The results were computed and hence the factors were ranked accordingly related to their chances/impact of delay in the construction project. From this study top five factors has been found which are responsible for delay in any construction project are: Equipment breakdown (Rank 1), Shortage of labour (Rank 2), Delay in sub-contractor work (Rank 3), Shortage of equipment (Rank 4) and Low productivity level of labors (Rank 5).

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ABBREVIATIONS

F.I.	Frequency Index
S.I.	Severity Index
I.I.	Importance Index
CPM	Critical Path Method
DAMUDS	Delay Analysis Method Using Delay Section
DS	Delay Section
CF	Contractor Float
VBA	Visual Basic for Application
DAT	Delay Analysis Technique
RNC	Reason for Noncompliance
DI	Delay Index

CHAPTER-1

INTRODUCTION

1.1General

In India, construction is the second largest economic activity next to agriculture. Delay in construction is a global phenomenon affecting not only the construction industry but the overall economy. The delay problem in construction industry is a worldwide phenomenon. Delays occur in most construction projects are either simple or complex. Delay can be defined as the extension of time in the completion of the project. Construction delays are the common problem in civil engineering. Construction delay means a time overrun either beyond the contract date or beyond the date that the parties have agreed upon for the delivery of the project. Delay can be classified as excusable (beyond the control) and non-excusable (with in control of the contractor). Delay can occurred due to many reasons:

1. Owner related delay
2. Consultant related delay
3. Contractor related delay
4. Material related delay
5. Labour and consultant related delay
6. Project related delay
7. External related delay

Delays are insidious often resulting in time overrun, cost overrun, disputes and litigation. The most common delay analysis include the CPM (critical path method), as planned expanded technique, collapsed but for technique, windows technique, bar chart etc.

1.2 Need of the study

Delay analysis is important in construction project as it will affect in project duration and cost. To avoid the project delay different factors causing delay should be analysed and managed properly. Different recommendation or delay management strategy will be helpful for smoothening of the construction project. Some research works have been carried out in other developed countries and few in India. So more investigation are required in Indian construction projects for recommendation of some guidelines to minimize project delay.

1.3 Objective

The primary goal of construction is to finish the project as specified, on schedule and within the budget with proper utilization of all the resources like manpower, material, money and equipment. The main objectives of this study are:

1. To identify different causes of delay in construction project.
2. To analyse delay factors.
3. To quantify delay duration in primavera taking a case study.

1.4 Scope of the project

This study is needed to evaluate the extent of understanding and applying these delay concepts in arising with, and field operation. Scope of the project includes investigation of different causes of delay in construction projects in Indian scenario.

1.5 Research methodology

The study area of this project is delay analysis. Initially literatures were collected and studied. Based on the knowledge gained on literatures, the project is carried out. It involves:

1. Literature review.
2. Collection of data causing delay of construction projects from interviews and questionnaire survey.
3. Study the factors causing delay and to find out factors.
4. Delay analysis based on delay obtained from questionnaire survey.
5. Obtaining results and analysing the factors causing delay using:
    - Frequency index
    - Severity index
    - Importance index
6. Delay analysis- a case study in Primavera.
7. Conclusion.

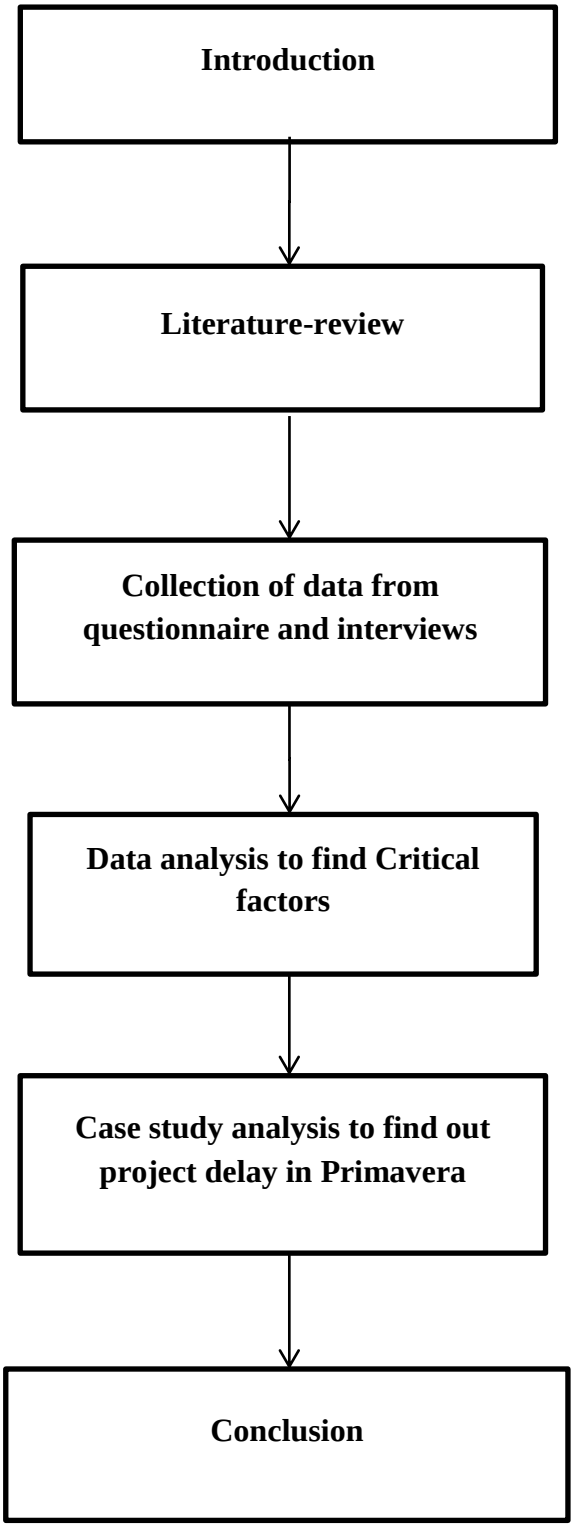

Fig. 1.1 Research methodology

CHAPTER-2

LITERATURE REVIEW

2.1 General

Delay happen in most construction project. Few researchers began to focus their attention on finding solution to existing shortcomings of delay analysis techniques. A number of solution method and delay analysis techniques were proposed.

2.2 Summary

[1]Refer to the paper by Zaki M. Kraie and James E. Diekmann on "Concurrent Delay in Construction Projects" published in Journal of Construction Engineering and Management, December, 1987 which conclude the present method for dealing with the concurrent delay. Concurrent delays are two or more delay occurring at the same time and have always been difficult to resolve. Basic construction delay is:

- Compensable
- Excusable
- Non-excusable

This delay should be considered carefully by making an adjustment on as-built schedule. The resulting as built schedule will then be adjusted to reflect events that have occurred during contract performance.

[2]Refer to the paper by Abdulaziz A. Bubshait and Michael J. Cunninghamon "Comparison of Delay Analysis Methodologies" published in Journal of Construction Engineering and Management, August, 1998 which describe construction project delay may result from many circumstances. Delay may cause by the owner, contractor, by the act of God or a third party. Network based scheduling is an excellent vehicle for negotiating settlement of changes, disputes and delay throughout the project. The result of this study indicates the outcomes of delay analysis are often not predictable, that one method may be universally over another in all situations. The study reveals the dependency upon the time and resource available; the accessibility of the project control documentation one method may be more practical or cost effective.

[3]Refer to the paper by Jonathan Jing sheng Shi, S. D. Cheungand David Arditi on "Construction Delay Computation Method" published in Journal of Construction Engineering

and Management, January, 2001 which conclude method of computing activity delay and assessing their contribution to project delay. Delay is one of the most common problems in the construction industry. The demand consists of a set of equations which can be easily coded by the computer program that allow speedy access to project delay information and activity contribution. This method is also applicable to any intermediate construction stage for evaluating in progress project delay.

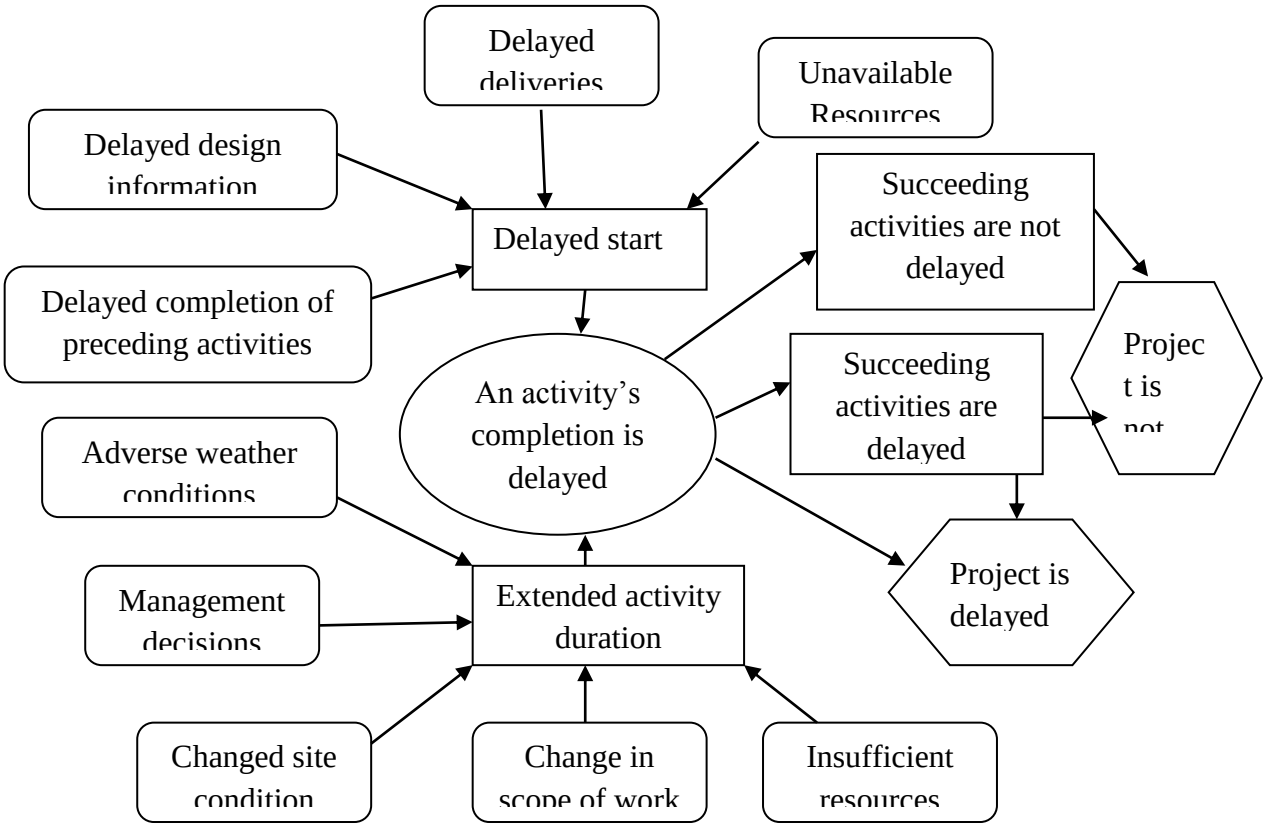

Fig. 2.1 Activity delay[3]

[4]Refer to the paper by Tarek Hegazy and Kehui Zhang on "Daily Windows Delay Analysis" published in Journal of Construction Engineering and Management, May, 2005 which conclude critical path method delay analysis are widely applied in the construction industry, with the windows method being regarded as technologically advantageous. A modified window approach is used in this paper with computerised daily analysis of delay, so that accurate result is obtained. It considers the day by day fluctuation in the critical path along the project duration. It introduces accurate and repeatable results for apportioning project delay among involve parties.

[5]Refer to the paper by Hyun-Soo Lee, Han-Guk Ryu, Jung-Ho Yu and Jae-Jun Kim on "Method of Calculating Schedule Delay Considering Lost Productivity" published in Journal of Construction Engineering and Management, November, 2005 which propose a practical method for converting lost productivity in to schedule delay. Among the various factors that causes delay thus study focus on the factors that cause loss of productivity. Few kind of productivity are:

- Labour productivity
- Equipment productivity

This study focuses on labour productivity because labour productivity representatively shows all kind of productivity. Productivity may be defined as the quantity of work produced per man hour, per equipment hour. This paper presents a method of calculating schedule delay considering lost productivity is an attempt to settle claims without litigation.

[6]Refer to the paper by Youngje Kim, Kyungrai Kim and Dongwoo Shin on "Daily Analysis Method Using Delay Section" published in Journal of Construction Engineering and Management, November, 2005 which conclude the objective of this study is to propose and describe an effective and logical method for evaluating construction delay. To achieve this objective a new methodology called "delay analysis method using delay section" (DAMUDS). DAMUDS incorporates two new concepts:

- DS (Delay Section)
- CF (Contractor Float)

DAMUDS presented in this paper is based upon the CPM methods and it require as planned schedule and actual activities.

[7]Refer to the paper by William Ibbs and Long D. Nguyen on "Schedule Analysis under the effect of Resource Allocation" published in Journal of Construction Engineering and Management, February, 2007 which shows that delay analysis without resource allocation practice substantially affects results of schedule analysis. Delays are the acts or events that extend the time necessary to finish activities under the contract. Performing schedule analysis without considering resource allocation may increase the owner and contractor risk of assuming delay responsibility which is not his or her fault. A case study was used to compare the analysis and result of the traditional and enhanced window analysis method.

[8]Refer to the paper by K.C. Iyer, N.B. Chaphalkar, and G.A. Joshi on "Understanding time delay disputes in construction contracts" published in International Journal of Project Management, May, 2007 which described an attempt to devise a rule based expert system to achieve this objective with a limits scope of dispute arising out of Time Delay and Extension in Indian Construction Contracts. Majority of the construction projects are carried out through contracts.

There are reason for inconsistencies and discrepancies in large contract which area beyond the control of the drafter of the contract. Hence better training to the professional can be said to be a great help in better understanding of the contract. It would reduce the occurrence of disputes. A knowledge based expert system was therefore considered as a handy tool for the judiciary and contract administrator to come to a conclusion faster and this being the motivation an attempt is made to develop the system.

[9]Refer to the paper by Issaka Ndekugri, Nuhu Braimah and Rod Gameson on "Delay Analysis within Construction Contracting Organization" published in Journal of Construction Engineering and Management, September, 2008 which conclude on an empirical study into the current practice in the use of methodologies in developed countries as part of a wider study aimed at developing framework for improving delay claim analysis. The methodologies most commented upon in the literature are:

- As planned versus as-built.
- Impacted as-planned.
- Collapsed as-built.
- Window analysis.
- Time impact analysis.
- Appropriate use of the methodologies requires multidisciplinary knowledge, understanding and skills, particularly in the areas of scheduling, construction method, estimating, costing and information technology tool.

[10]Refer to the paper by Jyn-Bin Yang and Ming-Kuan Tsai on "Computerised ICBF Method for Schedule Delay Analysis" published in Journal of Construction Engineering and Management, August, 2011 which conclude the reviews to access schedule delay is a common construction dispute. Many construction projects involve numerous complex activities, the procedure of using ICBF method is time consuming. Therefore, this study used Microsoft Visual Basic for Applications (VBA) language and spread sheet technique to

develop an Excel based program for rapid delay analysis rather than manual calculation. It involves:

- Increased accuracy of delay analysis.
- Developed program is beneficial tool for avoiding human errors and saving unnecessary calculation time.
- Enhanced comprehensibility of analysis result.

[11]Refer to the paper by Borvorn Israngkura Na Ayudhya on "Evaluation of common Delay causes of Construction Projects in Singapore" published in Journal of civil engineering and architecture, 2011 which conclude the common delay factor among owner, consultants and contractors in building projects in Singapore. The interview and questionnaire method were used in the research. Randomly distribution questionnaire method were applied to select sample of seventy four various construction practitioners consisting of owner, consultants, main contractors to evaluate the severity of thirty five delay factors. The result found that delay in progress payment by owner adverse weather condition, main contractor financial problem and act of God factor cause delay in construction projects.

[12]Refer to the paper by Chidambaram Ramanathan, SP Narayan and Arazi B Idruson "Construction Delay Causing Risk on Time and Cost- a critical review" published in Australian Journal of Construction Economic and Building, 2012 which conclude an increase in the number of construction projects experiencing extensive delays leading to exceeding the initial time and cost budget. This paper reviews 41 studies around the world which has surveyed the delay factors and classified them into groups. Most of the research has been analyzed from questionnaire surveys. The critical review undertaken in this paper covers research studies in the area of construction delay with time and cost risk. Totally 18 categories of causes were identified from the various related studies reported in the literature. Each study has a unique approach and unique results are derived from the questionnaire response data.

[13]Refer to the paper by Ashwini Arun Salunkhe and Rahul S. Patil on "Statistical Method for Construction Delay Analysis" published in Journal of Mechanical and Civil Engineering, 2013 which helps to avoid or minimize delays in future work. Numerous analytical methods are available for analyzing these impacts and selection of proper method depends upon: statistical data available, time available, limitation of method and money available for analyzing. However, information of activities which are responsible for project delay and their magnitude provides the baseline for investing the cause and assessing the responsibility

for project delay. This paper reviews research methodology suggested for assessing construction delay factors by analytical methods as well as with the help of computerized schedule analysis methods. The purpose of this study is to review various analytical & computerized schedule analysis methods for analysis of construction delay factor.

[14]Refer to the paper by Nuhu Braimah on "Construction Delay Analysis Techniques—A Review of Application Issues and Improvement Needs" published in Journal of Civil Engineering and Architect, 2013 which conclude issues that are often ignored in the analysis but would also affect delay analysis results are: functionality of the programming software employed for the analysis, resource loading and leveling requirements, resolving concurrent delays, and delay-pacing strategy. As part of a wider research work, this paper seeks to develop such knowledge and understanding via: an evaluation of the most common DATs based on a case study, a discussion of the key relevant issues often not addressed by the techniques and their improvement needs. The evaluation of the techniques confirmed that the various DATs give different allocations of delay responsibilities when applied to the same set of delay claims data, reinforcing the common notion that the most appropriate technique for any claims situation depends on the claims circumstances and the project.
The different results stem mainly from the unique set of requirements and application procedures each technique employs. In addition, there are a number of issues such as: functionality of the programming software employed for the analysis, resource loading and leveling requirements, concurrent delay and delay pacing, which are all vital to ensuring accurate and reliable analysis results but are not addressed by the DATs.

[15]Refer to the paper by Ashwini Arun Salunkhe and Rahul S. Patil on "Effect of Construction Delay on Project Time Overrun :Indian Scenario" published in International Journal of Research in Engineering and Technology, January,2014 which highlight the type of construction delay due to which project suffer time and cost overrun.

Brief reason for time overrun as reported by various project implementing agencies are:

- Delay in land acquisition.
- Delay in equipment erection.
- Delay in forest clearance.
- Cancellation of tender.
- Law and order problem.

- Delay in supply of equipment.
- Slow progress of civil works.

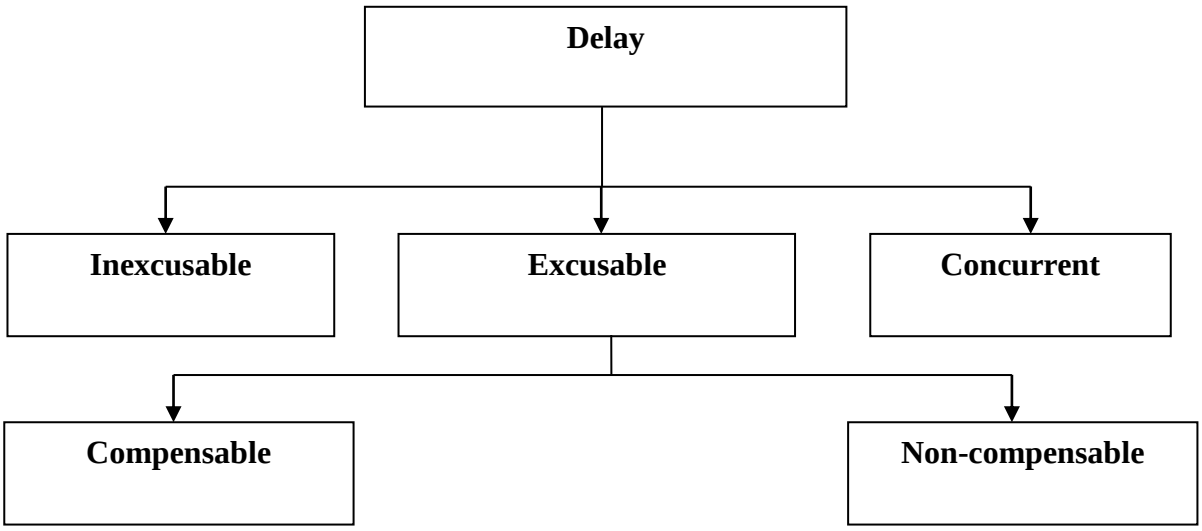

Fig. 2.2 Causes of delay[15]

Delay that occure concurrently	Entitlement to the contractor
Excusable and non excusable	Only time extention granted
Excusable with compensation and excusable without compensation	Entitled to time extention but not to damages
Two excusable with compensation	Entitled to both time extention and damages

Fig. 2.3 Identification of delay[15]

[16]Refer to the paper by B. Indhu, P. Ajai on "Study of Delay Management in a Construction Project-A Case Study" published in International Journal of Emerging Technology and Advanced Engineering, May, 2014 which identify the delay factors and the effect on the project completion by doing a case study on on-going projects. By analysing the reason for delay possible recommendation are given. The major factor identified in this case study is due to contractor, owner and due to nature act like rain.

The most important causes identified were:

- Delay in payment by the head office.
- Frequent change of staff.
- Poor site management.
- Improper management of the engineer.
- Delay in supply of material.
- Lack of man power.

[17]Refer to the paper by Nuhu Braimah on "Understanding Construction Delay Analysis and the Role of Preconstruction Programming" published in Journal of Management Engineering, 2014 which described modern construction projects commonly suffer from delay in their completion. The study result provides a better understanding of key issue that need attention if improvements are to be made in delay claim resolutions. This paper reports on an aspect of the study conducted to throw light on the underlying programming issues affecting delay claim resolutions as demonstrated by an initial large scale survey of the research.

[18]Refer to the paper by Pablo Gonzalez, Vicente Gonzalez, Keith Molenaar and Francisco Orozco on "Analysis of Causes of Delay and Time Performance in Construction Projects " published in Journal of Construction Engineering and Management, 2014 which conclude to a methodology to examine the qualitative (delay causes) and quantitative dimensions (time performance) of the delay issue. The paper proposes two indicators:

- Reason for noncompliance (RNC) as an indicator that characterizes scheduling failure. on critical and noncritical activities.
- Delay index (DI) as a time performance indicator that describe the impact of critical and noncritical activities.

The methodology provided information for project managers to make better decision about the delay causes and assisted in focusing management actions toward mitigating delay impacts on weekly basis.

[19]Refer to the paper by M. Talat Birgonul, Irem Dikmen and Sinasi Bektas on "Integrated Approach to Overcome Shortcoming in Current Delay Analysis practices" published in Journal of Construction Engineering and Management, 2015 which conclude many factors, unforeseen able events, financial problem, and insufficient technical capacity of site team of contractor or consultant or so on. Integrated approach is developed which is composed of a set of rules solving all identified shortcomings and a flow chart guiding the parties until the end of the project. The integrated approach brings a new perspective to delay analysis.

[20]Refer to the paper by Alenas Vasilyeva-Lyulina, Masamitsu Onishi and Kiyoshi Kobayash on “Delay Analysis Methods for Construction Projects: Mathematical Modeling “published in International Journal of Transportation, 2015 which conclude variety of factors contribute to the delay of project completion in the complex interdependencies of a number of tasks. Although academic papers and guides published by authoritative societies introduce the protocol of delay analysis methods, those are described in the natural language. Being tempted by such a motive, this paper formalized typical delay analysis methods including impacted as-planned, time impact analysis and collapsed as-built commonly used in practice.

CHAPTER-3

QUESTIONNAIRE SURVEY AND DATA COLLECTION

3.1 General

The purpose of the study is to critically review and identify the applicability of past studies on determining the factor causing time delay and cost overrun in current projects. When projects are delayed they are either extended or accelerated and therefore, incur additional cost.

Research literature from all around the world has been collected and consolidated for the better understanding and to conceive the overall picture of the issues. Different author focus on selected categories for study and analysis. Cost and schedule overrun occur due to wide range of factors. There is an increase in the number of construction projects experiencing extensive delays leading to exceeding the initial time and cost budget. Most of the result has been analysed from responses of the questionnaire surveys. The questionnaire was designed to evaluate the frequency of occurrence, severity and the importance of the identified causes. The questionnaire was distributed to contractors, consultant and clients. In the field survey respondent were asked to indicate the level of importance of each cause using five point likert scales ranging from 1-5.

The questionnaire study conducted the investigation in two phases. The first phase included a literature search. The first phase identified 63 causes of delay. In the second phase a questionnaire was developed using these delay causes. Scope was limited to industry expert, contractor, architecture and public owner. Total 20 responses were collected, Out of these, 7 responses were collected by the Project Manager and 13 responses were collected from the Site Engineers. Their comments were used to revise and prepare the final questionnaire. Responses to the questionnaire were then collected and analysed. The analysis included ranking the problem in terms of degree of occurrence and level of influence.

3.2 Questionnaire Survey

QUESTIONNAIRE REGARDING DELAY ANALYSIS IN CONSTRUCTION PROJECTS

(Please fill the appropriate boxes with yellow color as shown)

Section I: Company Profile

1. Company Name (Please write full Name)

2. Phone No:

3. Nature of Company:

Client		e.g. Client	
Contractor		Contractor	
Designer			
Consultant			
Other: (Please Specify)			

(Please write full Name)

4. Age of the Company:

1-5 Years	
6-10 Years	
10-15 Years	
More Than 15 Years	

Section II: Respondent Profile

1.Name (Optional) (Please write full Name)

2. Position in the Company:

Engineer	
Construction Manager	
Project Manager	
Contract/Business Development Officer	
Business/Cluster Head	
Site Co-coordinator	
Any Other (Please specify)	

(write full designation)

3. Experience in the Construction industry

1-2 Years	
3-4 Years	
5-6 Years	
7-10 Years	
10 Years and above	

Section III: Delay Analysis in Construction Projects

1. Which of the following delays are generally faced in the construction projects?

(R= Rarely, S= Sometimes, A= Average, VF= Very Frequently, M= Mostly, SD= Strongly Disagree, D= Disagree, NSF= No Strong Feeling, A= Agree, SA= Strongly Agree)

Table-1 Questionnaire Survey

S. No.	Type of Delays	Delay Probability (A)					Delay Impact (B)					Total Delay (AB)
		R	S	A	VF	M	SD	D	NSF	A	SA	
A	**Owner Contributed Factors**											
1	Delay in progress payments	1	2	3	4	5	1	2	3	4	5	
2	Delay to furnish and deliver the site	1	2	3	4	5	1	2	3	4	5	
3	Change orders by owner during construction	1	2	3	4	5	1	2	3	4	5	
4	Late in revising and approving design documents	1	2	3	4	5	1	2	3	4	5	
5	Delay in approving shop drawing and sample material	1	2	3	4	5	1	2	3	4	5	
6	Poor communication and coordination	1	2	3	4	5	1	2	3	4	5	
7	Slowness in decision making process	1	2	3	4	5	1	2	3	4	5	

		R	S	A	VF	M	SD	D	NSF	A	SA	
8	Conflicts between joint-ownership of the project	1	2	3	4	5	1	2	3	4	5	
9	Suspension of work by owner	1	2	3	4	5	1	2	3	4	5	
B	**Contractor Contributed Factors**											
1	Difficulties in financing project	1	2	3	4	5	1	2	3	4	5	
2	Conflict in subcontractors schedule in execution of project	1	2	3	4	5	1	2	3	4	5	
3	Rework due to errors during construction	1	2	3	4	5	1	2	3	4	5	
4	Conflicts between contractor and other parties	1	2	3	4	5	1	2	3	4	5	
5	Poor communication and coordination	1	2	3	4	5	1	2	3	4	5	
6	Ineffective planning and scheduling of project	1	2	3	4	5	1	2	3	4	5	
7	Improper construction methods implement	1	2	3	4	5	1	2	3	4	5	
8	Delay in sub-contractor work	1	2	3	4	5	1	2	3	4	5	

		R	S	A	VF	M	SD	D	NSF	A	SA	
9	Inadequate contractor's work	1	2	3	4	5	1	2	3	4	5	
C	**Consultant Contributed Factors**											
1	Delay in approving major changes in the scope of work	1	2	3	4	5	1	2	3	4	5	
2	Poor communication and coordination	1	2	3	4	5	1	2	3	4	5	
3	Inadequate experience of consultant	1	2	3	4	5	1	2	3	4	5	
4	Mistakes and discrepancies in design documents	1	2	3	4	5	1	2	3	4	5	
5	Delay in producing design documents	1	2	3	4	5	1	2	3	4	5	
6	Insufficient data collection and survey before design	1	2	3	4	5	1	2	3	4	5	
7	Un-use of advanced engineering design software	1	2	3	4	5	1	2	3	4	5	
8	Conflicts with other parties and financial problems	1	2	3	4	5	1	2	3	4	5	
9	Unclear and inadequate drawings	1	2	3	4	5	1	2	3	4	5	

		R	S	A	VF	M	SD	D	NSF	A	SA	
D	**Material Contributed Factors**											
1	Shortage of construction material in market	1	2	3	4	5	1	2	3	4	5	
2	Change in material type during construction	1	2	3	4	5	1	2	3	4	5	
3	Delay in material delivery	1	2	3	4	5	1	2	3	4	5	
4	Damage of sorted material while they are needed urgently	1	2	3	4	5	1	2	3	4	5	
5	Delay in manufacturing special building materials	1	2	3	4	5	1	2	3	4	5	
6	Late procurement of material	1	2	3	4	5	1	2	3	4	5	
7	Quality problem with procured material	1	2	3	4	5	1	2	3	4	5	
8	Procuring undesired or unwanted material instead	1	2	3	4	5	1	2	3	4	5	
9	Problem with material transport and processing at site	1	2	3	4	5	1	2	3	4	5	

		R	S	A	VF	M	SD	D	NSF	A	SA	
E	**Equipment Contributed Factors**											
1	Equipment breakdowns	1	2	3	4	5	1	2	3	4	5	
2	Shortage of equipment	1	2	3	4	5	1	2	3	4	5	
3	Low level of equipment-operator's skill	1	2	3	4	5	1	2	3	4	5	
4	Low productivity and efficiency of equipment	1	2	3	4	5	1	2	3	4	5	
5	Lack of heavy equipment when needed	1	2	3	4	5	1	2	3	4	5	
6	Wrong kind verity of equipment	1	2	3	4	5	1	2	3	4	5	
7	Lack of hi-tech and advanced equipment	1	2	3	4	5	1	2	3	4	5	
8	Unavailability of special equipment	1	2	3	4	5	1	2	3	4	5	
9	Difficulty in transporting equipment	1	2	3	4	5	1	2	3	4	5	
F	**Labour Contributed Factors**											
1	Shortage of labours	1	2	3	4	5	1	2	3	4	5	

		R	S	A	VF	M	SD	D	NSF	A	SA	
2	Working permit of labours	1	2	3	4	5	1	2	3	4	5	
3	Low productivity level of labours	1	2	3	4	5	1	2	3	4	5	
4	Personal conflicts among labours	1	2	3	4	5	1	2	3	4	5	
5	High labour wages	1	2	3	4	5	1	2	3	4	5	
6	Labour exodus	1	2	3	4	5	1	2	3	4	5	
7	Labour strikes at site	1	2	3	4	5	1	2	3	4	5	
8	Labour health problem when working in hazardous condition	1	2	3	4	5	1	2	3	4	5	
9	Labour safety problems	1	2	3	4	5	1	2	3	4	5	
G	**External Factors**											
1	Effect of sub-surface and ground condition factors	1	2	3	4	5	1	2	3	4	5	
2	Delay in obtaining permits from municipality	1	2	3	4	5	1	2	3	4	5	
3	Weather effect on construction activities	1	2	3	4	5	1	2	3	4	5	
4	Traffic control and restriction at job site	1	2	3	4	5	1	2	3	4	5	

		R	**S**	**A**	**VF**	**M**	**SD**	**D**	**NSF**	**A**	**SA**	
5	Accident during construction	1	2	3	4	5	1	2	3	4	5	
6	Changes in government regulations and laws	1	2	3	4	5	1	2	3	4	5	
7	Delay in providing services from utilities	1	2	3	4	5	1	2	3	4	5	
8	Delay in performing final inspection and certification	1	2	3	4	5	1	2	3	4	5	
9	Civil unrest and public strikes	1	2	3	4	5	1	2	3	4	5	

CHAPTER-4

RESULTS & ANALYSIS

4.1 General

Total 20 responses has been collected from the various researchers and engineers and frequency index, severity index and importance index has been ranked according to the ranking given.

4.2 Analysis

Delay analysis will be based on the following factors:

- Frequency Index
- Severity Index
- Importance Index

Frequency Index=$\frac{\sum an}{N \times A} \times 100$

Where a= constant expressing the weight assigned to each responses from 1 to 5.

n= frequency of each response

N= total number of responses

A= highest weight (i.e. 5 in this case)

Severity Index=$\frac{\sum an}{N \times A} \times 100$

Where a= constant expressing the weight assigned to each responses from 1 to 5.

n= impact of each response

N= total number of responses

A= highest weight (i.e. 5 in this case)

Importance Index= Frequency index x Severity index

CALCULATION OF F.I., S.I. & I.I.

Table- 2 Calculation of F.I., S.I. & I.I.

S. No.	Types Of Factors	F.I.= $\frac{\sum a \times n}{A \times N}$	S.I.= $\frac{\sum a \times n}{A \times N}$	I.I.=F.I. × S.I.
A	**Owner Contributed Factors**			
1	Delay in progress payments	0.55	0.63	0.35
2	Delay to furnish and deliver the site	0.56	0.77	0.43
3	Change orders by owner during construction	0.48	0.64	0.31
4	Late in revising and approving design documents	0.53	0.71	0.38
5	Delay in approving shop drawing and sample material	0.47	0.67	0.31
6	Poor communication and coordination	0.52	0.7	0.36
7	Slowness in decision making process	0.54	0.75	0.41
8	Conflicts between joint-ownership of the project	0.47	0.62	0.29
9	Suspension of work by owner	0.42	0.63	0.26
B	**Contractor Contributed Factors**			
1	Difficulties in financing project	0.54	0.78	0.42
2	Conflict in subcontractors schedule in execution of project	0.6	0.74	0.44
3	Rework due to errors during construction	0.51	0.74	0.38
4	Conflicts between contractor and other parties	0.55	0.72	0.40
5	Poor communication and coordination	0.35	0.73	0.26
6	Ineffective planning and scheduling of project	0.52	0.83	0.43

S. No.	Types Of Factors	F.I.	S.I.	I.I.
7	Improper construction methods implement	0.5	0.76	0.38
8	Delay in sub-contractor work	0.68	0.8	0.54
9	Inadequate contractor's work	0.58	0.78	0.45
C	**Consultant Contributed Factors**			
1	Delay in approving major changes in the scope of work	0.53	0.77	0.41
2	Poor communication and coordination	0.5	0.73	0.37
3	Inadequate experience of consultant	0.45	0.67	0.30
4	Mistakes and discrepancies in design documents	0.46	0.75	0.35
5	Delay in producing design documents	0.53	0.78	0.41
6	Insufficient data collection and survey before design	0.57	0.78	0.44
7	Un-use of advanced engineering design software	0.54	0.65	0.35
8	Conflicts with other parties and financial problems	0.48	0.69	0.33
9	Unclear and inadequate details in drawings	0.48	0.73	0.35
D	**Material Contributed Factors**			
1	Shortage of construction material in market	0.55	0.88	0.48
2	Change in material type during construction	0.42	0.69	0.29
3	Delay in material delivery	0.59	0.86	0.51
4	Damage of sorted material while they are needed urgently	0.51	0.81	0.41

S. No.	Types Of Factors	F.I.	S.I.	I.I.
5	Delay in manufacturing special building materials	0.53	0.77	0.41
6	Late procurement of material	0.59	0.67	0.40
7	Quality problem with procured material	0.51	0.71	0.36
8	Procuring undesired or unwanted material instead	0.46	0.61	0.28
9	Problem with material transport and processing at site	0.57	0.76	0.43
E	**Equipment Contributed Factors**			
1	Equipment breakdowns	0.64	0.89	0.57
2	Shortage of equipment	0.64	0.84	0.54
3	Low level of equipment-operator's skill	0.56	0.81	0.45
4	Low productivity and efficiency of equipment	0.54	0.74	0.40
5	Lack of heavy equipment when needed	0.51	0.75	0.38
6	Wrong kind verity of equipment	0.4	0.77	0.31
7	Lack of hi-tech and advanced equipment	0.56	0.69	0.39
8	Unavailability of special equipment	0.59	0.75	0.44
9	Difficulty in transporting equipment	0.58	0.78	0.45
F	**Labour Contributed Factors**			
1	Shortage of labour’s	0.65	0.87	0.57
2	Working permit of labours	0.48	0.7	0.34
3	Low productivity level of labours	0.63	0.84	0.53
4	Personal conflicts among labours	0.42	0.58	0.24

S. No.	Types Of Factors	F.I.	S.I.	I.I.
5	High labour wages	0.47	0.55	0.26
6	Labour exodus	0.47	0.65	0.31
7	Labour strikes at site	0.54	0.84	0.45
8	Labour health problem when working in hazardous condition	0.48	0.76	0.36
9	Labour safety problems	0.59	0.71	0.42
G	**External Factors**			
1	Effect of sub-surface and ground condition factors	0.6	0.85	0.51
2	Delay in obtaining permits from municipality	0.53	0.81	0.43
3	Weather effect on construction activities	0.68	0.77	0.52
4	Traffic control and restriction at job site	0.52	0.72	0.37
5	Accident during construction	0.56	0.8	0.45
6	Changes in government regulations and laws	0.47	0.68	0.32
7	Delay in providing services from utilities	0.52	0.58	0.30
8	Delay in performing final inspection and certification	0.53	0.66	0.35
9	Civil unrest and public strikes	0.5	0.81	0.41

RANKING OF DELAY FACTORS ACCORDING TO THE IMPORTANCE INDEX (I.I.):

Delay factors are ranked based on their Importance Index value.

Table-3 Ranking of delay factors

Types Of Factors	I.I.	Rank
Equipment breakdowns	0.57	1
Shortage of labors	0.57	2
Delay in sub-contractor work	0.54	3
Shortage of equipment	0.54	4
Low productivity level of labors	0.53	5
Weather effect on construction activities	0.52	6
Effect of sub-surface and ground condition factors	0.51	7
Delay in material delivery	0.51	8
Shortage of construction material in market	0.48	9
Low level of equipment-operator's skill	0.45	10
Labour strikes at site	0.45	11
Inadequate contractor's work	0.45	12
Difficulty in transporting equipment	0.45	13
Accident during construction	0.45	14
Insufficient data collection and survey before design	0.44	15
Conflict in subcontractors schedule in execution of project	0.44	16
Unavailability of special equipment	0.44	17
Problem with material transport and processing at site	0.43	18
Ineffective planning and scheduling of project	0.43	19
Delay to furnish and deliver the site	0.43	20
Delay in obtaining permits from municipality	0.43	21
Difficulties in financing project	0.42	22
Labor safety problems	0.42	23
Delay in producing design documents	0.41	24

Types Of Factors	I.I.	Rank
Damage of sorted material while they are needed urgently	0.41	25
Delay in approving major changes in the scope of work	0.41	26
Delay in manufacturing special building materials	0.41	27
Slowness in decision making process	0.41	28
Civil unrest and public strikes	0.41	29
Low productivity and efficiency of equipment	0.40	30
Conflicts between contractor and other parties	0.40	31
Late procurement of material	0.40	32
Lack of hi-tech and advanced equipment	0.39	33
Lack of heavy equipment when needed	0.38	34
Improper construction methods implement	0.38	35
Rework due to errors during construction	0.38	36
Late in revising and approving design documents	0.38	37
Traffic control and restriction at job site	0.37	38
Poor communication and coordination	0.37	39
labours health problem when working in hazardous condition	0.36	40
Poor communication and coordination	0.36	41
Quality problem with procured material	0.36	42
Un-use of advanced engineering design software	0.35	43
Unclear and inadequate details in drawings	0.35	44
Delay in performing final inspection and certification	0.35	45
Delay in progress payments	0.35	46
Mistakes and discrepancies in design documents	0.35	47
Working permit of labors	0.34	48
Conflicts with other parties and financial problems	0.33	49
Changes in government regulations and laws	0.32	50

Types Of Factors	I.I.	Rank
Delay in approving shop drawing and sample material	0.31	51
Wrong kind verity of equipment	0.31	52
Change orders by owner during construction	0.31	53
labors exodus	0.31	54
Delay in providing services from utilities	0.30	55
Inadequate experience of consultant	0.30	56
Conflicts between joint-ownership of the project	0.29	57
Change in material type during construction	0.29	58
Procuring undesired or unwanted material instead	0.28	59
Suspension of work by owner	0.26	60
High labors wages	0.26	61
Poor communication and coordination	0.26	62
Personal conflicts among labors	0.24	63

4.3 A Case Study

4.3.1 Introduction

Rattle hydropower project, in Kistwar Tehsil of Doda district of Jammu & Kashmir, is located downstream of Dulhsti power house. A concrete dam is proposed across the river Chenab just downstream of the Rattle village. The power house will have an installed capacity of 560 MW(4×140 MW).

4.3.2 Profile

Fig.3.1 Location of Rattle dam in India

Country	India
Location	Rattle, Doda District Jammu & Kashmir
Purpose	Power
Status	Under construction
Construction begun	2013
Opening date	February 2018
Owner(s)	GVK Rattle Hydroelectric plan
Type of dam	Gravity
Height	133 m
Installed capacity	850 MW

4.3.3 Work performance

Rattle hydroelectric project implementation including erection, testing and commissioning of four generating units of 205 MW. The project being in snow bound area, the working season for over groundwork is considered as 7 to 8 months starting from august to November and February to May in the subsequent year. The extension of time, delay in handing over of the land and site possession in a progressive manner in line with the construction schedule without affecting the works. There are also some political reasons which affect the performance of project.

Here is a document which shows the performance of the Rattle Hydropower Project. Therefore following are the hindrances in the performance of Rattle Hydroelectric Project:

1. Environment factors
2. Political environment
3. Factors related to labour and time

4.3.4 Hindrances in Rattle Hydropower Project

I- S. No.

II- type of hindrance

III- description of hindrance

IV- location affected due to hindrance

V- Date of start of hindrance

VI- end date of hindrance

VII- period of hindrance and days

Table-4 Hindrances details in Rattle Hydroelectric Project

I	II	III	IV	V	VI	VII=VI-V
1	i) Force Majeure as defined in Article 36.2 (c): 36.2 The term 'Force Majeure' as employed herein shall mean an event or circumstance; (c). which, having arisen, could not have reasonably been avoided or overcome, by the Affected Party	Incidence of murder in Drabshalla (near project site) following stoppage of works.	i) Left bank-Upstream access road (1710m) from NH 1 B to Upstream Bridge. ii) Left bank-Downstream access road (720m) from NH 1 B to Downstream Bridge. iii) Construction of Upstream bridge (85m).	07-Feb-13	08-Feb-13	1
2	i) Force Majeure as defined in Article 36.2 (c): 36.2 The term 'Force Majeure' as employed herein shall mean an event or circumstance; (c). which, having arisen, could not have reasonably been avoided or overcome, by the Affected Party	Incidence of murder in Drabshalla (near project site) following stoppage of works.	i) Left bank-Upstream access road (1710m) from NH 1 B to Upstream Bridge. ii) Left bank-Downstream access road (720m) from NH 1 B to Downstream Bridge. iii) Construction of Upstream bridge (85m).	07-Feb-13	08-Feb-13	1

I	II	III	IV	V	VI	VII=VI-V
3	Clause 24: Extension of Time: ii) Delay in handing over of land and Site Possession in a progressive manner in line with the construction schedule	Handover of Upstream bridge and Right bank area by GVK.	i) Road from Upstream bridge to Diversion Tunnel (450m). ii) Road from Upstream bridge to Power Intake (845m). iii) Link road towards DT outlet (1050m). iv) Construction of Diversion Tunnel including Portal. v) Construction of Pressure shafts.	15-Jan-13	15-Jun-13	151
4	PAF's, locals / neighbouring land owners etc., provided such events are not attributable to the Sub-Contractor	Strike and stoppage of works by local Contractors for non-payment of previous bills by GVK.	i) Left bank-Upstream access road (1710m) from NH 1 B to Upstream Bridge. ii) Left bank-Downstream access road (720m) from NH 1 B to Downstream Bridge. iii) Construction of Upstream bridge (85m).	09-Jan-13	05-Apr-13	86

I	II	III	IV	V	VI	VII=VI-V
			Surge cavern drift.	07-Sep-13	08-Sep-13	1
			Surge cavern drift.	19-Sep-13	20-Sep-13	1
5	Clause 24: Extension of Time: xi) Local unrest including that of any strikes called/staged /volunteered by PAF's, locals / neighbouring land owners etc., provided such events are not attributable to the Sub- Contractor	Work stopped by local people regarding issues related to PAFs which were committed by GVK.	i) Road from Upstream bridge to Diversion Tunnel (450m). ii) Road from Upstream bridge to Power Intake (845m). iii) Link road towards DT outlet (1050m).	01-Oct-13	02-Oct-13	1
6	Clause 24: Extension of Time: xi) Local unrest including that of any strikes called/staged /volunteered by PAF's, locals / neighbouring land owners etc., provided such events are not attributable to the Sub- Contractor	Strike and stoppage of works by local villagers. for not fulfilling their demands as committed by GVK.	i) Road from Upstream bridge to Diversion Tunnel (450m). ii) Road from Upstream bridge to Power Intake (845m). iii) Link road towards DT outlet (1050m). iv) Surge Cavern drift.	07-Oct-13	08-Oct-13	1

I	II	III	IV	V	VI	VII=VI-V
7	Clause 24: Extension of Time: xi) Local unrest including that of any strikes called/staged /volunteered by PAF's, locals / neighbouring land owners etc., provided such events are not attributable to the Sub- Contractor	Work stopped by locals/Subcontractors demanding deployment of PAFs in GVK.	Total Project	30 Oct 13	03 Nov 13	4
8	Clause 24: Extension of Time: xi) Local unrest including that of any strikes called/staged /volunteered by PAF's, locals / neighbouring land owners etc., provided such events are not attributable to the Sub- Contractor	Work stoppage by PAFs demanding for employment in GVK.	Total Project	21-Nov-13	03-Dec-13	12

4.3.5 Quantifying Delay in Primavera

A revised schedule of construction programme incorporating those delays in Rattle Hydropower Project has been prepared in primavera given in the annexure. This schedule has been compared with the tender schedule of Rattle Hydro Electric Project to find the net effective delay duration as shown in the table below;

Table-4 Comparison of Tender Schedule & Revised Schedule

Description of work		Completion as per tender schedule	Completion as per revised schedule
Rattle Project		**28 Dec, 2018**	**2 April, 2019**
i.	Temporary structure facilities	4 Nov, 2015	4 Nov, 2015
ii.	Approach road	13 Jan, 2014	2 May, 2014
iii.	Notice for proceed for planning and design engineer	15 Nov, 2018	15 Nov, 2018
iv.	Dam complex	19 Nov, 2012	19 Nov, 2012
v.	Portal development	5 Sept, 2013	10 Dec, 2013
vi.	Underground excavation	10 Jan, 2014	15 April, 2014
vii.	lining	4 Jul,2014	7 Oct, 2014
viii.	Inlet structure	22 Aug, 2014	25 Nov, 2014
ix.	Outlet structure	15 Aug, 2014	18 Nov, 2014
x.	Upstream cofferdam	27 April, 2015	19 July, 2015
xi.	Downstream cofferdam	27 April, 2015	29 July, 2015
xii.	Civil works	7 Nov, 2017	8 Feb, 2018
xiii.	Hydro mechanical works	4 May, 2018	7 Aug, 2018
xiv.	Plunge pool	30 July, 2015	30 July, 2015
xv.	Civil works I	8 Sept, 2017	8 Sept, 2017
xvi.	Hydro mechanical work I	18 Dec, 2018	18 Dec, 2018
xvii.	Pressure shaft	3 Oct, 2016	3 Oct, 2016
xviii.	Power house complex	19 Nov, 2012	19 Nov, 2012
xix.	Civil works II	23 Feb, 2018	15 May, 2018

Description of work		Completion as per tender schedule	Completion as per revised schedule
xx.	Civil works III	27 Dec, 2016	16 March, 2017
xxi.	Civil works IV	22 Aug, 2016	9 Nov, 2016
xxii.	Hydro mechanical work II	1 Aug, 2017	19 Oct, 2017
xxiii.	Portal development I	13 Jan, 2014	17 April, 2017
xxiv.	Underground excavation(TRT 1 & 2)	2 Feb, 2015	7 May, 2015
xxv.	Underground excavation(TRT 3 & 4)	17 Dec, 2015	22 March, 2016
xxvi.	Lining(TRT 1 & 2)	10 Aug, 2016	15 Nov, 2016
xvii.	Lining(TRT 3 & 4)	17 Jul, 2017	19 Oct, 2017
xviii.	Outlet structure (Tunnel 1& 2)	2 June, 2017	6 Sept, 2017
xxix.	Outlet structure (Tunnel 3& 4)	15 May, 2018	7 Aug, 2018
xxx.	Port head yard	28 Dec,2018	2 April, 2019

As per tender schedule total duration of the project = 1582 days

As per revised schedule total duration of the project = 1649 days

Therefore;

Net Effective Delay = Revised Schedule duration – Tender Schedule duration

= 1649 – 1582

= 67 days

CHAPTER-5

CONCLUSION

5.1 Conclusion

This research has identified 63 factors classified into seven groups responsible for delays in construction projects through the literature review & review of questionnaire survey from twenty respondents. This gives all the combination of factors and categories responsible for construction delays. Ratings given by respondents are not same as the response from different organisation have different point of view on factor causing delay. The data from the questionnaire survey were analysed. This results into a consolidated list of factors according to their ranking. Various indices like Importance Index (I.I), Frequency Index (F.I) and Severity Index (S.I) were determined to assess the probability and impact of the factors at various stages based on the requirement of the project. Each study has rated with their influence in the project. These ranks were compared for better understanding.

From the study top five factors has been found which are majorly responsible for delay in any construction projects are: Equipment breakdown (Rank 1), Shortage of labors (Rank 2), Delay in sub-contractor work (Rank 3), Shortage of equipment (Rank 4) and Low productivity level of labors (Rank 5) were the major causes for the delay in the Construction project. It has been also concluded that the delay duration was quantified using primavera and the net effective delay was found to be as 67 Days.

5.2 Future Scope

In this study delay analysis has been done by calculating frequency index, severity index and importance index and by quantifying delay using Primavera. Some other methodology can be adopted for delay analysis in construction projects like Computerizing Isolated Collapsed But –For (ICBF), Integrated Approach and Delay Section.

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ANNEXURE-1
CALCULATION OF FREQUENCY INDEX (PROBABILITY OF DELAY):

S.N.	Types Of Factors	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14	R 15	R 16	R 17	R 18	R 19	R 20	F.I. $(\sum a\times n)/(A\times N)$
A	**Owner Contributed Factors**																					
1	Delay in progress payments	1	4	5	2	5	2	2	2	2	4	3	2	3	4	1	3	1	3	3	3	0.55
2	Delay to furnish and deliver the site	5	1	5	3	5	1	2	3	1	5	4	3	4	3	1	2	1	2	2	3	0.56
3	Change orders by owner during construction	3	2	4	3	4	2	1	3	2	2	3	2	4	5	1	1	2	1	2	1	0.48
4	Late in revisisng and approving design documents	3	3	4	2	3	1	2	4	1	5	2	4	3	4	2	2	3	2	1	2	0.53
5	Delay in approving shop drawing and sample material	3	1	4	2	4	1	3	3	1	4	3	3	2	3	1	2	2	2	1	2	0.47
6	Poor communicatio n and coordination	4	1	4	2	5	2	2	3	2	5	2	3	3	5	2	1	1	2	1	2	0.52
7	Slowness in decision making process	4	3	5	3	4	2	3	3	2	4	3	2	4	3	1	2	1	2	1	2	0.54
8	Conflicts between joint-ownership of the project	4	1	4	3	3	1	1	3	1	4	2	3	3	4	2	2	1	2	2	1	0.47
9	Suspension of work by owner	3	1	5	1	2	1	1	3	1	4	2	1	2	5	1	1	4	1	2	1	0.42
B	**Contractor Contributed Factors**																					
1	Difficulties in financing project	4	1	5	1	5	2	3	1	2	4	4	2	5	4	1	2	2	2	2	2	0.54

S.N.	Types Of Factors	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14	R 15	R 16	R 17	R 18	R 19	R 20	F.I.
2	Conflict in subcontractor s schedule in execution of project	3	3	5	4	4	2	4	1	2	3	4	4	4	3	2	2	3	3	1	3	0.6
3	Rework due to errors during construction	4	2	4	3	5	1	3	2	1	4	3	3	3	4	1	1	2	2	2	1	0.51
4	Conflicts between contractor and other parties	4	1	4	3	4	1	3	2	1	4	3	2	5	5	2	1	5	1	2	2	0.55
5	Poor communicatio n and coordination	4	2	5	2	5	2	2	1	2	5	2	2	3	5	1	2	1	1	3	2	0.35
6	Ineffective planning and scheduling of project	4	3	5	2	4	1	3	1	1	5	3	1	5	5	2	1	2	1	2	1	0.52
7	Improper construction methods implement	2	2	5	1	3	1	4	1	1	4	4	2	4	5	1	1	4	2	1	2	0.5
8	Delay in sub-contractor work	4	4	4	3	4	2	5	3	2	4	5	3	4	4	3	2	4	3	2	3	0.68
9	Inadequate contractor's work	4	1	5	1	4	2	5	1	2	4	4	3	4	3	1	2	3	3	3	3	0.58
C	**Consultant Contributed Factors**																					
1	Delay in approving major changes in the scope of work	4	1	5	2	3	1	3	1	1	4	3	3	4	5	1	1	4	2	3	2	0.53
2	Poor communicatio n and coordination	4	1	4	2	4	1	3	1	1	4	4	3	2	3	2	1	4	2	2	2	0.5
3	Inadequate experience of consultant	4	1	4	1	2	1	4	1	1	5	4	2	1	4	3	1	1	1	2	2	0.45
4	Mistakes and discrepancies in design documents	4	2	5	1	2	1	2	3	1	4	2	2	2	5	1	1	2	2	2	2	0.46

S.N.	Types Of Factors	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14	R 15	R 16	R 17	R 18	R 19	R 20	F.I.
5	Delay in producing design documents	5	3	4	2	3	1	3	2	1	5	4	3	3	3	1	2	2	2	2	2	0.53
6	Insufficient data collection and survey before design	3	1	5	1	4	1	4	2	1	5	4	2	4	5	1	2	4	2	3	3	0.57
7	Un-use of advanced engineering design software	3	1	4	2	3	2	5	1	2	2	5	1	3	4	3	1	1	4	4	3	0.54
8	Conflicts with other parties and financial problems	3	1	4	2	3	2	3	1	2	3	3	2	5	4	1	1	2	3	2	1	0.48
9	Unclear and inadequate details in drawings	4	2	4	1	4	2	3	1	1	4	3	1	4	5	1	1	2	2	1	2	0.48
D	**Material Contributed Factors**																					
1	Shortage of construction material in market	4	1	5	2	2	2	3	3	2	4	4	2	3	4	3	2	3	2	2	2	0.55
2	Change in material type during construction	3	3	3	2	2	1	3	2	1	4	2	2	4	3	1	1	1	1	1	2	0.42
3	Delay in material delivery	4	2	4	2	4	2	3	2	2	5	4	4	5	4	3	2	1	2	1	3	0.59
4	Damage of sorted material while they are needed urgently	4	1	5	2	4	1	3	1	1	5	3	2	4	5	1	1	1	3	2	2	0.51
5	Delay in manufacturing special building materials	3	1	5	2	4	1	4	2	1	4	5	3	4	4	1	2	2	2	2	1	0.53
6	Late procurement of material	4	3	5	2	5	2	4	3	2	4	4	3	4	5	2	1	2	2	1	1	0.59
7	Quality problem with procured material	4	3	4	1	4	2	3	2	2	3	3	2	4	4	1	1	3	2	2	1	0.51

S.N.	Types Of Factors	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14	R 15	R 16	R 17	R 18	R 19	R 20	F.I.
8	Procuring undesired or unwanted material instead	4	1	4	3	3	1	2	2	1	4	2	1	4	5	1	1	1	1	3	2	0.46
9	Problem with material transport and processing at site	3	1	4	2	4	2	3	2	2	5	3	4	5	4	1	2	3	4	1	2	0.57
E	**Equipment Contributed Factors**																					
1	Equipment breakdowns	5	3	5	2	4	2	4	3	2	4	4	3	5	4	4	2	2	1	2	3	0.64
2	Shortage of equipment	5	3	4	2	5	2	4	3	2	4	4	3	5	4	3	2	2	2	3	2	0.64
3	Low level of equipment-operator's skill	2	1	4	2	4	2	4	2	2	3	4	3	4	4	2	2	5	3	2	1	0.56
4	Low productivity and efficiency of equipment	4	2	4	1	4	2	4	3	2	4	5	2	4	5	1	1	2	2	1	1	0.54
5	Lack of heavy equipment when needed	4	1	4	2	3	1	4	3	1	4	5	2	4	4	1	1	2	2	2	1	0.51
6	Wrong kind verity of equipment	3	1	5	1	3	1	2	3	1	3	2	1	2	5	2	1	1	1	1	1	0.4
7	Lack of hi-tech and advanced equipment	3	1	3	2	4	2	5	2	2	3	4	2	5	3	2	2	3	3	3	2	0.56
8	Unavailability of special equipment	4	1	4	2	3	2	5	3	2	3	4	2	4	5	2	1	3	4	3	2	0.59
9	Difficulty in transporting equipment	3	1	4	2	4	1	5	3	1	4	5	3	4	4	3	2	2	3	2	2	0.58
F	**Labour Contributed Factors**																					
1	Shortage of labors	4	3	5	2	3	2	5	4	2	4	5	2	4	5	2	2	3	4	2	2	0.65
2	Working permit of labors	3	1	3	2	5	1	4	3	1	4	4	2	2	3	1	1	3	2	2	1	0.48
3	Low productivity level of labors	4	3	4	2	5	2	4	3	2	4	4	3	4	5	2	2	3	2	2	3	0.63
4	Personal conflicts	2	1	4	3	4	1	2	4	1	3	3	1	2	4	1	1	2	1	1	1	0.42

S.N.	Types Of Factors	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14	R 15	R 16	R 17	R 18	R 19	R 20	F.I.
5	High labor wages	4	3	3	3	5	1	1	3	1	4	1	1	2	4	1	1	2	3	2	2	0.47
6	Labor exodus	3	1	4	3	4	1	2	3	1	4	3	2	3	4	1	1	2	2	2	1	0.47
7	Labor strikes at site	4	3	5	2	3	2	2	4	2	3	3	2	4	5	2	2	2	2	1	1	0.54
8	Labor health problem when working in hazardous condition	4	1	4	2	3	2	5	4	2	4	5	3	4	5	2	3	2	3	1	2	0.48
9	Labor safety problems	4	1	4	2	5	2	5	3	1	4	5	3	4	4	2	2	2	2	2	2	0.59
G	**External Factors**																					
1	Effect of sub-surface and ground condition factors	4	3	4	2	3	2	3	4	2	4	4	3	4	4	3	2	2	2	2	3	0.6
2	Delay in obtaining permits from municipality	4	3	4	2	4	1	4	3	1	4	4	2	3	5	1	2	2	2	1	1	0.53
3	Weather effect on construction activities	5	3	4	2	3	2	5	4	2	5	5	3	4	4	2	2	2	4	3	4	0.68
4	Traffic control and restriction at job site	4	1	4	2	3	1	4	4	1	3	5	2	2	4	1	1	2	2	2	4	0.52
5	Accident during construction	5	2	5	1	4	2	4	3	2	4	4	2	2	5	1	2	2	2	2	2	0.56
6	Changes in government regulations and laws	5	2	5	2	2	1	2	2	1	3	2	2	2	5	2	1	2	2	2	2	0.47
7	Delay in providing services from utilities	4	1	4	2	3	2	2	3	2	4	2	3	4	5	1	2	3	2	2	1	0.52
8	Delay in performing final inspection and certification	3	3	4	2	5	1	4	2	1	3	4	2	4	4	1	2	2	1	3	2	0.53
9	Civil unrest and public strikes	5	1	4	2	1	1	3	4	1	3	4	4	4	5	1	1	2	1	1	2	0.5

ANNEXURE-2

CALCULATIONS OF SEVERITY INDEX (IMPACT OF DELAY):

S.N.	Types Of Factors	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14	R 15	R 16	R 17	R 18	R 19	R 20	S.I. $(\sum a\times n)/(A\times N)$
A	**Owner Contributed Factors**																					
1	Delay in progress payments	1	5	5	3	5	4	3	2	4	5	3	4	2	4	4	3	2	4	4	4	0.63
2	Delay to furnish and deliver the site	5	2	5	4	5	4	4	3	4	4	4	4	4	5	5	4	2	3	3	3	0.77
3	Change orders by owner during construction	1	2	3	4	4	4	3	2	4	1	3	5	4	3	5	4	4	3	3	2	0.64
4	Late in revising and approving design documents	1	3	4	3	4	5	3	3	5	5	3	5	3	5	5	4	4	2	2	2	0.71
5	Delay in approving shop drawing and sample material	1	2	4	3	5	4	4	2	4	4	4	4	3	5	3	5	2	3	2	3	0.67
6	Poor communication and coordination	3	2	4	3	5	4	4	2	4	5	4	4	3	4	4	5	2	3	3	2	0.7
7	Slowness in decision making process	4	3	5	3	5	4	5	3	4	3	5	3	4	3	5	4	1	3	4	4	0.75
8	Conflicts between joint-ownership of the project	4	2	4	3	3	3	2	3	3	5	2	4	3	4	2	4	1	4	3	3	0.62
9	Suspension of work by owner	1	4	5	4	5	5	1	3	5	5	1	3	2	5	3	5	1	2	2	3	0.63
B	**Contractor Contributed Factors**																					
1	Difficulties in financing project	4	3	5	3	5	4	4	1	4	5	4	4	5	4	4	4	4	3	4	4	0.78

S.N.	Types Of Factors	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14	R 15	R 16	R 17	R 18	R 19	R 20	S.I.
2	Conflict in subcontractors schedule in execution of project	3	4	5	4	5	4	5	1	4	3	5	5	4	3	5	4	4	4	2	4	0.74
3	Rework due to errors during construction	1	4	4	4	4	4	4	1	4	3	4	4	4	4	5	5	4	4	4	3	0.74
4	Conflicts between contractor and other parties	4	1	4	4	4	4	4	1	4	5	3	3	4	3	4	4	5	4	3	4	0.72
5	Poor communication and coordination	4	3	5	4	5	4	3	1	4	5	3	3	3	5	4	4	4	3	3	3	0.73
6	Ineffective planning and scheduling of project	4	5	5	4	4	5	5	1	5	5	5	3	4	5	5	5	4	3	2	4	0.83
7	Improper construction methods implement	2	4	5	2	4	5	5	1	5	4	5	3	3	5	4	5	2	5	3	4	0.76
8	Delay in sub-contractor work	4	3	4	4	5	4	5	2	4	5	5	4	4	4	4	4	4	4	4	3	0.8
9	Inadequate contractor's work	4	1	5	2	4	4	5	1	4	5	5	4	4	3	4	4	4	4	3	3	0.78
C	**Consultant Contributed Factors**																					
1	Delay in approving major changes in the scope of work	4	2	5	4	5	5	4	1	5	4	4	4	4	5	5	5	2	2	3	4	0.77
2	Poor communication and coordination	4	1	4	4	5	5	4	1	5	5	4	4	3	4	4	4	2	2	3	3	0.73
3	Inadequate experience of consultant	4	3	4	2	4	4	5	1	4	5	5	4	1	4	2	5	2	3	2	3	0.67
4	Mistakes and discrepancy in design documents	4	3	5	2	4	5	3	2	5	5	3	4	3	5	4	5	4	4	2	3	0.75

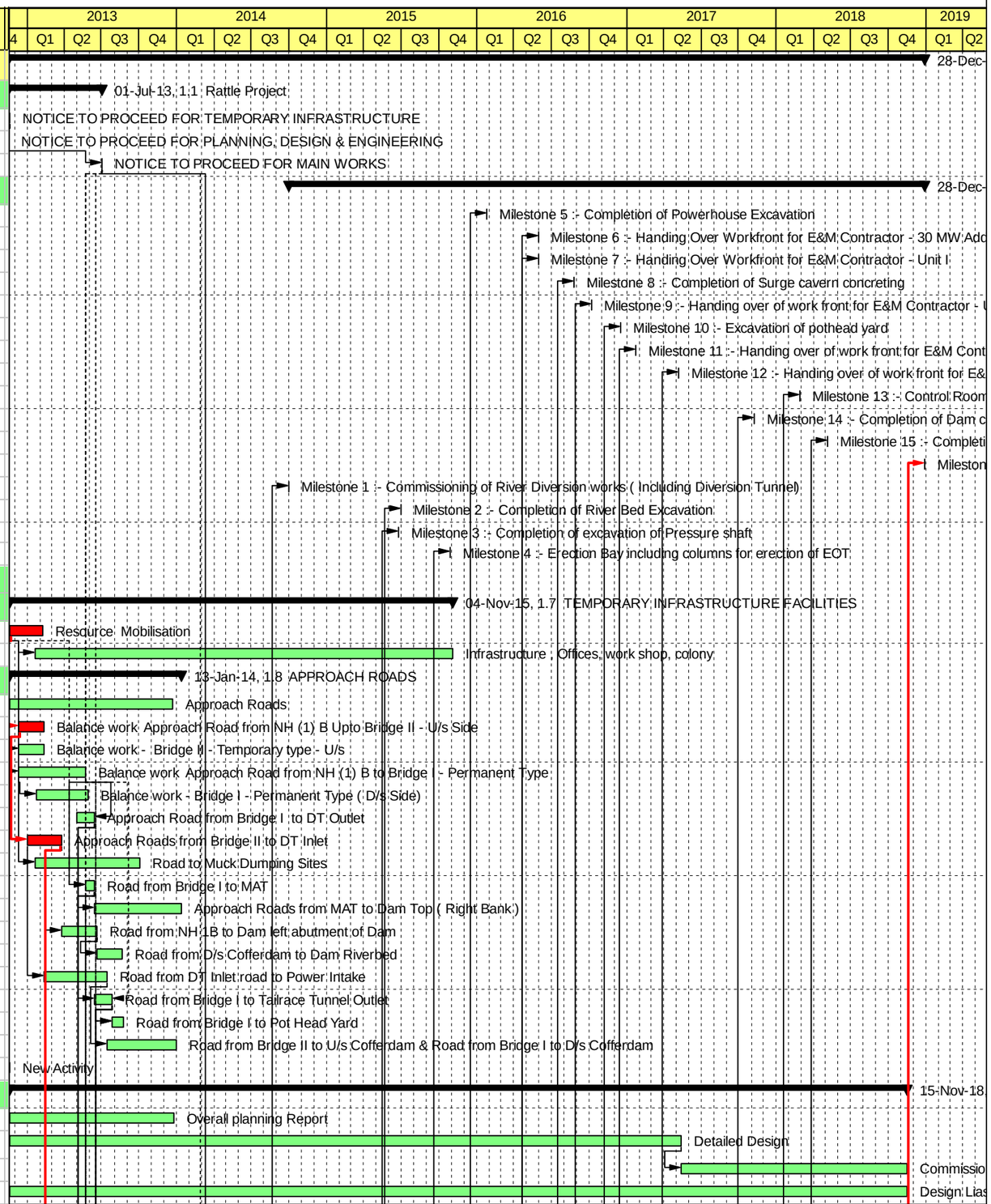
S.N.	Types Of Factors	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14	R 15	R 16	R 17	R 18	R 19	R 20	S.I.
5	Delay in producing design documents	5	4	4	4	5	4	4	2	4	5	3	4	3	3	4	4	4	4	4	4	0.78
6	Insufficient data collection and survey before design	3	1	5	4	5	5	5	1	5	5	5	3	4	5	2	5	4	4	4	3	0.78
7	Un-use of advanced engineering design software	3	1	4	4	3	3	5	1	3	2	5	3	2	4	4	4	2	3	4	5	0.65
8	Conflicts with other parties and financial problems	3	1	4	4	4	4	4	1	4	3	4	3	4	4	4	4	4	3	3	4	0.69
9	Unclear and inadequate details in drawings	4	3	4	4	5	4	3	1	4	4	3	3	4	5	5	4	5	3	4	2	0.73
D	**Material Contributed Factors**																					
1	Shortage of construction material in market	4	1	5	4	4	4	4	2	4	5	4	4	3	4	5	5	5	4	4	4	0.88
2	Change in material type during construction	3	3	3	4	3	4	3	2	4	4	3	3	4	3	4	4	4	3	4	4	0.69
3	Delay in material delivery	4	3	4	4	5	5	5	2	5	5	5	5	5	4	4	5	5	4	3	4	0.86
4	Damage of sorted material while they are needed urgently	4	1	5	4	5	5	5	1	5	4	5	4	4	5	5	5	4	3	3	4	0.81
5	Delay in manufacturing special building materials	3	1	5	4	4	5	5	1	5	4	5	4	4	4	5	5	4	3	3	3	0.77
6	Late procurement of material	5	3	3	4	5	5	5	2	5	4	5	4	4	5	4	5	4	3	3	3	0.67

S.N.	Types Of Factors	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14	R 15	R 16	R 17	R 18	R 19	R 20	S.I.
7	Quality problem with procured material	3	3	4	4	4	4	4	2	4	3	4	3	4	4	4	4	4	3	3	3	0.71
8	Procuring undesired or unwanted material instead	4	1	4	2	3	3	3	2	3	4	3	3	4	5	4	4	2	3	2	2	0.61
9	Problem with material transport and processing at site	3	1	4	4	4	5	4	2	5	5	4	4	4	4	5	4	4	4	3	3	0.76
E	**Equipment Contributed Factors**																					
1	Equipment breakdowns	5	2	5	4	5	5	5	2	5	4	5	4	5	4	5	5	5	5	4	5	0.89
2	Shortage of equipment	5	3	4	4	5	4	5	3	4	4	5	4	5	4	5	5	5	4	3	3	0.84
3	Low level of equipment-operator's skill	3	1	3	4	4	4	5	2	4	3	5	4	4	3	4	4	5	3	3	4	0.81
4	Low productivity and efficiency of equipment	4	3	3	4	2	4	5	2	4	5	5	4	4	4	5	4	4	3	2	3	0.74
5	Lack of heavy equipment when needed	4	2	4	4	2	4	4	3	4	5	5	4	4	4	3	4	4	5	3	3	0.75
6	Wrong kind verityof equipment	3	1	5	2	5	5	4	3	5	4	4	3	3	5	5	5	4	5	4	2	0.77
7	Lack of hi-tech and advanced equipment	3	1	3	4	3	3	5	1	3	3	5	4	5	3	5	4	4	4	2	4	0.69
8	Unavailabilit y of special equipment	4	1	4	4	5	3	5	3	3	3	5	4	4	5	4	5	4	3	3	3	0.75
9	Difficulty in transporting equipment	3	1	4	4	4	5	5	2	5	4	5	4	4	4	4	5	5	3	3	4	0.78

S.N.	Types Of Factors	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14	R 15	R 16	R 17	R 18	R 19	R 20	S.I.
F	**Labour Contributed Factors**																					
1	Shortage of labors	4	4	5	4	4	4	5	3	4	5	5	4	4	5	5	4	4	5	5	4	0.87
2	Working permit of labors	3	1	3	4	4	4	5	3	4	4	4	4	3	3	5	5	4	2	2	3	0.7
3	Low productivity level of labors	4	5	4	4	5	4	5	3	4	4	5	4	4	5	4	4	4	4	4	4	0.84
4	Personal conflicts among labors	2	1	4	3	4	3	3	3	3	4	3	3	2	4	3	4	2	2	2	3	0.58
5	High labor wages	3	4	3	2	1	3	1	3	3	4	1	2	3	4	5	2	2	3	3	3	0.55
6	Labor exodus	3	1	4	2	2	5	3	3	5	4	3	4	3	4	4	5	2	3	2	3	0.65
7	Labor strikes at site	4	3	5	4	5	5	4	3	5	3	4	5	4	5	5	5	2	5	4	4	0.84
8	Labor health problem when working in hazardous condition	3	1	4	4	5	4	5	3	4	4	5	4	4	5	4	4	4	4	2	3	0.76
9	Labor safety problems	4	1	4	4	5	4	5	2	4	4	5	4	4	4	3	4	4	2	2	2	0.71
G	**External Factors**																					
1	Effect of sub-surface and ground condition factors	4	5	4	4	5	5	4	4	5	4	4	4	4	4	5	5	5	3	3	4	0.85
2	Delay in obtaining permits from municipality	4	3	4	4	4	4	4	3	4	4	5	4	4	5	5	5	5	5	2	3	0.81
3	Weather effect on construction activities	5	2	4	4	4	5	5	4	5	4	5	5	4	4	4	5	5	5	4	4	0.77

S.N.	Types Of Factors	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14	R 15	R 16	R 17	R 18	R 19	R 20	S.I.
4	Traffic control and restriction at job site	4	1	4	4	3	4	4	3	4	3	5	3	3	4	4	3	4	4	4	4	0.72
5	Accident during construction	5	5	5	4	5	4	4	2	4	5	4	4	2	5	5	4	5	2	3	3	0.8
6	Changes in government regulations and laws	5	3	5	4	4	4	3	2	4	4	3	3	2	5	4	2	2	3	3	3	0.68
7	Delay in providing services from utilities	4	1	5	4	4	4	3	2	4	4	3	4	4	5	4	4	4	3	3	3	0.58
8	Delay in performing final inspection and certification	3	3	4	4	5	4	4	2	4	3	4	3	4	4	3	4	2	3	3	4	0.66
9	Civil unrest and public strikes	5	2	4	4	5	5	4	3	5	3	4	5	4	5	5	5	4	4	2	3	0.81

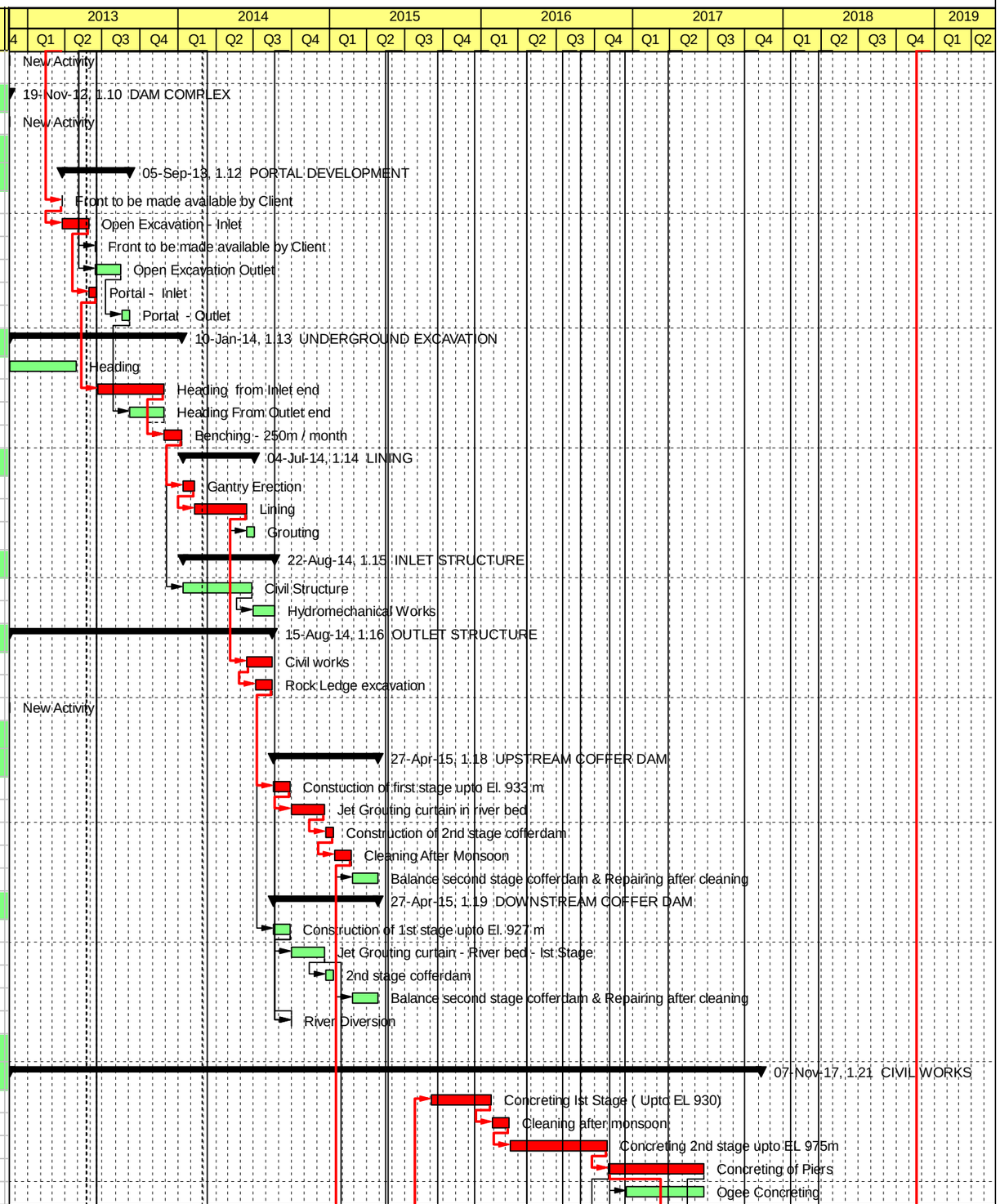
Activity ID	Activity Name	Original Duration	Start	Finish
1	Rattle H.E. project	1594	17-Nov-12	28-Dec-18
1.1	**Rattle Project**	160	17-Nov-12	01-Jul-13
2	NOTICE TO PROCEED FOR TEMPORARY INFRASTRUCTURE	0	19-Nov-12	19-Nov-12
3	NOTICE TO PROCEED FOR PLANNING, DESIGN & ENGINEERING	0	17-Nov-12	17-Nov-12
4	NOTICE TO PROCEED FOR MAIN WORKS	0	01-Jul-13	01-Jul-13
1.5	**MILESTONES**	1109	29-Sep-14	28-Dec-18
10	Milestone 5 :- Completion of Powerhouse Excavation	0	25-Jan-16	25-Jan-16
11	Milestone 6 :- Handing Over Workfront for E&M Contractor - 30 MW Additional u...	0	31-May-16	31-May-16
12	Milestone 7 :- Handing Over Workfront for E&M Contractor - Unit I	0	31-May-16	31-May-16
13	Milestone 8 :- Completion of Surge cavern concreting	0	24-Aug-16	24-Aug-16
14	Milestone 9 :- Handing over of work front for E&M Contractor - Unit – II	0	07-Oct-16	07-Oct-16
15	Milestone 10 :- Excavation of pothead yard	0	16-Dec-16	16-Dec-16
16	Milestone 11 :- Handing over of work front for E&M Contractor - Unit – III	0	23-Jan-17	23-Jan-17
17	Milestone 12 :- Handing over of work front for E&M Contractor - Unit – IV	0	08-May-17	08-May-17
18	Milestone 13 :- Control Room Civil works to be handed over to E&M	0	27-Feb-18	27-Feb-18
19	Milestone 14 :- Completion of Dam concreting	0	08-Nov-17	08-Nov-17
20	Milestone 15 :- Completion of Dam Works for Reservoir Impounding	0	07-May-18	07-May-18
21	Milestone 16 :- Commercial Operation Date for the Project	0	28-Dec-18	28-Dec-18
6	Milestone 1 :- Commissioning of River Diversion works (Including Diversion Tun...	0	29-Sep-14	29-Sep-14
7	Milestone 2 :- Completion of River Bed Excavation	0	01-Jul-15	01-Jul-15
8	Milestone 3 :- Completion of excavation of Pressure shaft	0	25-Jun-15	25-Jun-15
9	Milestone 4 :- Erection Bay including columns for erection of EOT	0	29-Oct-15	29-Oct-15
1.6	**ACTIVITIES - NOTICE TO PROCEED FOR TEMPORARY I...**	0		
1.7	**TEMPORARY INFRASTRUCTURE FACILITIES**	773	19-Nov-12	04-Nov-15
25	Resource Mobilisation	60	19-Nov-12	08-Feb-13
26	Infrastructure , Offices, work shop, colony	728	21-Jan-13	04-Nov-15
1.8	**APPROACH ROADS**	301	19-Nov-12	13-Jan-14
28	Approach Roads	285	19-Nov-12	20-Dec-13
29	Balance work Approach Road from NH (1) B Upto Bridge II - U/s Side	45	11-Dec-12	11-Feb-13
30	Balance work - Bridge II - Temporary type - U/s	45	11-Dec-12	11-Feb-13
31	Balance work Approach Road from NH (1) B to Bridge I - Permanent Type	118	11-Dec-12	23-May-13
32	Balance work - Bridge I - Permanent Type (D/s Side)	90	23-Jan-13	28-May-13
33	Approach Road from Bridge I to DT Outlet	30	03-May-13	13-Jun-13
34	Approach Roads from Bridge II to DT Inlet	60	01-Jan-13	25-Mar-13
35	Road to Muck Dumping Sites	182	21-Jan-13	01-Oct-13
36	Road from Bridge I to MAT	15	24-May-13	13-Jun-13
37	Approach Roads from MAT to Dam Top (Right Bank)	152	14-Jun-13	13-Jan-14
38	Road from NH 1B to Dam left abutment of Dam	62	26-Mar-13	19-Jun-13
39	Road from D/s Cofferdam to Dam Riverbed	45	20-Jun-13	21-Aug-13
40	Road from DT Inlet road to Power Intake	110	12-Feb-13	15-Jul-13
41	Road from Bridge I to Tailrace Tunnel Outlet	30	14-Jun-13	25-Jul-13
42	Road from Bridge I to Pot Head Yard	20	26-Jul-13	22-Aug-13
43	Road from Bridge II to U/s Cofferdam & Road from Bridge I to D/s Cofferdam	120	16-Jul-13	30-Dec-13
44	New Activity	0	19-Nov-12	19-Nov-12
1.9	**ACTIVITIES - NOTICE TO PROCEED FOR PLANNING, DE...**	1564	19-Nov-12	15-Nov-18
46	Overall planning Report	288	19-Nov-12	25-Dec-13
47	Detailed Design	1170	19-Nov-12	12-May-17
48	Commissioning manual and O&M Manual	394	15-May-17	15-Nov-18
49	Design Liasion with owner	1564	19-Nov-12	15-Nov-18



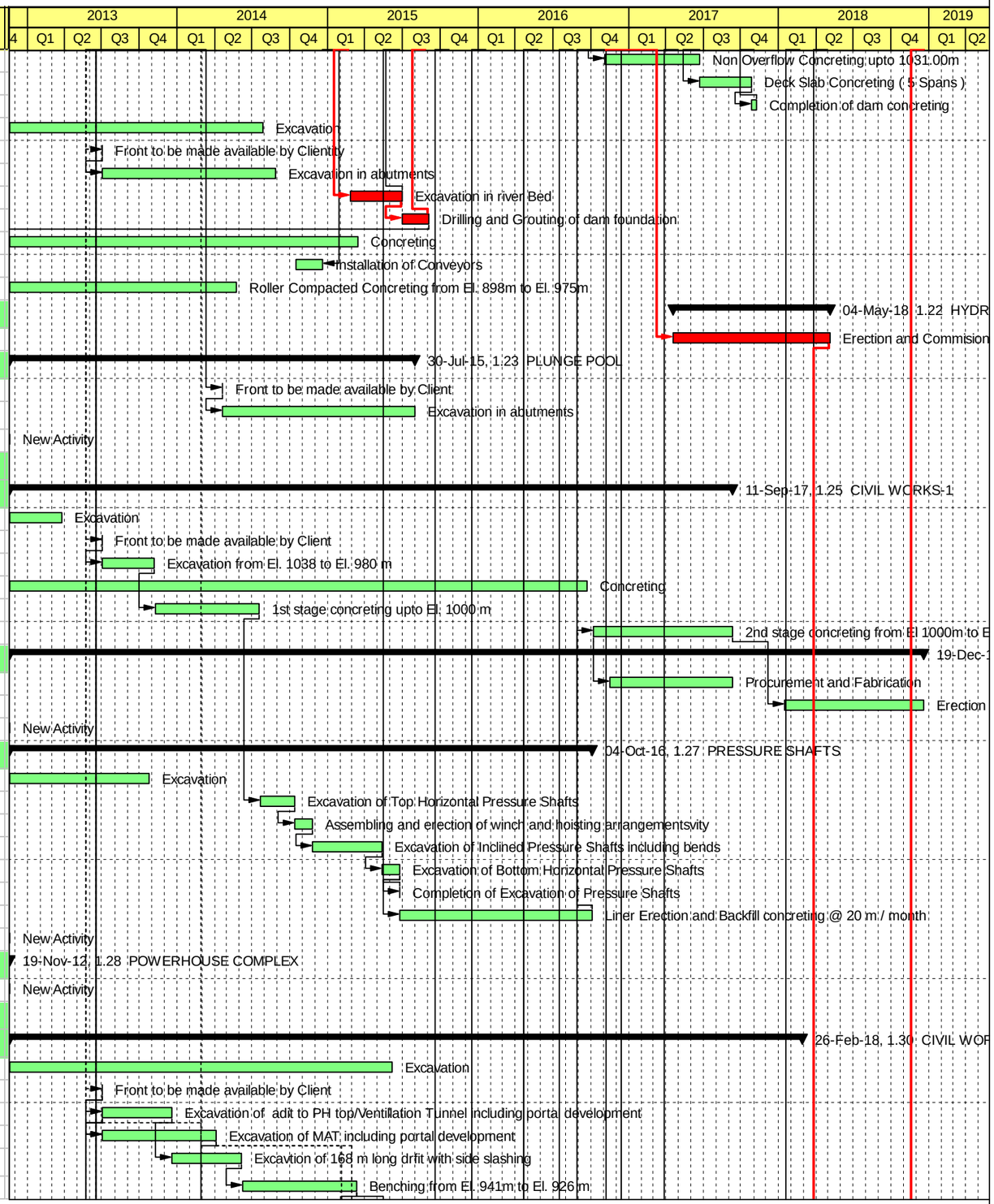
Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

TASK filter: All Activities

Activity ID	Activity Name	Original Duration	Start	Finish
50	New Activity	0	19-Nov-12	19-Nov-12
1.10	**DAM COMPLEX**	0	19-Nov-12	19-Nov-12
52	New Activity	0	19-Nov-12	19-Nov-12
1.11	**DIVERSION TUNNELS**	0		
1.12	**PORTAL DEVELOPMENT**	117	27-Mar-13	05-Sep-13
55	Front to be made available by Client	0	27-Mar-13	27-Mar-13
56	Open Excavation - Inlet	45	27-Mar-13	28-May-13
57	Front to be made available by Client	0	14-Jun-13	14-Jun-13
58	Open Excavation Outlet	45	14-Jun-13	15-Aug-13
59	Portal - Inlet	15	29-May-13	18-Jun-13
60	Portal - Outlet	15	16-Aug-13	05-Sep-13
1.13	**UNDERGROUND EXCAVATION**	300	19-Nov-12	10-Jan-14
62	Heading	116	19-Nov-12	29-Apr-13
63	Heading from Inlet end	116	19-Jun-13	27-Nov-13
64	Heading From Outlet end	58	06-Sep-13	26-Nov-13
65	Benching - 250m / month	32	28-Nov-13	10-Jan-14
1.14	**LINING**	125	13-Jan-14	04-Jul-14
67	Gantry Erection	20	13-Jan-14	07-Feb-14
68	Lining	90	10-Feb-14	13-Jun-14
69	Grouting	15	16-Jun-14	04-Jul-14
1.15	**INLET STRUCTURE**	160	13-Jan-14	22-Aug-14
71	Civil Structure	120	13-Jan-14	27-Jun-14
72	Hydromechanical Works	40	30-Jun-14	22-Aug-14
1.16	**OUTLET STRUCTURE**	455	19-Nov-12	15-Aug-14
74	Civil works	45	16-Jun-14	15-Aug-14
75	Rock Ledge excavation	30	07-Jul-14	15-Aug-14
76	New Activity	0	19-Nov-12	19-Nov-12
1.17	**COFFERDAMS**	0		
1.18	**UPSTREAM COFFER DAM**	181	18-Aug-14	27-Apr-15
79	Constuction of first stage upto El. 933 m	30	18-Aug-14	26-Sep-14
80	Jet Grouting curtain in river bed	60	29-Sep-14	19-Dec-14
81	Construction of 2nd stage cofferdam	15	22-Dec-14	09-Jan-15
82	Cleaning After Monsoon	30	13-Jan-15	23-Feb-15
83	Balance second stage cofferdam & Repairing after cleaning	45	24-Feb-15	27-Apr-15
1.19	**DOWNSTREAM COFFER DAM**	181	18-Aug-14	27-Apr-15
85	Construction of 1st stage upto El. 927 m	30	18-Aug-14	26-Sep-14
86	Jet Grouting curtain - River bed - Ist Stage	60	29-Sep-14	19-Dec-14
87	2nd stage cofferdam	15	22-Dec-14	09-Jan-15
88	Balance second stage cofferdam & Repairing after cleaning	45	24-Feb-15	27-Apr-15
89	River Diversion	0	29-Sep-14	29-Sep-14
1.20	**DAM**	0		
1.21	**CIVIL WORKS**	1297	19-Nov-12	07-Nov-17
100	Concreting Ist Stage (Upto EL 930)	104	04-Sep-15	27-Jan-16
101	Cleaning after monsoon	30	29-Jan-16	10-Mar-16
102	Concreting 2nd stage upto EL 975m	168	11-Mar-16	01-Nov-16
103	Concreting of Piers	165	03-Nov-16	21-Jun-17
104	Ogee Concreting	135	16-Dec-16	22-Jun-17



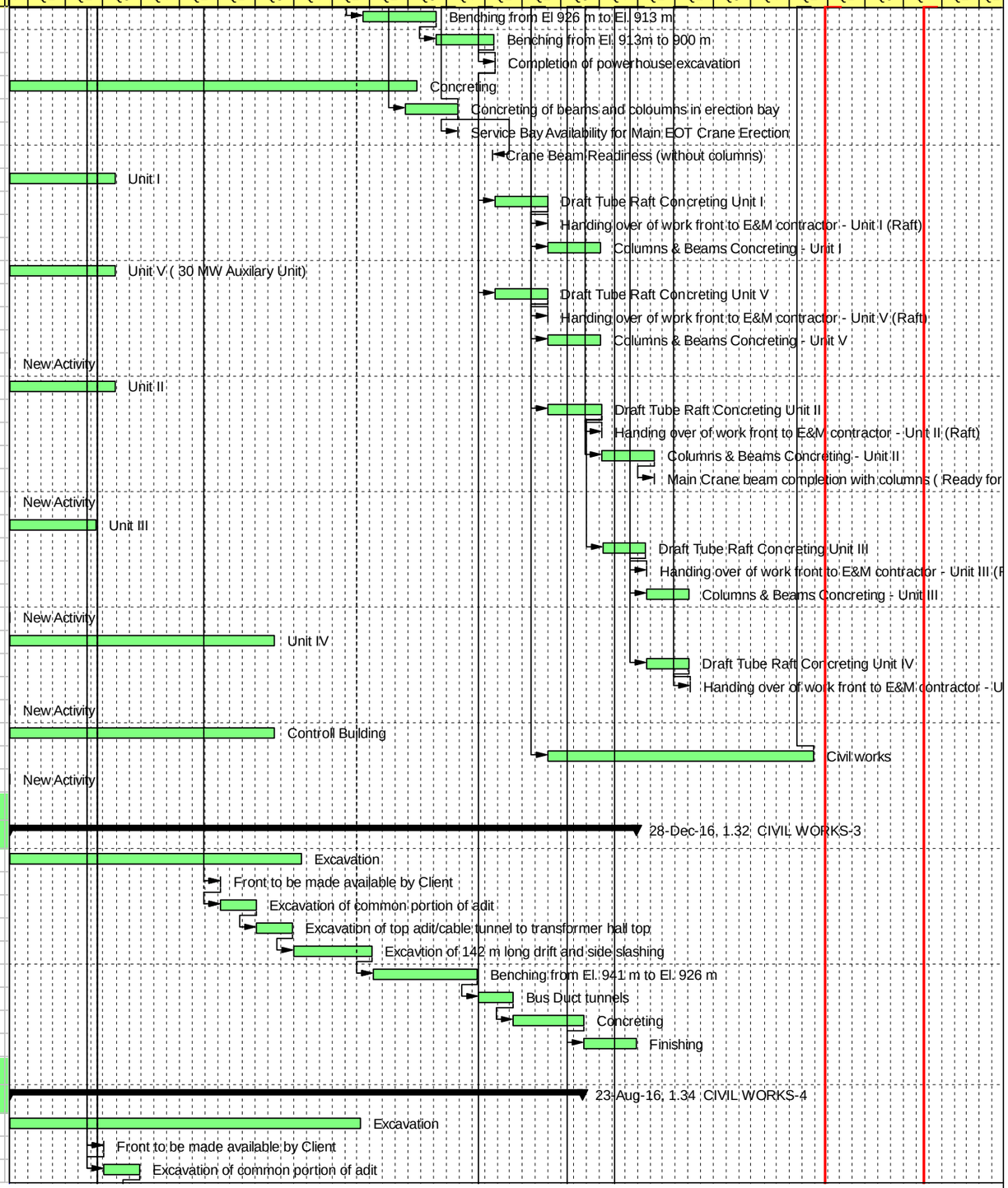
Activity ID	Activity Name	Original Duration	Start	Finish
105	Non Overflow Concreting upto 1031.00m	166	03-Nov-16	22-Jun-17
106	Deck Slab Concreting (5 Spans)	90	22-Jun-17	25-Oct-17
107	Completion of dam concreting	9	26-Oct-17	07-Nov-17
92	Excavation	441	19-Nov-12	29-Jul-14
93	Front to be made available by Clientity	0	02-Jul-13	02-Jul-13
94	Excavation in abutments	303	02-Jul-13	28-Aug-14
95	Excavation in river Bed	91	24-Feb-15	30-Jun-15
96	Drilling and Grouting of dam foundation	47	01-Jul-15	03-Sep-15
97	Concreting	606	19-Nov-12	16-Mar-15
98	Installation of Conveyors	47	16-Oct-14	19-Dec-14
99	Roller Compacted Concreting from El. 898m to El. 975m	395	19-Nov-12	23-May-14
1.22 HYDROMECHANICAL WORKS		272	20-Apr-17	04-May-18
109	Erection and Commisioning of spillway gates	272	20-Apr-17	04-May-18
1.23 PLUNGE POOL		704	19-Nov-12	30-Jul-15
111	Front to be made available by Client	0	21-Apr-14	21-Apr-14
112	Excavation in abutments	334	21-Apr-14	30-Jul-15
113	New Activity	0	19-Nov-12	19-Nov-12
1.24 POWER INTAKE STRUCTURE		0		
1.25 CIVIL WORKS-1		1256	19-Nov-12	11-Sep-17
116	Excavation	91	19-Nov-12	25-Mar-13
117	Front to be made available by Client	0	02-Jul-13	02-Jul-13
118	Excavation from El. 1038 to El. 980 m	91	02-Jul-13	05-Nov-13
119	Concreting	1003	19-Nov-12	21-Sep-16
120	1st stage concreting upto El. 1000 m	182	07-Nov-13	18-Jul-14
121	2nd stage concreting from El 1000m to El. 1031m	243	06-Oct-16	11-Sep-17
1.26 HYDROMECHANICAL WORKS-1		1588	19-Nov-12	19-Dec-18
123	Procurement and Fabrication	213	17-Nov-16	11-Sep-17
124	Erection and Commissioning	242	16-Jan-18	19-Dec-18
125	New Activity	0	19-Nov-12	19-Nov-12
1.27 PRESSURE SHAFTS		1012	19-Nov-12	04-Oct-16
127	Excavation	243	19-Nov-12	23-Oct-13
128	Excavation of Top Horizontal Pressure Shafts	61	21-Jul-14	13-Oct-14
129	Assembling and erection of winch and hoisting arrangementsvity	31	14-Oct-14	25-Nov-14
130	Excavation of Inclined Pressure Shafts including bends	121	26-Nov-14	13-May-15
131	Excavation of Bottom Horizontal Pressure Shafts	30	14-May-15	24-Jun-15
132	Completion of Excavation of Pressure Shafts	0	25-Jun-15	25-Jun-15
133	Liner Erection and Backfill concreting @ 20 m / month	334	25-Jun-15	04-Oct-16
134	New Activity	0	19-Nov-12	19-Nov-12
1.28 POWERHOUSE COMPLEX		0	19-Nov-12	19-Nov-12
136	New Activity	0	19-Nov-12	19-Nov-12
1.29 POWER HOUSE CAVERN		0		
1.30 CIVIL WORKS-2		1376	19-Nov-12	26-Feb-18
139	Excavation	665	19-Nov-12	05-Jun-15
140	Front to be made available by Client	0	02-Jul-13	02-Jul-13
141	Excavation of adit to PH top/Ventillation Tunnel including portal development	122	02-Jul-13	18-Dec-13
142	Excavation of MAT including portal development	199	02-Jul-13	04-Apr-14
143	Excavtion of 168 m long drfit with side slashing	122	19-Dec-13	06-Jun-14
144	Benching from El. 941m to El. 926 m	200	09-Jun-14	13-Mar-15



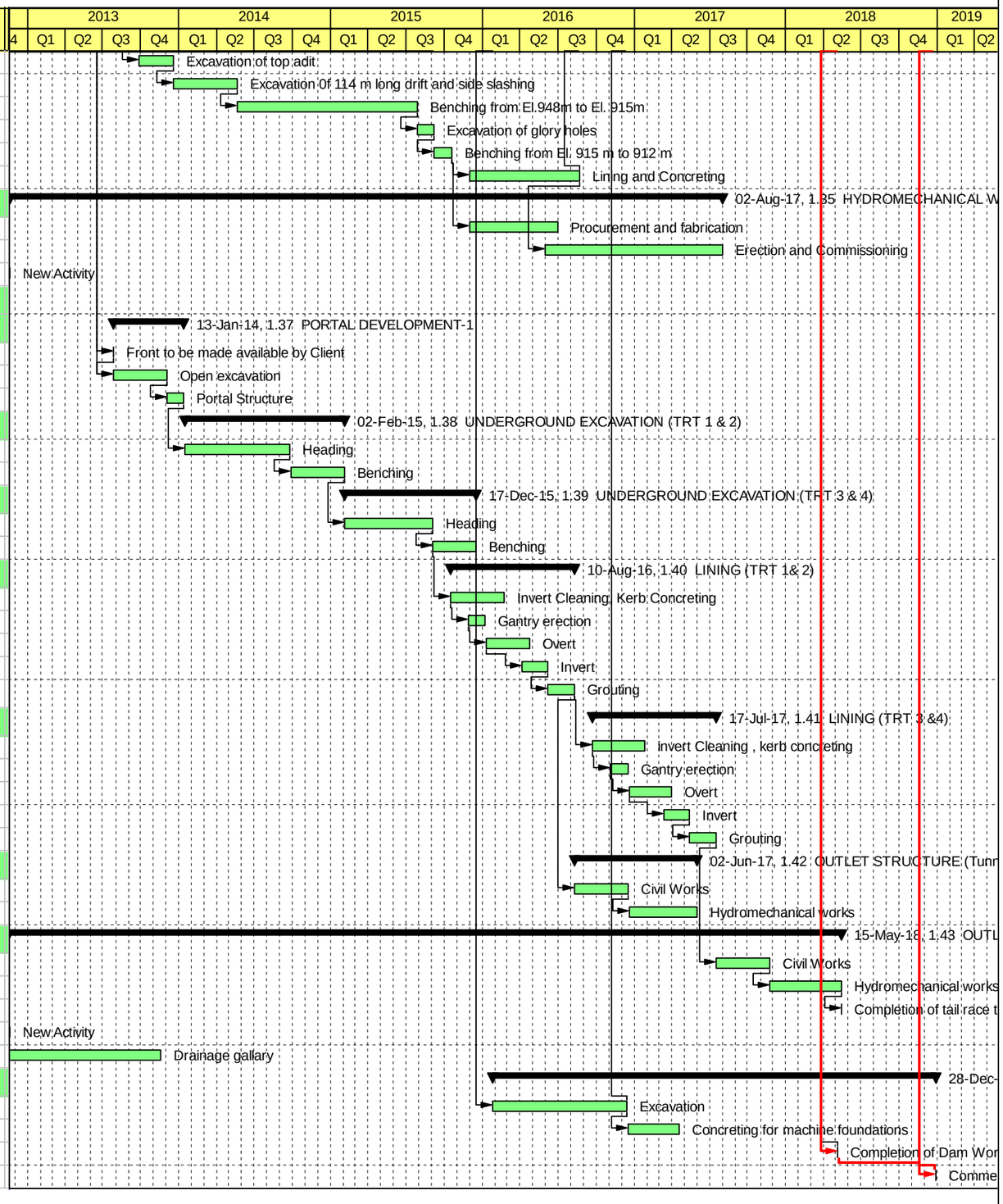
Actual Work Critical Remaining Work Summary
Remaining Work Milestone

TASK filter: All Activities

Activity ID	Activity Name	Original Duration	Start	Finish
145	Benching from El 926 m to El. 913 m	126	16-Mar-15	07-Sep-15
146	Benching from El. 913m to 900 m	99	08-Sep-15	22-Jan-16
147	Completion of powerhouse excavation	0	25-Jan-16	25-Jan-16
148	Concreting	699	19-Nov-12	23-Jul-15
149	Concreting of beams and coloumns in erection bay	91	24-Jun-15	28-Oct-15
150	Service Bay Availability for Main EOT Crane Erection	0	29-Oct-15	29-Oct-15
151	Crane Beam Readiness (without columns)	0	21-Jan-16	21-Jan-16
152	Unit I	181	19-Nov-12	29-Jul-13
153	Draft Tube Raft Concreting Unit I	91	25-Jan-16	30-May-16
154	Handing over of work front to E&M contractor - Unit I (Raft)	0	31-May-16	31-May-16
155	Columns & Beams Concreting - Unit I	90	31-May-16	03-Oct-16
156	Unit V (30 MW Auxilary Unit)	181	19-Nov-12	29-Jul-13
157	Draft Tube Raft Concreting Unit V	91	25-Jan-16	30-May-16
158	Handing over of work front to E&M contractor - Unit V (Raft)	0	31-May-16	31-May-16
159	Columns & Beams Concreting - Unit V	90	31-May-16	03-Oct-16
160	New Activity	0	19-Nov-12	19-Nov-12
161	Unit II	182	19-Nov-12	30-Jul-13
162	Draft Tube Raft Concreting Unit II	92	01-Jun-16	06-Oct-16
163	Handing over of work front to E&M contractor - Unit II (Raft)	0	07-Oct-16	07-Oct-16
164	Columns & Beams Concreting - Unit II	90	07-Oct-16	09-Feb-17
165	Main Crane beam completion with columns (Ready for Main EOT Crane Travel)	0	10-Feb-17	10-Feb-17
166	New Activity	0	19-Nov-12	19-Nov-12
167	Unit III	150	19-Nov-12	14-Jun-13
168	Draft Tube Raft Concreting Unit III	75	10-Oct-16	20-Jan-17
169	Handing over of work front to E&M contractor - Unit III (Raft)	0	23-Jan-17	23-Jan-17
170	Columns & Beams Concreting - Unit III	75	23-Jan-17	05-May-17
171	New Activity	0	19-Nov-12	19-Nov-12
172	Unit IV	455	19-Nov-12	15-Aug-14
173	Draft Tube Raft Concreting Unit IV	75	23-Jan-17	05-May-17
174	Handing over of work front to E&M contractor - Unit III (Raft)	0	08-May-17	08-May-17
175	New Activity	0	19-Nov-12	19-Nov-12
176	Controll Building	455	19-Nov-12	15-Aug-14
177	Civil works	455	31-May-16	26-Feb-18
178	New Activity	0	19-Nov-12	19-Nov-12
1.31 TRANSFORMER CAVERN		0		
1.32 CIVIL WORKS-3		1073	19-Nov-12	28-Dec-16
181	Excavation	501	19-Nov-12	20-Oct-14
182	Front to be made available by Client	0	07-Apr-14	07-Apr-14
183	Excavation of common portion of adit	64	07-Apr-14	03-Jul-14
184	Excavation of top adit/cable tunnel to transformer hall top	61	04-Jul-14	26-Sep-14
185	Excavtion of 142 m long drift and side slashing	137	29-Sep-14	07-Apr-15
186	Benching from El. 941 m to El. 926 m	180	08-Apr-15	15-Dec-15
187	Bus Duct tunnels	61	16-Dec-15	09-Mar-16
188	Concreting	120	10-Mar-16	24-Aug-16
189	Finishing	90	25-Aug-16	28-Dec-16
1.33 SURGE CAVERN		0		
1.34 CIVIL WORKS-4		982	19-Nov-12	23-Aug-16
192	Excavation	601	19-Nov-12	09-Mar-15
193	Front to be made available by Client	0	02-Jul-13	02-Jul-13
194	Excavation of common portion of adit	62	02-Jul-13	25-Sep-13



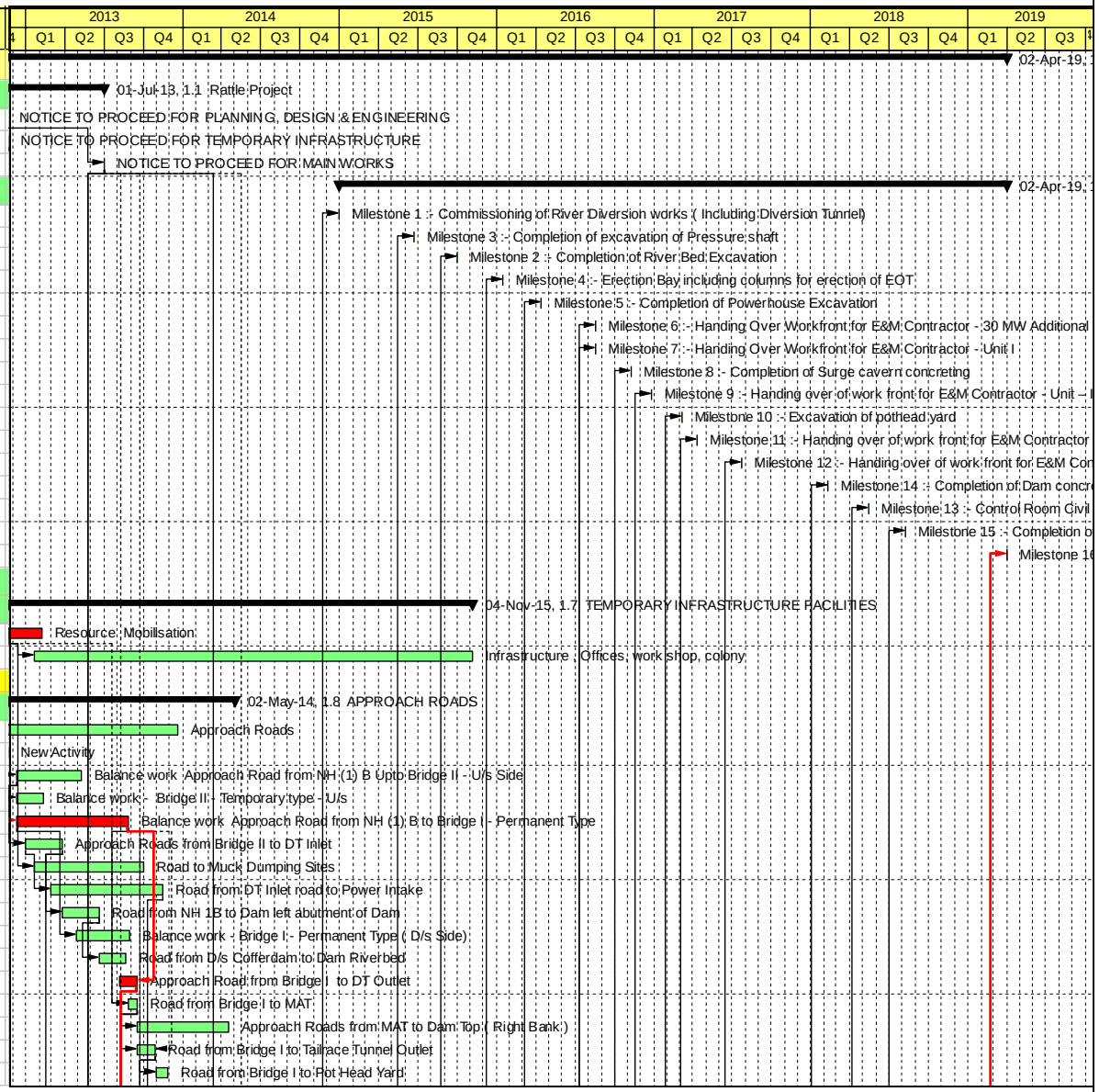
Activity ID	Activity Name	Original Duration	Start	Finish
195	Excavation of top adit	60	26-Sep-13	18-Dec-13
196	Excavation 0f 114 m long drift and side slashing	110	19-Dec-13	21-May-14
197	Benching from El.948m to El. 915m	310	22-May-14	29-Jul-15
198	Excavation of glory holes	28	30-Jul-15	07-Sep-15
199	Benching from El. 915 m to 912 m	31	08-Sep-15	20-Oct-15
200	Lining and Concreting	190	02-Dec-15	23-Aug-16
1.35 HYDROMECHANICAL WORKS-2		1228	19-Nov-12	02-Aug-17
202	Procurement and fabrication	153	02-Dec-15	01-Jul-16
203	Erection and Commissioning	306	01-Jun-16	02-Aug-17
204	New Activity	0	19-Nov-12	19-Nov-12
1.36 TAIL RACE TUNNELS		0		
1.37 PORTAL DEVELOPMENT-1		122	26-Jul-13	13-Jan-14
207	Front to be made available by Client	0	26-Jul-13	26-Jul-13
208	Open excavation	92	26-Jul-13	02-Dec-13
209	Portal Structure	30	03-Dec-13	13-Jan-14
1.38 UNDERGROUND EXCAVATION (TRT 1 & 2)		274	15-Jan-14	02-Feb-15
211	Heading	182	15-Jan-14	25-Sep-14
212	Benching	92	26-Sep-14	02-Feb-15
1.39 UNDERGROUND EXCAVATION (TRT 3 & 4)		228	03-Feb-15	17-Dec-15
214	Heading	153	03-Feb-15	03-Sep-15
215	Benching	75	04-Sep-15	17-Dec-15
1.40 LINING (TRT 1& 2)		214	16-Oct-15	10-Aug-16
217	Invert Cleaning, Kerb Concreting	92	16-Oct-15	22-Feb-16
218	Gantry erection	30	30-Nov-15	08-Jan-16
219	Overt	75	12-Jan-16	25-Apr-16
220	Invert	46	05-Apr-16	07-Jun-16
221	Grouting	46	08-Jun-16	10-Aug-16
1.41 LINING (TRT 3 &4)		212	23-Sep-16	17-Jul-17
223	invert Cleaning , kerb concreting	91	23-Sep-16	27-Jan-17
224	Gantry erection	31	04-Nov-16	16-Dec-16
225	Overt	74	19-Dec-16	30-Mar-17
226	Invert	45	13-Mar-17	12-May-17
227	Grouting	46	15-May-17	17-Jul-17
1.42 OUTLET STRUCTURE (Tunnels 1&2)		212	11-Aug-16	02-Jun-17
229	Civil Works	92	11-Aug-16	16-Dec-16
230	Hydromechanical works	120	19-Dec-16	02-Jun-17
1.43 OUTLET STRUCTURE (Tunnels 3&4)		1431	17-Nov-12	15-May-18
232	Civil Works	93	18-Jul-17	23-Nov-17
233	Hydromechanical works	122	24-Nov-17	14-May-18
234	Completion of tail race tunnels including outlet structure	0	15-May-18	15-May-18
235	New Activity	0	19-Nov-12	19-Nov-12
236	Drainage gallary	365	17-Nov-12	16-Nov-13
1.45 POTHEAD YARD		764	25-Jan-16	28-Dec-18
239	Excavation	234	25-Jan-16	15-Dec-16
240	Concreting for machine foundations	90	16-Dec-16	20-Apr-17
241	Completion of Dam Works for Impounding	0	07-May-18	07-May-18
242	Commercial Operation Date for Project	0	28-Dec-18	28-Dec-18



Actual Work | Remaining Work | Critical Remaining Work | Milestone | Summary

TASK filter: All Activities

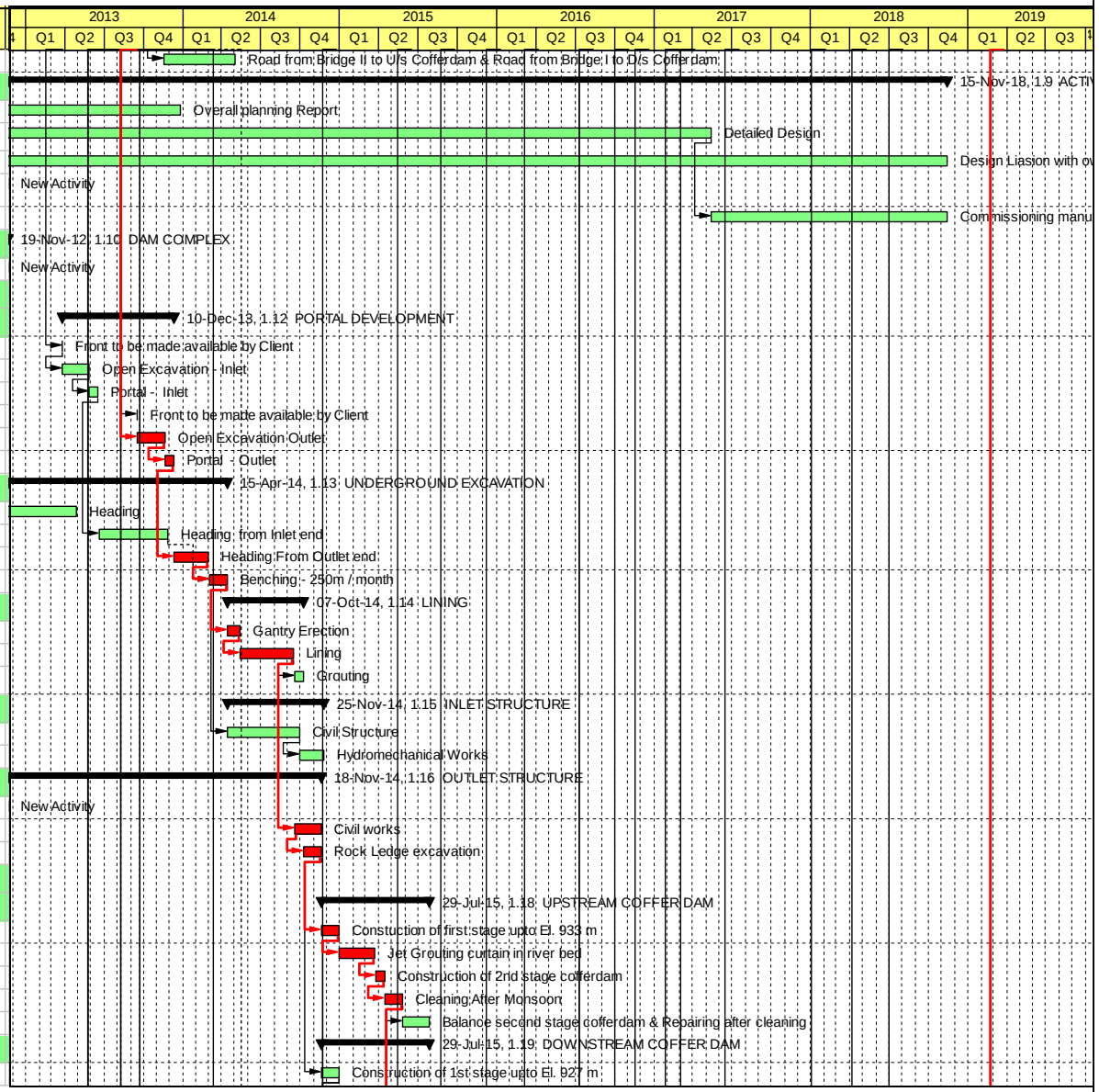
Activity ID	Activity Name	Original Duration	Start	Finish
1	Rattle H.E. project	1649	17-Nov-12	02-Apr-19
1.1	**Rattle Project**	160	17-Nov-12	01-Jul-13
3	NOTICE TO PROCEED FOR PLANNING, DESIGN &...	0	17-Nov-12	17-Nov-12
2	NOTICE TO PROCEED FOR TEMPORARY INFRAST...	0	19-Nov-12	19-Nov-12
4	NOTICE TO PROCEED FOR MAIN WORKS	0	01-Jul-13	01-Jul-13
1.5	**MILESTONES**	1097	31-Dec-14	02-Apr-19
6	Milestone 1 :- Commissioning of River Diversion works ...	0	31-Dec-14	31-Dec-14
8	Milestone 3 :- Completion of excavation of Pressure shaft	0	24-Jun-15	24-Jun-15
7	Milestone 2 :- Completion of River Bed Excavation	0	02-Oct-15	02-Oct-15
9	Milestone 4 :- Erection Bay including columns for erecti...	0	15-Jan-16	15-Jan-16
10	Milestone 5 :- Completion of Powerhouse Excavation	0	12-Apr-16	12-Apr-16
11	Milestone 6 :- Handing Over Workfront for E&M Contra...	0	17-Aug-16	17-Aug-16
12	Milestone 7 :- Handing Over Workfront for E&M Contra...	0	17-Aug-16	17-Aug-16
13	Milestone 8 :- Completion of Surge cavern concreting	0	10-Nov-16	10-Nov-16
14	Milestone 9 :- Handing over of work front for E&M Cont...	0	26-Dec-16	26-Dec-16
15	Milestone 10 :- Excavation of pothead yard	0	06-Mar-17	06-Mar-17
16	Milestone 11 :- Handing over of work front for E&M Con...	0	11-Apr-17	11-Apr-17
17	Milestone 12 :- Handing over of work front for E&M Con...	0	25-Jul-17	25-Jul-17
19	Milestone 14 :- Completion of Dam concreting	0	09-Feb-18	09-Feb-18
18	Milestone 13 :- Control Room Civil works to be handed ...	0	16-May-18	16-May-18
20	Milestone 15 :- Completion of Dam Works for Reservoi...	0	08-Aug-18	08-Aug-18
21	Milestone 16 :- Commercial Operation Date for the Proj...	0	02-Apr-19	02-Apr-19
1.6	**ACTIVITIES - NOTICE TO PROCEED FO...**	0		
1.7	**TEMPORARY INFRASTRUCTURE FACILI...**	773	19-Nov-12	04-Nov-15
25	Resource Mobilisation	60	19-Nov-12	08-Feb-13
26	Infrastructure , Offices, work shop, colony	728	21-Jan-13	04-Nov-15
1.7.1	**(New WBS)**	0		
1.8	**APPROACH ROADS**	380	19-Nov-12	02-May-14
28	Approach Roads	285	19-Nov-12	20-Dec-13
44	New Activity	0	19-Nov-12	19-Nov-12
29	Balance work Approach Road from NH (1) B Upto Brid...	45	11-Dec-12	09-May-13
30	Balance work - Bridge II - Temporary type - U/s	45	11-Dec-12	11-Feb-13
31	Balance work Approach Road from NH (1) B to Bridge ...	118	11-Dec-12	27-Aug-13
34	Approach Roads from Bridge II to DT Inlet	60	01-Jan-13	25-Mar-13
35	Road to Muck Dumping Sites	182	21-Jan-13	01-Oct-13
40	Road from DT Inlet road to Power Intake	110	01-Mar-13	15-Nov-13
38	Road from NH 1B to Dam left abutment of Dam	62	26-Mar-13	19-Jun-13
32	Balance work - Bridge I - Permanent Type (D/s Side)	90	29-Apr-13	30-Aug-13
39	Road from D/s Cofferdam to Dam Riverbed	45	20-Jun-13	21-Aug-13
33	Approach Road from Bridge I to DT Outlet	30	07-Aug-13	17-Sep-13
36	Road from Bridge I to MAT	15	28-Aug-13	17-Sep-13
37	Approach Roads from MAT to Dam Top (Right Bank)	152	18-Sep-13	17-Apr-14
41	Road from Bridge I to Tailrace Tunnel Outlet	30	18-Sep-13	29-Oct-13
42	Road from Bridge I to Pot Head Yard	20	30-Oct-13	26-Nov-13



Actual Work | Remaining Work | Critical Remaining Work | Milestone | Summary

TASK filter: All Activities

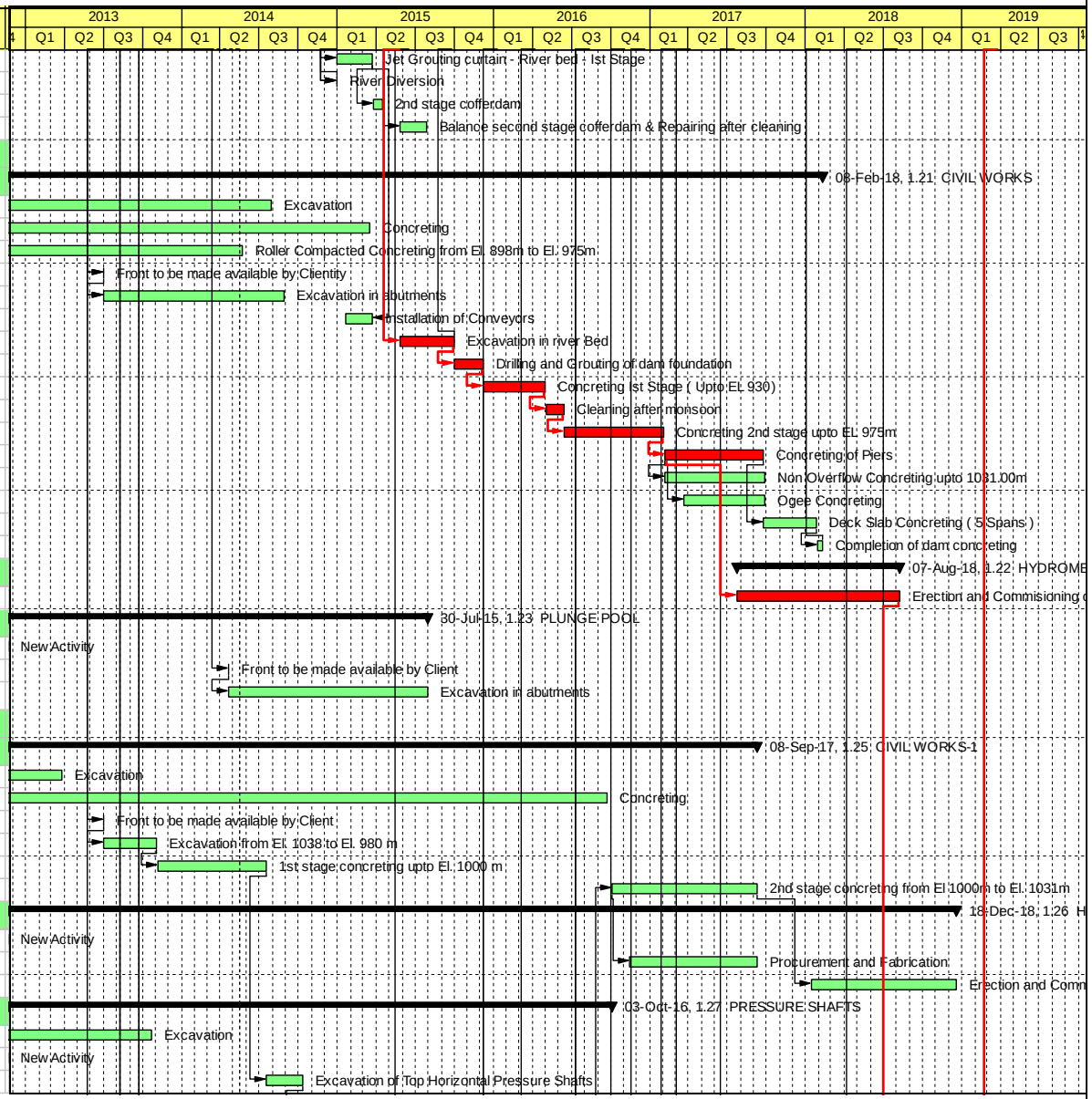
Activity ID	Activity Name	Original Duration	Start	Finish
43	Road from Bridge II to U/s Cofferdam & Road from Brid...	120	18-Nov-13	02-May-14
1.9	**ACTIVITIES - NOTICE TO PROCEED FOR...**	1552	19-Nov-12	15-Nov-18
46	Overall planning Report	288	19-Nov-12	25-Dec-13
47	Detailed Design	1170	19-Nov-12	12-May-17
49	Design Liasion with owner	1564	19-Nov-12	15-Nov-18
50	New Activity	0	19-Nov-12	19-Nov-12
48	Commissioning manual and O&M Manual	394	15-May-17	15-Nov-18
1.10	**DAM COMPLEX**	0	19-Nov-12	19-Nov-12
52	New Activity	0	19-Nov-12	19-Nov-12
1.11	**DIVERSION TUNNELS**	0		
1.12	**PORTAL DEVELOPMENT**	185	27-Mar-13	10-Dec-13
55	Front to be made available by Client	0	27-Mar-13	27-Mar-13
56	Open Excavation - Inlet	45	27-Mar-13	28-May-13
59	Portal - Inlet	15	29-May-13	18-Jun-13
57	Front to be made available by Client	0	18-Sep-13	18-Sep-13
58	Open Excavation Outlet	45	18-Sep-13	19-Nov-13
60	Portal - Outlet	15	20-Nov-13	10-Dec-13
1.13	**UNDERGROUND EXCAVATION**	367	19-Nov-12	15-Apr-14
62	Heading	116	19-Nov-12	29-Apr-13
63	Heading from Inlet end	116	19-Jun-13	27-Nov-13
64	Heading From Outlet end	58	11-Dec-13	28-Feb-14
65	Benching - 250m / month	32	03-Mar-14	15-Apr-14
1.14	**LINING**	125	16-Apr-14	07-Oct-14
67	Gantry Erection	20	16-Apr-14	13-May-14
68	Lining	90	14-May-14	16-Sep-14
69	Grouting	15	17-Sep-14	07-Oct-14
1.15	**INLET STRUCTURE**	160	16-Apr-14	25-Nov-14
71	Civil Structure	120	16-Apr-14	30-Sep-14
72	Hydromechanical Works	40	01-Oct-14	25-Nov-14
1.16	**OUTLET STRUCTURE**	522	19-Nov-12	18-Nov-14
76	New Activity	0	19-Nov-12	19-Nov-12
74	Civil works	45	17-Sep-14	18-Nov-14
75	Rock Ledge excavation	30	08-Oct-14	18-Nov-14
1.17	**COFFERDAMS**	0		
1.18	**UPSTREAM COFFER DAM**	181	19-Nov-14	29-Jul-15
79	Constuction of first stage upto El. 933 m	30	19-Nov-14	30-Dec-14
80	Jet Grouting curtain in river bed	60	31-Dec-14	24-Mar-15
81	Construction of 2nd stage cofferdam	15	25-Mar-15	14-Apr-15
82	Cleaning After Monsoon	30	16-Apr-15	27-May-15
83	Balance second stage cofferdam & Repairing after clea...	45	28-May-15	29-Jul-15
1.19	**DOWNSTREAM COFFER DAM**	181	19-Nov-14	29-Jul-15
85	Construction of 1st stage upto El. 927 m	30	19-Nov-14	30-Dec-14



Actual Work | Remaining Work | Critical Remaining Work | Milestone | Summary

TASK filter: All Activities

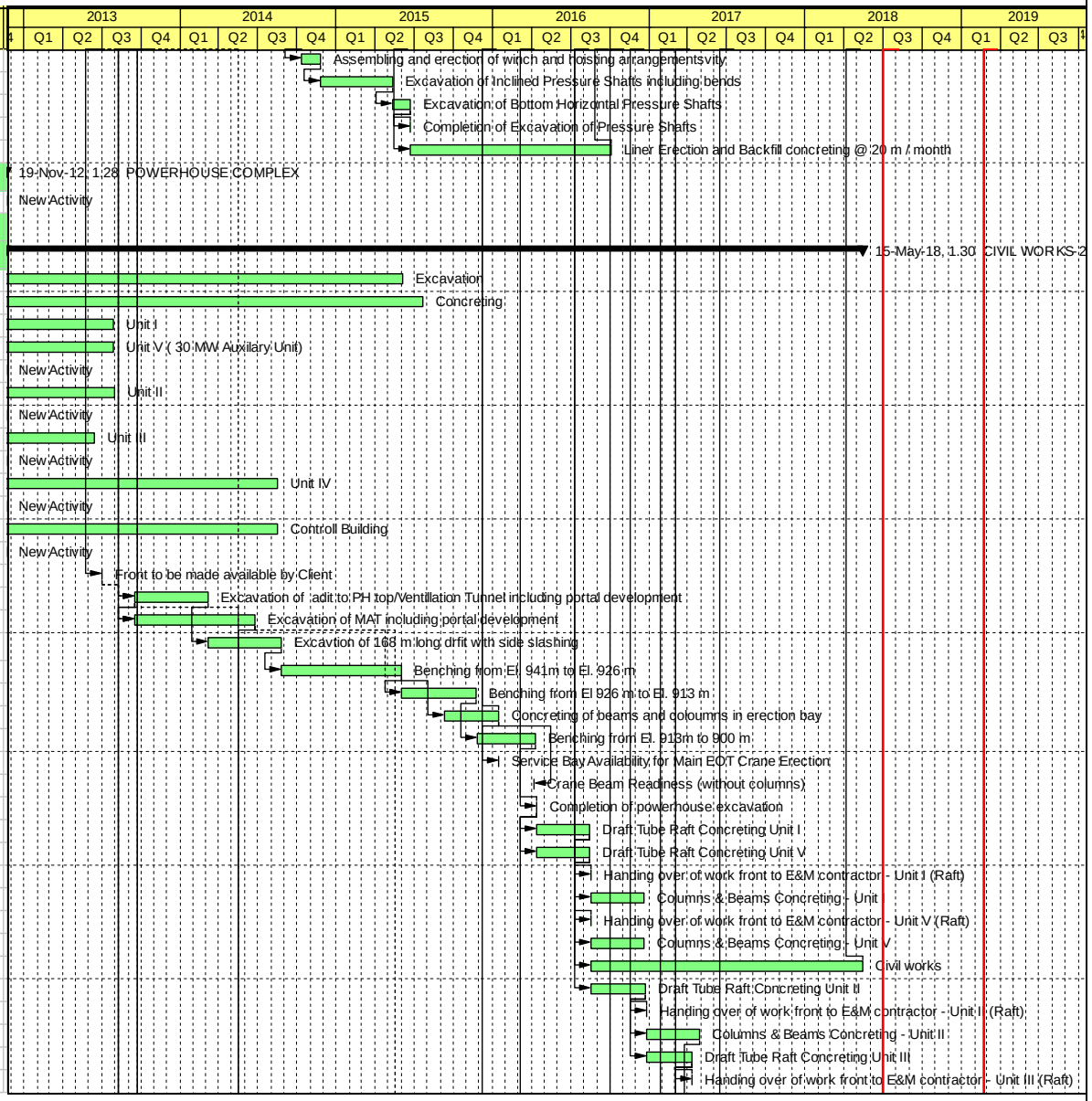
Activity ID	Activity Name	Original Duration	Start	Finish
86	Jet Grouting curtain - River bed - Ist Stage	60	31-Dec-14	24-Mar-15
89	River Diversion	0	31-Dec-14	31-Dec-14
87	2nd stage cofferdam	15	25-Mar-15	14-Apr-15
88	Balance second stage cofferdam & Repairing after clea...	45	28-May-15	29-Jul-15
1.20 DAM		0		
1.21 CIVIL WORKS		1352	19-Nov-12	08-Feb-18
92	Excavation	441	19-Nov-12	29-Jul-14
97	Concreting	606	19-Nov-12	16-Mar-15
99	Roller Compacted Concreting from El. 898m to El. 975m	395	19-Nov-12	23-May-14
93	Front to be made available by Clientity	0	01-Jul-13	01-Jul-13
94	Excavation in abutments	303	01-Jul-13	27-Aug-14
98	Installation of Conveyors	47	19-Jan-15	24-Mar-15
95	Excavation in river Bed	91	28-May-15	01-Oct-15
96	Drilling and Grouting of dam foundation	47	02-Oct-15	07-Dec-15
100	Concreting Ist Stage (Upto EL 930)	104	08-Dec-15	29-Apr-16
101	Cleaning after monsoon	30	03-May-16	13-Jun-16
102	Concreting 2nd stage upto EL 975m	168	14-Jun-16	02-Feb-17
103	Concreting of Piers	165	06-Feb-17	22-Sep-17
105	Non Overflow Concreting upto 1031.00m	166	06-Feb-17	25-Sep-17
104	Ogee Concreting	135	21-Mar-17	25-Sep-17
106	Deck Slab Concreting (5 Spans)	90	25-Sep-17	26-Jan-18
107	Completion of dam concreting	9	29-Jan-18	08-Feb-18
1.22 HYDROMECHANICAL WORKS		272	24-Jul-17	07-Aug-18
109	Erection and Commisioning of spillway gates	272	24-Jul-17	07-Aug-18
1.23 PLUNGE POOL		704	19-Nov-12	30-Jul-15
113	New Activity	0	19-Nov-12	19-Nov-12
111	Front to be made available by Client	0	21-Apr-14	21-Apr-14
112	Excavation in abutments	334	21-Apr-14	30-Jul-15
1.24 POWER INTAKE STRUCTURE		0		
1.25 CIVIL WORKS-1		1243	19-Nov-12	08-Sep-17
116	Excavation	91	19-Nov-12	25-Mar-13
119	Concreting	1003	19-Nov-12	21-Sep-16
117	Front to be made available by Client	0	01-Jul-13	01-Jul-13
118	Excavation from El. 1038 to El. 980 m	91	01-Jul-13	04-Nov-13
120	1st stage concreting upto El. 1000 m	182	06-Nov-13	17-Jul-14
121	2nd stage concreting from El 1000m to El. 1031m	243	05-Oct-16	08-Sep-17
1.26 HYDROMECHANICAL WORKS-1		1575	19-Nov-12	18-Dec-18
125	New Activity	0	19-Nov-12	19-Nov-12
123	Procurement and Fabrication	213	16-Nov-16	08-Sep-17
124	Erection and Commissioning	242	15-Jan-18	18-Dec-18
1.27 PRESSURE SHAFTS		999	19-Nov-12	03-Oct-16
127	Excavation	243	19-Nov-12	23-Oct-13
134	New Activity	0	19-Nov-12	19-Nov-12
128	Excavation of Top Horizontal Pressure Shafts	61	18-Jul-14	10-Oct-14



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

TASK filter: All Activities

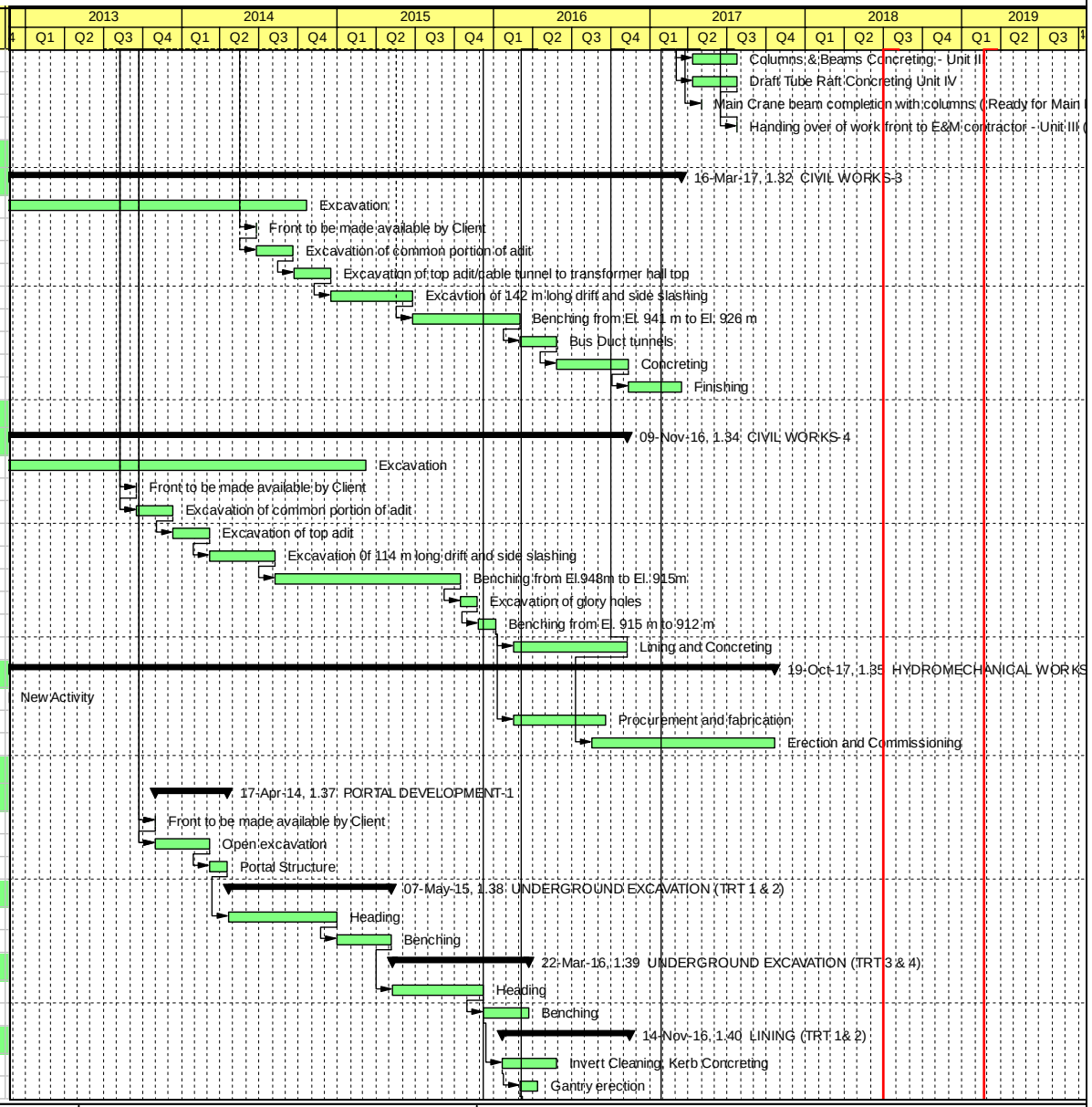
Activity ID	Activity Name	Original Duration	Start	Finish
129	Assembling and erection of winch and hoisting arrange...	31	13-Oct-14	24-Nov-14
130	Excavation of Inclined Pressure Shafts including bends	121	25-Nov-14	12-May-15
131	Excavation of Bottom Horizontal Pressure Shafts	30	13-May-15	23-Jun-15
132	Completion of Excavation of Pressure Shafts	0	24-Jun-15	24-Jun-15
133	Liner Erection and Backfill concreting @ 20 m / month	334	24-Jun-15	03-Oct-16
1.28 POWERHOUSE COMPLEX		0	19-Nov-12	19-Nov-12
136	New Activity	0	19-Nov-12	19-Nov-12
1.29 POWER HOUSE CAVERN		0		
1.30 CIVIL WORKS-2		1420	19-Nov-12	15-May-18
139	Excavation	665	19-Nov-12	05-Jun-15
148	Concreting	699	19-Nov-12	23-Jul-15
152	Unit I	181	19-Nov-12	29-Jul-13
156	Unit V (30 MW Auxilary Unit)	181	19-Nov-12	29-Jul-13
160	New Activity	0	19-Nov-12	19-Nov-12
161	Unit II	182	19-Nov-12	30-Jul-13
166	New Activity	0	19-Nov-12	19-Nov-12
167	Unit III	150	19-Nov-12	14-Jun-13
171	New Activity	0	19-Nov-12	19-Nov-12
172	Unit IV	455	19-Nov-12	15-Aug-14
175	New Activity	0	19-Nov-12	19-Nov-12
176	Controll Building	455	19-Nov-12	15-Aug-14
178	New Activity	0	19-Nov-12	19-Nov-12
140	Front to be made available by Client	0	01-Jul-13	01-Jul-13
141	Excavation of adit to PH top/Ventillation Tunnel includin...	122	18-Sep-13	06-Mar-14
142	Excavation of MAT including portal development	199	18-Sep-13	23-Jun-14
143	Excavtion of 168 m long drfit with side slashing	122	07-Mar-14	25-Aug-14
144	Benching from El. 941m to El. 926 m	200	26-Aug-14	01-Jun-15
145	Benching from El 926 m to El. 913 m	126	02-Jun-15	24-Nov-15
149	Concreting of beams and coloumns in erection bay	91	10-Sep-15	14-Jan-16
146	Benching from El. 913m to 900 m	99	25-Nov-15	11-Apr-16
150	Service Bay Availability for Main EOT Crane Erection	0	15-Jan-16	15-Jan-16
151	Crane Beam Readiness (without columns)	0	08-Apr-16	08-Apr-16
147	Completion of powerhouse excavation	0	12-Apr-16	12-Apr-16
153	Draft Tube Raft Concreting Unit I	91	12-Apr-16	16-Aug-16
157	Draft Tube Raft Concreting Unit V	91	12-Apr-16	16-Aug-16
154	Handing over of work front to E&M contractor - Unit I (...	0	17-Aug-16	17-Aug-16
155	Columns & Beams Concreting - Unit I	90	17-Aug-16	20-Dec-16
158	Handing over of work front to E&M contractor - Unit V (...	0	17-Aug-16	17-Aug-16
159	Columns & Beams Concreting - Unit V	90	17-Aug-16	20-Dec-16
177	Civil works	455	17-Aug-16	15-May-18
162	Draft Tube Raft Concreting Unit II	92	18-Aug-16	23-Dec-16
163	Handing over of work front to E&M contractor - Unit II (...	0	26-Dec-16	26-Dec-16
164	Columns & Beams Concreting - Unit II	90	26-Dec-16	28-Apr-17
168	Draft Tube Raft Concreting Unit III	75	27-Dec-16	10-Apr-17
169	Handing over of work front to E&M contractor - Unit III (...	0	11-Apr-17	11-Apr-17



Actual Work | Remaining Work | Critical Remaining Work | Milestone | Summary

TASK filter: All Activities

Activity ID	Activity Name	Original Duration	Start	Finish
170	Columns & Beams Concreting - Unit III	75	11-Apr-17	24-Jul-17
173	Draft Tube Raft Concreting Unit IV	75	11-Apr-17	24-Jul-17
165	Main Crane beam completion with columns (Ready for ...	0	01-May-17	01-May-17
174	Handing over of work front to E&M contractor - Unit III (...	0	25-Jul-17	25-Jul-17
1.31	**TRANSFORMER CAVERN**	0		
1.32	**CIVIL WORKS-3**	1117	19-Nov-12	16-Mar-17
181	Excavation	501	19-Nov-12	20-Oct-14
182	Front to be made available by Client	0	24-Jun-14	24-Jun-14
183	Excavation of common portion of adit	64	24-Jun-14	19-Sep-14
184	Excavation of top adit/cable tunnel to transformer hall top	61	22-Sep-14	15-Dec-14
185	Excavtion of 142 m long drift and side slashing	137	16-Dec-14	24-Jun-15
186	Benching from El. 941 m to El. 926 m	180	25-Jun-15	02-Mar-16
187	Bus Duct tunnels	61	03-Mar-16	26-May-16
188	Concreting	120	27-May-16	10-Nov-16
189	Finishing	90	11-Nov-16	16-Mar-17
1.33	**SURGE CAVERN**	0		
1.34	**CIVIL WORKS-4**	1026	19-Nov-12	09-Nov-16
192	Excavation	601	19-Nov-12	09-Mar-15
193	Front to be made available by Client	0	18-Sep-13	18-Sep-13
194	Excavation of common portion of adit	62	18-Sep-13	12-Dec-13
195	Excavation of top adit	60	13-Dec-13	06-Mar-14
196	Excavation 0f 114 m long drift and side slashing	110	07-Mar-14	07-Aug-14
197	Benching from El.948m to El. 915m	310	08-Aug-14	15-Oct-15
198	Excavation of glory holes	28	16-Oct-15	24-Nov-15
199	Benching from El. 915 m to 912 m	31	25-Nov-15	06-Jan-16
200	Lining and Concreting	190	18-Feb-16	09-Nov-16
1.35	**HYDROMECHANICAL WORKS-2**	1272	19-Nov-12	19-Oct-17
204	New Activity	0	19-Nov-12	19-Nov-12
202	Procurement and fabrication	153	18-Feb-16	19-Sep-16
203	Erection and Commissioning	306	18-Aug-16	19-Oct-17
1.36	**TAIL RACE TUNNELS**	0		
1.37	**PORTAL DEVELOPMENT-1**	122	30-Oct-13	17-Apr-14
207	Front to be made available by Client	0	30-Oct-13	30-Oct-13
208	Open excavation	92	30-Oct-13	06-Mar-14
209	Portal Structure	30	07-Mar-14	17-Apr-14
1.38	**UNDERGROUND EXCAVATION (TRT 1 &...**	274	21-Apr-14	07-May-15
211	Heading	182	21-Apr-14	30-Dec-14
212	Benching	92	31-Dec-14	07-May-15
1.39	**UNDERGROUND EXCAVATION (TRT 3 &...**	228	08-May-15	22-Mar-16
214	Heading	153	08-May-15	08-Dec-15
215	Benching	75	09-Dec-15	22-Mar-16
1.40	**LINING (TRT 1& 2)**	202	20-Jan-16	14-Nov-16
217	Invert Cleaning, Kerb Concreting	92	20-Jan-16	26-May-16
218	Gantry erection	30	03-Mar-16	13-Apr-16



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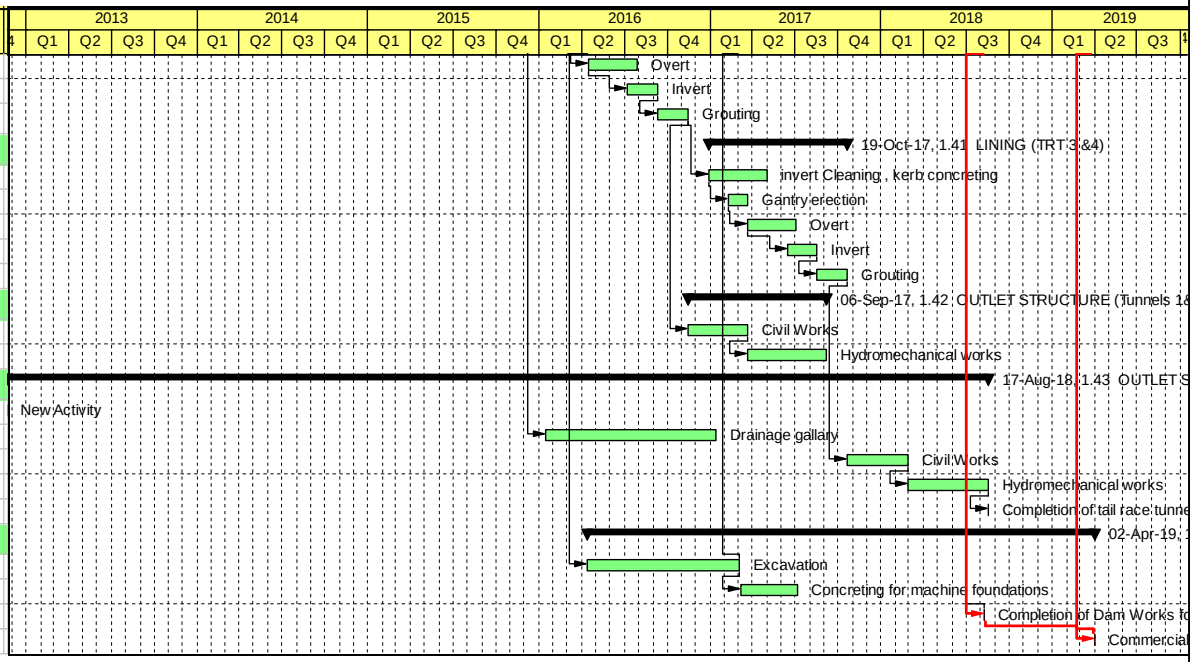
Activity ID	Activity Name	Original Duration	Start	Finish
219	Overt	75	15-Apr-16	28-Jul-16
220	Invert	46	08-Jul-16	09-Sep-16
221	Grouting	46	12-Sep-16	14-Nov-16
1.41	**LINING (TRT 3 &4)**	212	28-Dec-16	19-Oct-17
223	invert Cleaning , kerb concreting	91	28-Dec-16	03-May-17
224	Gantry erection	31	08-Feb-17	22-Mar-17
225	Overt	74	23-Mar-17	04-Jul-17
226	Invert	45	15-Jun-17	16-Aug-17
227	Grouting	46	17-Aug-17	19-Oct-17
1.42	**OUTLET STRUCTURE (Tunnels 1&2)**	212	15-Nov-16	06-Sep-17
229	Civil Works	92	15-Nov-16	22-Mar-17
230	Hydromechanical works	120	23-Mar-17	06-Sep-17
1.43	**OUTLET STRUCTURE (Tunnels 3&4)**	1487	19-Nov-12	17-Aug-18
235	New Activity	0	19-Nov-12	19-Nov-12
236	Drainage gallary	365	15-Jan-16	13-Jan-17
232	Civil Works	93	20-Oct-17	27-Feb-18
233	Hydromechanical works	122	28-Feb-18	16-Aug-18
234	Completion of tail race tunnels including outlet structure	0	17-Aug-18	17-Aug-18
1.45	**POTHEAD YARD**	763	12-Apr-16	02-Apr-19
239	Excavation	234	12-Apr-16	03-Mar-17
240	Concreting for machine foundations	90	06-Mar-17	07-Jul-17
241	Completion of Dam Works for Impounding	0	08-Aug-18	08-Aug-18
242	Commercial Operation Date for Project	0	02-Apr-19	02-Apr-19



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