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CONSTRUCTION & MANAGEMENT OF UNDERGROUNDSTRUCTURE WITH SCHEDULING & ESTIMATION

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Abstract
The construction of tunnel is important for different purposes. They can be constructed for railways, roadways, pedestrian footways and can be built in hard rock, soft ground, river bed and are also used to convey Hydroelectric power, water stream, or as a sewer. The construction of Diversion Tunnel, Pressure Shaft, and Tailrace Tunnel to convey water is considered in this project. To identify Scheduling of different activities by various methods Network Diagram, C.P.M., P.E.R.T. and their cycle time is calculated. Scheduling for different activity is carried out with the help of Network Diagram & Primavera Software will be carried out in a project stage II. Study of Estimation for a DiversionTunnel, Pressure Shaft, and Tailrace Tunnel by both methods. Excavation in heading and benching, Rock bolt support work, lining work is considered for cycle time and cost estimation calculation in Diversion Tunnel, Pressure Shaft, and Tailrace Tunnel. Estimation is also carried out by two methods. The comparison of two methods adopted for excavation work and estimation will be carried out in a project stage II.

Keywords- Scheduling, C.P.M., P.E.R.T., Gantt chart, Network Diagram, Estimation, Heading, Benching, Cycle time, Lining, Rock Bolts, Diversion Tunnel, Pressure Shaft,Tailrace Tunnel.

I. INTRODUCTION

The main interpretation that usually follows the termfeasibility is one of the following: The case in which analternative option, a strategy plan, a design or a differentlocation is proved economically preferable; the case in which an alternative option is deemed appropriate in social Or environmental terms and the case in which probable construction and operation of a project Can be financially viable as well as manageable. A feasibility study is a multidimensional set of actions which aims to analysis and evaluate a project in order to determine if its construction is feasible. Such a study refers to the assessment of resultswhich concern the economic forecast in relation to other important factors, such as socioeconomic efficiency and environmental impact. The defining point of a feasibility study is the necessary information that leads decision-makers to decide if the proposed option or project should be implemented. Its necessity in project development is considered significant, as the identification of errors in this stage contributes to better performance of the project. Thus, the success of a project is determined by the assumptions that are set during the feasibility study process. In some cases, a project is not profitable in economic terms; however, its feasibility is attributed to serve another purpose. Underground construction projects, particularly those in urban areas, ostensibly experience more significant problems than other infrastructure engineering projects. In many underground projects, technology is more challenging than in otherinfrastructure projects, increasing the chance of failure.
Primavera is used for scheduling of the project:

- Diminished risk along with cost connected withschedule overrun.
- It helps easily prepare and control project things to do.
- It optimizes management of resources.
- It offers clear field of vision of what is taking in theparticular project.

These are the some of the key benefits of the primavera. With the help of the primavera we can rescheduled the activities that are delayed and reduce the delay and made a comparison between the delayed activities and reschedule activities. Construction delays area unit widespread in most comes round the world. Some delays may happen in the preconstruction phase which is defined as the period beginning from the initial conception of the project to the signing of the contract between the owners and also the contractor; but a number of them might happen within the construction section that's the amount once actual construction is beneath method. Project schedules areconsistently dynamic and uncertain. Several governable and uncontrollable factors will adversely have an effect on the project schedule and cause delays. These delays positively produce negative impacts on project performance. Schedule delay within the completion

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of a construction project is also a serious issue for contractors resulting in pricey disputes and adverse relationships between project participants. The challenge is to live World Wide Web impact of construction delays accurately. Otherwise, there could seem delay claimsbetween all parties concerned within the construction method. The method of schedule delay analysis technique ought to be acceptable to all or any participants through the project. Moreover, in underground projects the consequence of eventual failure is often more profound than in other projects, increasing the overall consequences of failure. As a result, underground projects have a reputation for being risky because they are susceptible to implementation problems. Society growing demand for space, however, makes us heavily dependent on underground space to satisfy contemporary spatial claims. This should provide ideas about how to set up a project organization to best handle the efforts this requires. To do so, the complexity of underground projects will first be analysis. The main manageability problem of organizations dealing with this complexity is identified. Subsequently, details from some real projects will show the virtues and drawbacks of some types of project organizations in the face of complexity, particularly in terms of their ability to handle manageability problems.

Underground construction is in a great demand in many civil and infrastructure projects all over the world, such as metro and hydropower projects. In construction has presented a powerful momentum for rapid economic development. However, owing to various risk factors associated with complex project environments, violations of safety rule occur frequently in tunnel construction, resulting in serious problems in the related project operation To study economic feasibility for railway tunnel; the study addresses the factors that determine location, the attributes that enhance rail use through passenger satisfaction and financial analysis, presents the social impacts and their requirements for the achievement ofthe social objectives and discusses the benefits social, economic, environmental that are accrued from the existence of railway tunnel. The proposed Project, in Vasai-Virar tehsilof Palghar District of Maharashtra state, is located downstream of the Ulhas river power house which is in advance stage of construction on Ulhas river as identified by Central Electricity Authority in their ranking studies. The Ulhas River originates at Rajmachi village,Lonavala Dist Pune till it meets Vasai Creek,Arabian Sea. A dam is proposed across the river just downstream of the Pelhar,Vasai-Virar village (Latitude 19°26'39"N,Longitude 72°53'57"E) and an underground powerhouse with an installed capacity of 72 MW is proposed near Bhivpuri village in Palghar District. Two nos. of Diversion Tunnel has to be constructed in order to divert the Ulhas river water flow during Dam construction. Diversion Tunnels are having circular shape. Construction work for Diversion tunnels has to be carried out from Inlet and Outlet ends. Diversion Tunnel works includes excavation by conventional method likedrilling and blasting or by Road header or as directed by Engineer In-charge. Diversion tunnels are common in the construction of dams. When a dam is built, a tunnel is bored in order to divert water away from the dam construction site so that it essentially bypasses it, hence the term diversion tunnel.

Need of the study of project

- Scheduling of different activities by using Network Diagram i.e. CPM & PERT Method by using numericalmethod.
- Scheduling of different activities by using Primaverasoftware.
- Estimate comparison in three types of tunnel i.e. Pressure Shaft, Diversion Tunnel & Tailrace Tunnel.
- The need of the study of project is to identify different activities of Underground infrastructure Tunnel of hydroelectric project construction work in a proper sequence from start to finish work.
- To be able to have a clear understanding and knowledge of Tunnel in a hydroelectric project construction & management of activities in a sequential order.
- Study of different component in tunnel of hydroelectricproject.

Aim

- Reduction in construction period due to concurrent workingfor substructure and superstructure.
- For segmental, pre-cast element, transportation from construction depot to site is easy and economical.
- As the pre-cast elements are cast on production line in a construction depot, very good quality can be ensured.

Objectives

- To find out different activities involved and to prepare a construction schedule of underground structure Tunnel fora hydroelectric project.
- Scheduling of different activities by using Network diagram i.e. CPM & PERT, Primavera Software.
- Estimation of three types of Tunnels by using two typesof excavation method drill blast method and mechanical.
- To estimate the cost of underground tunnel works in hydroelectric project.
- To compare the excavation method by Drill & blast, Mechanical excavation as well in their Schedule & Cost.

II. LITERATURE REVIEW

Mr. I. Michael Raj1, Ms. M. Panimalar

Schedule Delay Analysis in Construction Managementusing Primavera. International Research Journal of Engineering and Technology (IRJET) Construction schedule delays in a project can cause major problems for contractors and owners, resulting in costly disputes, controversial issues and adverse relationships between all the project participants. As Arditi et al. (1985) point out, the most important causes of delays in public projects of Turkey are shortage of

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resources, financial difficulties and organizational deficiencies of public agencies and contracting companies, delays in design work, large quantities of extra work and frequent change orders. In this multi-specialty project work the delay has been rectified in basement 2 and the project has been goes on and it has beenfinished with schedule delay analysis.

Qihu Qian a, Peng Lin
Safety risk management of underground engineering in China: Progress, challenges and strategies Journal of Rock Mechanics and Geotechnical Engineering, 2016 The laws and regulations of underground engineering should be improved. The safety risk management plans should be implemented in construction management of underground projects. Information technology should be employed to implement early-warning and decision-making support functions for safety risk management. More resources should be invested into researches on safety risk management, prediction and prevention of major accidents.

G.Poovizhi S.Manoj, D.Ambika , V.Santha Rubini, V.Nandhini, S.Dhinu Priya
Risk Safety Management in Construction of Metro Rail Projects International Journal of Advanced Science and Technology, 2020 The aim is to construct a new type of model for risk safety management in metro rail projects, to study the existing risk safety management system and toidentify the risks that occur during construction and to create, implement, and determine the efficiency of the modelfor safety in the construction of metro rail projects.

Rajwardhan Kale, Kartik Kharde, Mohanish Vengurlekar, Shantini Bokil
Collation between Underground and Elevated System International Journal of Engineering Research in Mechanicaland Civil Engineering, 2017 An underground connectivity will be more beneficial rather than an elevated as in Delhi, Mumbai and Bangalore and highlights various parameters of its onsite implementation.

Qian Zhang, Jing Wang, Wenyu Wang, Songsong Bai & Peng Lin (2019)
Study on slope stability due to the influence of excavationof the highspeed rail tunnel IJRET, 2018
In this study, based on a high-speed railway tunnel project undercrossing slope, model tests and numerical simulation methods were carried out to study the interaction law of tunnel excavation and slope stability. Firstly, the numerical model of finite element analysis and the numerical model of excavation tunnel under the slope were established. The influence mechanism of tunnel excavation on the stability ofthe slope was studied.

G Zhang et al 2020
Effect of Construction Ventilation Scheme on Pollutant Transport in a High-Speed Railway Tunnel InternationalJournal of Pure and Applied Mathematics, 2014 To find out the distribution of dust and harmful gases and check the effect of ventilation and dust prevention after blasting in tunnel construction with the drilling and blasting method,the wind velocity, dust concentration and the concentration of harmful gas in You-zhu-shan tunnel of GuiGuang high- speed railway were studied by CFD simulation and fieldtest.

Anwar 2014
A new megaproject model and a new funding model. International journal of research 2019 Deals with the governance patterns at different scales through Delhi Metro Megaproject and its financing mechanism through Land value capture.

W. P Chakrun 2012
Land value capture finance for transport accessibility: a review. Research Gate Deals with the main land value capture finance (LVC) mechanisms (betterment tax,accessibility increment contribution, and joint development) in relation to increased transport accessibility.

N. Sheelan, 2014
Self-financing land and urban development via land readjustment and value capture, IEEE .
Showcases how a regional level infrastructure asset can be created using the LR technique, and how rapidly growing fringe area can benefit using the LR technique.

Mahdi Khosravi and Kalle
Issues in financing urban rail transit projects and value captures, IEEE.
This paper re-examines the financing system and analysesthe possible menus for fund-raising from the viewpoint of imbalance between benefit receivers and cost burdens on the basis of benefit principle.

Martijn Leijten
Management of complex underground construction projects Research Gate, August 2018
Decision makers are usually not the actors with the most extensive information resources and the principal owners of these resources are often not the ones who make decisions. This all keeps uncertainty intact. Rather than attempting to

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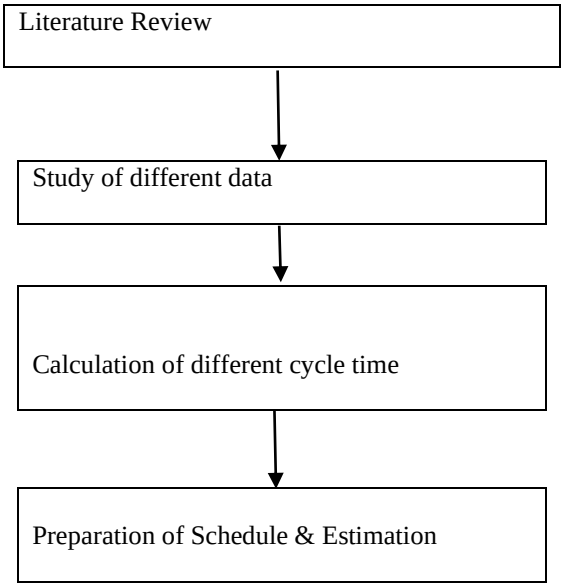
increase information to reduce uncertainty in traditional project manager-functional manager relationships, avoidance of the principal-agent problem between those twotypes of managers may provide more support.

Lisa Avestedt
Comparison of Risk Assessments for UndergroundConstruction Projects
June 2012
Identify a theoretical general approach to risk management and specifically risk assessments based on a literature study. Identify similarities between risk management practices in the two countries. Identify differences between risk management practices in the two countries. Identify how risk management practices differ in the two countries from the theoretical approach established from the literature study.

METHODOLOGY
The first step of the research consists of gathering information about activities and resources used in tunneling construction. This is mainly done by means of a literature study. In order to identify the main variables of tunneling construction a deterministic model is constructed. The deterministic model is used to help to understand the processes involved in tunneling construction and identify the model variables for which information needs to be collected data about model parameters, probability distributions of time durations of activities, resourcesand the relationships between models parameters are examined. A sensitivity analysis is carried out on real tunneling case studies, to identify and analysis the most critical tunneling variables affecting productivity of tunneling construction processes. Critical variables are the variables that have major impact on productivity and cost of tunneling construction. On thebasis of the results produced, the „best" excavation method regarding a real tunneling project is determined also, a comparison will be made between the road header and drill and blast excavation methods. These analyses are done based on productivity (in terms of tunnel advance rate) and cost.
Project methodology described can be graphically represented as shown:



Project Methodology

3.1 Challenges that Sustainable Buildings Face in India
1. Scope of study
Reconnaissance survey to assess the existing environmentalconditions in the project area, including the identification of sensitive environment and social receptors

- Consultations with local community and other key stakeholders of the project to understand public perception and their expectations from project.
- Collection of information on forestry, flora and fauna, and natural habitats and species of special conservation/scientific interest through primary ecologicalsurvey of the study area.
- Collection of additional secondary environmental, social anddemographic information; Identification and review of the applicable standards and identification of key issues.
- Preparation of Environmental Management Plan (EMP) and Social Management Plan (SMP) based on the findings of theEIA and SIA and develop procedures for mitigation and monitoring of environment and social impacts on an on- going basis and to identify any impacts/mitigation requirements that may occur subsequent to the completion of the EIA and SIA.

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2. Advantages of underground Construction

- Underground electrification system has less number of components and a very simple design as compared to overhead or elevated electrification system.
- These projects are usually funded by the World Bank with very low interest rates at free of custom duty because theyreduce large amount of co2 emission done by the vehicles.
- Expected life of elevated is much less than underground construction due to the above ground steel and concrete structures.
- Interconnectivity of elevated structure route with other routes cannot be done but it is possible in the case of underground construction.
- Operation and maintenance cost of underground construction is very less because it is unaffected byexternal weather conditions.
- Additional traffic capacities were provided for individualtransport.

2 Limitations

- The impact assessment study for the proposed project is largely based on the available project information, discussion with local community and other stakeholders and observations from various surveys and investigations undertaken in the study area. Professional judgment and subjective interpretation of facts has been applied for this study.
- This impact assessment study has been undertaken for the alignment that was approved. Any change in project location, alignment, proposed project components, proposed project activities is likely to result in variation of the impacts. It is to be noted that any technological advances during the course of construction and execution of the project will alter the extentand severity of impacts on the surroundings.

3 Method statement

- **Equipment's:**

Two boom drill jumbo, Dumpers, Excavators, Loaders, Shotcrete machine, Concrete pump, Gantry with shutter Hydra crane, Batching plant, Scissor Lift etc.

- **Excavation:**

Open excavation:

This work shall consist of excavation by mechanical means inall types of strata, in rock by blasting or line drilling using pneumatic equipment and expanding agents, chiseling including dressing to final line, level, grades including haulingof excavated materials to site, also disposal of unsuitable cut materials in specified manner.

- **Job procedure:**

Rock excavation by blasting includes all solid rock in place which cannot be removed until loosened by blasting, barringor wedging, removal of all boulders or detached pieces ofsolid rock larger than 1 cum in volume, as well as any existingstructural foundation made of concrete or masonry placed in mortar which cannot be removed during common excavation or by ripping. The blasting operations shall be prepared or made by the competent and experienced personnel and workmen who are thoroughly acquainted with details of handling explosives and blasting operations. Diameter and spacing of blast holes shall be constantly adapted to the actual site conditions. The charge holes shall be drilled by using jack hammer drill. All the excavated rock shall be removed fromthe bench toe before the next shot. If a misfire is due to a
defective detonator or dynamite the whole quantity or box from the defective article was taken must be thoroughly inspected.

- **Underground excavation:**

1. The underground excavation of Diversion Tunnel will be carried out in 2 stages:

Heading: Excavation of top arch shaped area ofDiversion Tunnel and providing required support systems.

Benching: Excavation of bottom area of Diversion Tunnel.

2. Drill holes shall be cleaned for dust & rock cutting by air flushing before charging.
3. After charging operation, Mining Engineer/ Shift In- charge along with Engineer In- charge shall note down charge concentration per hole, positioning of delay detonators, and capacity of blasting device in prescribed format.
4. Dewatering of seepage water shall be removed to avoidwater logging in the tunnel.

- **Blasting pattern:**

Drilling and blasting pattern i.e. the number of holes; depth of holes, quantity, quality and distribution of explosives shall be decided as to suit the rock conditions encountered. Drilling and Blasting shall be carried out as per the pattern proposed and approved by Engineer In-charge and shall be changed or modified as per the rock conditions encountered.

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- **Heading in Diversion tunnel:**

Heading excavation will be carried out by Drilling & Blasting methodology. Heading work will be carried out continuously in a cyclic process along with the supporting work. Types of supporting work will depend on the rock classes encountered.

- **Sequence of operation in tunnel excavation without ribsupporting:**

1. Profile marking by surveyor
2. Drilling by Two boom drill jumbo
3. Charging & blasting by professional blaster
4. Mucking by wheel loader and dumpers
5. Scaling/Trimming to the required excavation line
6. Supporting by Steel Fiber Reinforced Shotcrete.
7. Fixing of Rock Bolts & Extension of ventilation duct.

- **Sequence of operation in tunnel excavation with ribsupporting:**

1. Profile marking by surveyor
2. Drilling by Two boom drill jumbo
3. Charging & blasting by professional blaster
4. Mucking by wheel loader and dumpers
5. Scaling/Trimming to the required excavation line
6. Supporting by Steel Fiber Reinforced Shotcrete
7. Fixing of Rock Bolts
8. Supporting by steel Ribs
9. Precast RCC lagging fixing
10. Back fill concreting 11.Extension ventilation duct

- **Cycle time calculation for different activities for headingwork of DT by Drill & Blast method**
- **Cycle time for heading in Diversion tunnel**
- **Cycle time for heading without rib support in DT**
- **Benching in Diversion tunnel:**

Benching work will be started on completion of heading work. It will be carried out continuously in a cyclic process using Drilling& Blasting method. Sequences of works are same as mentioned
in "Heading" except that no Rock Bolt support is required in Benching work and supporting works are required in both sidefaces.

- **Cycle time calculation for benching in Diversion tunnels byDrill & Blast method**
- **Rock support work in Diversion tunnels:**

Rock support works in the tunnel shall be provided as given in the construction drawings in accordance to the rock classificationgiven by the geologists and as per the directions of Engineer in Charge. The Rock Supports are classified depending upon the amount of hindrance it poses for the advancement of excavation work. The details of support system for each class of excavation are given below.

- **Concrete lining in Diversion tunnel:**

Concrete lining of tunnel will be taken up when the Heading and Benching excavation of the Diversion tunnel will be completed. Concrete lining for overt will be carried out using 15 m gantry equipped with 2 shutters and 1 traveller. The concrete lining of Diversion tunnel will commence from Inlet end.

- **Concrete lining of the tunnel will be carried out in threestages:**

1. Kerb Lining
2. Invert Lining
3. Overt Lining

- **Cycle time in kerb lining in Diversion tunnel:**

1. Surface cleaning should be done before Kerb concreting.
2. Kerb concreting will commence parallel to benchingexcavation.
3. Kerb shutters with requisite anchoring in the rock will beused for kerb concreting.

- **Cycle time in invert lining in Diversion tunnel:**

1. Invert lining will be done using the invert template

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- **Safety:**
- **Every Personnel working inside the tunnel shall wear personal protective equipment such as helmets, shoes, glovesand reflective bands etc.**

1. In the location of drilling where personnel are employed tohigher noise level, noise protection shall be provided.
2. Employees, working in places having an inherent danger of eye or face injury, shall be provided with protection glass, goggles or masks.
3. Stretchers, appliances for artificial breathing, oxygen flask,gas masks etc. shall be available in the front.
4. Fire extinguishers shall be provided at suitable locations inthe tunnels where construction activity is carried out.
5. The electrical cables used shall be of waterproof and earthed.
6. Suitable communication system working in underground areas shall be provided for better communication during works.
7. An effective safety program should follow as

- Planning to avoid hazards.
- Detection of potential hazards.
- Timely correction of hazards.
- Dedication to the protection of the public and the worker.
- Dedicated safety staff

CONCLUSION

Scheduling of different activities of the project by use of Network diagrams & Primavera Software. We can carry out activities as mentioned above.

1. For Drill and Blast method
2. For Mechanical method

Estimation of tunneling of hydropower project for followingmethods of excavations.

1. By Drill and Blast method
2. By Mechanical method

Comparisons in the Schedule & Cost/Estimation can be done in all methods of excavation of Tunnel will be workout in Project Stage II. So we can find which method is best suitable and economical. Delays in the construction timeline can lead to significant issues for both owners and contractors. Resulting in expensive disagreements, contentious matters, and strained relationships between all project stakeholders. Study & identify the different Risk factors and analysis process for the underground construction. Construction and operation of long tunnels for hydropowerplants & railways by examining others that are already finished and that can be organized and carried out in a way such that the experiences and bottlenecks found in previouscompleted construction projects can be eliminated

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