A STUDY ON CONSTRUCTION MANAGEMENT OF DIFFERENT SUB-STATIONS IN BANGLADESH WITH SPECIAL FOCUS ON 132/33KV SUBSTATIONS AT KERANIGANJ AND BARGUNA

Md. Ariful Islam ID: BCE1701010032
Md. Mohidul Islam ID: BCE1701010030
Md. Nesar Uddin ID: BCE1701010067
Md. Enamul Haque ID: BCE1701010009
Md. Mostafijur Rahman ID: BCE1701010049

Department of Civil Engineering

SONARGAON UNIVERSITY

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

October, 2020

A STUDY ON CONSTRUCTION MANAGEMENT OF DIFFERENT SUB-STATIONS IN BANGLADESH WITH SPECIAL FOCUS ON 132/33KV SUBSTATIONS AT KERANIGANJ AND BARGUNA

By

Md. Ariful Islam ID: BCE1701010032
Md. Mohidul Islam ID: BCE1701010030
Md. Nesar Uddin ID: BCE1701010067
Md. Enamul Haque ID: BCE1701010009
Md. Mostafijur Rahman ID: BCE1701010049

A thesis submitted in partial fulfillment of the requirement for the degree of

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

October, 2020

Department of Civil Engineering

SONARGAON UNIVERSITY

Dhaka, Bangladesh

TABLE OF CONTENTS

TABLE OF FIGURES

LETTER OF TRANSMITTAL

28 October, 2020

To
Md. Lutfor Rahman
Assistant Professor & Head,
Department of Civil Engineering
Sonargaon University

Subject: Submission of Project Report.

Dear Sir,

We are hereby pleased to submit the project paper on **"A Study on Construction Management of Different Sub-stations in Bangladesh with Special Focus on 132/33KV Substations at Keraniganj and Barguna".** We believe this project paper will certainly help us in evaluating our project work. We would be happy to provide any assistance in interpreting any part of the report whenever necessary.

Signature:

1. **Md. Ariful Islam** ID: BCE1701010032
2. **Md. Mohidul Islam** ID: BCE1701010030
3. **Md. Nesar Uddin** ID: BCE1701010067
4. **Md. Enamul Haque** ID: BCE1701010009
5. **Md. Mostafijur Rahman** ID: BCE1701010049

Candidate's Declaration

We, hereby declare that this thesis has been prepared in partial fulfillment of the requirements for the Degree of Bachelor of Science in Civil Engineering at the Sonargaon University (SU), Dhaka and has not been submitted anywhere else for any other degree.

Signature:

1. **Md. Ariful Islam** ID: BCE1701010032
2. **Md. Mohidul Islam** ID: BCE1701010030
3. **Md. Nesar Uddin** ID: BCE1701010067
4. **Md. Enamul Haque** ID: BCE1701010009
5. **Md. Mostafijur Rahman** ID: BCE1701010049

Sonargaon University (SU)

CERTIFICATE

This is to certify that the project on **"A Study on Construction Management of Different Sub-stations in Bangladesh with Special Focus on 132/33KV Substations at Keraniganj and Barguna ."** Is the eventual record of project done by **Md. Ariful Islam, Md. Mohidul Islam, Md. Nesar Uddin, Md. Enamul Haque and Md. Mostafijur Rahman.** For partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering from The Sonargaon University (SU)

The project work has been carried out under my guidance and is a record of successful work.

Md. Lutfor Rahman

Assistant Professor & Head, Department of Civil Engineering

Sonargaon University

Acknowledgement

First of all, we would like to express our deepest gratitude to Almighty Allah for his blessings to grant me the opportunity.

We are grateful to a number of individuals who have contributed in many ways towards the completion of this thesis. Firstly, we would like to express our profound gratitude and acknowledgement to our supervisor, Md. Lutfor Rahman, Assistant Professor & Head, Department of Civil Engineering, Sonargaon University for his constant guidance, continual encouragement and patience since the inception of the study. We would like to thank our supervisor for his intensive discussion and constructive comments throughout the thesis with kind co-operation.

Special thanks go to those people who actively participated in the successful completion of this study through their time and suggestions.

Moreover, thanks to all government and non-government agencies, and professionals for their kind support and co-operation for which it was possible to complete the study successfully.

Finally, we would like to thanks our family for their unconditional support and love throughout our life that encourages us to go forward. Special thanks to our friends and colleagues for their inspiration, co-operation and support to those whom we did not mention here.

ABSTRACT

At present, the demand for electrical power is growing rapidly, and this can be fulfilled by the power generating substations. There are different types of power generating substations like thermal, atomic, and hydro-electric. Based on the availability of different resources, substations are building at different locations, but these locations may not be closer to load centers. The actual power utilization can be done by the load center. So it is essential to transmit the power from the substation to load center locations. So, high and long transmission networks are required for this function.

Power is generated fairly in the level of low voltage level; however, it is inexpensive to supply the power at a high-voltage level. For preserving high and low voltage levels a number of switching as well as transformation stations have to be produced among the generating place & customer ends. Generally, these two stations are named as electrical substations.

A substation is an electrical system with high-voltage capacity and can be used to control the apparatus, generators, electrical circuits, etc. The Substations are mainly used to convert AC (alternating current) to DC (direct current). Some types of substations are tiny in size with an inbuilt transformer as well as related switches. Other types of substations are very huge with different types of transformers, equipment, circuit breakers, and switches.

The different types of substations mainly include Step-up Type Substation, Step-down Transformer, Distribution, Underground Distribution, Switchyard, Customer Substation, and System Station.

CHAPTER I

INTRODUCTION

1.0. Introduction

A power substation is a subsidiary station of an electricity generation, transmission and distribution system where voltage is transformed from high or medium to low or the reverse using transformers. Electric power flows through several substations between generating plant and consumer changing the voltage level in several stages.

A substation that has a step-up transformer increases the voltage with decreasing current, while a step-down transformer decreases the voltage with increasing the current for domestic and commercial distribution. The word substation comes from the days before the distribution system became a grid.

Substations generally contain one or more transformers and have switching, protection and control equipment. In a large substation, circuits breakers are used to interrupt any short-circuit or overload currents that may occur on the network. Smaller distribution stations may use re-closer circuit breakers or fuses for protection of branch circuits. A typical substation will contain line termination structures, high-voltage switchgear, one or more power transformers, low voltage switchgear, surge protection, controls, grounding (earthling) system, and metering. Other devices such as power factor correction capacitors and voltage regulators may also be located at a substation.

Substations may be on the surface in fenced enclosures, underground, or located in special-purpose buildings. High-rise buildings may have indoor substations. Indoor substations are usually found in urban areas to reduce the noise from the transformers, to protect switchgear from extreme climate or pollution conditions.

1.1. Background of the Study

We have studied on construction management of two 132/33KV substations in Bangladesh. The construction activity of 132/33KV substations is one of the important services of the companies; dynamically developing from the beginnings of the 2010 and 2018 the companies is able to implement all the civil engineering, foundation, reinforced concrete installation, control room and craft works from the geodesic works to the technical handover. It is the turnkey investment projects.

The construction works of 132/33KV substations, both accomplished and those being just in progress, are in a considerable part constructions, renewals, extensions associated with the national high-voltage transmission main distribution network, but it makes use of its capacities in the framework of other assignments as well e.g. construction of the traction substations of the Power Grid Company of Bangladesh. The construction activity of 132/33KV substation is built on the available, highly qualified staff of specialists and on the fleet of up-to-date prime movers, devices and tools, as well as on the knowledge base of several decades.

1.2. Objectives of the Study

The main objectives of the study are:

- To make a list for the construction activities of substations.
- To highlight the materials management systems
- To highlight the procurement management systems
- To identify the problems of construction activities.
- To compare of construction activities of substations.

1.3. Methodology

This study started by examining the construction management system, and identified the existing issues in construction of different substations, in order to answer the research questions by reviewing the existing system to adopt the following:

1. Extensive literature review, using books, articles web sites and e- journals to produce and evaluate competency models.

2. Study on the activities of construction management of different substations in Bangladesh through contracting companies by:

    a. Analyze roles and uses of the methodology and processes in managing projects.
    b. Design interview questions that will help the researcher in understanding the managing process in construction projects.
    c. Conduct a pilot study with people who are pioneers in project management field, and take feedback about the questions and their point of view.
    d. Make the necessary changes in the questions according to the information taken from the pilot study.
    e. Gather data through semi-structured interviews.

3. Conduct thematic analysis of the data collected.

4. Develop two bar charts and CPM and compare with each other based on construction activities duration and the results from theory, literature view and practice, and then test the model through discussing it with practitioners.

5. Develop conclusions and recommendations.

1.4. Organization of the Report

This report consists of nine main chapters as follows:

- Chapter One: Introduction. This chapter represented an overview of the main objectives of the research, methodology of the study and objectives of the study.
- Chapter Two: Construction activity of 132/33KV substation, Keraniganj. This chapter presented an overview of construction activity management, and highlighted the knowledge, tasks and techniques that are needed to understand the basic philosophy and principles of construction Management.

- Chapter Three: Construction activity of 132/33KV substation, Barguna. This chapter presented an overview of construction activity management, and highlighted the knowledge, tasks and techniques that are needed to understand the basic philosophy and principles of construction Management.
- Chapter Four: Procurement Management. In this chapter described the procedure of procurement management.
- Chapter Five: Material Management. In this chapter described the procedure of material management.
- Chapter Six: Problems of Construction Activities. In this chapter finding the problems of construction activities which is the cause of delayed the project. This chapter summarized the problems in managing projects and role of each of the stakeholders.
- Chapter Seven: Comparison of Project Construction of the Substation. In this chapter, compare 'the Project Construction by two ways.
- Chapter Eight: CPM and Bar Chart of Construction Activities: in this chapter developed CPM diagram and Bar Chart of the project activities.
- Chapter Nine: Conclusion and Recommendations. In this chapter presented a summary of the report of construction management.

CHAPTER II

LITERATURE SURVEY

2.1. Introduction

The literature survey of any research plays a very significant role for future optimization and enhancements. This is also the matter of fact that an optimal literature reviews and analysis is the backbone of further research and optimization. Taking into consideration of these significances, here in this thesis, an extensive literature review for varied existing researches in very fast transient over voltages have been done.

The prime objective of this literature study is to achieve optimal insight of the research domain and technologies so as to come up and propose a better and highly efficient system for construction, estimation of substation and its analysis.

2.2. Background

In 1972, the first Government of Bangladesh, in an effort to speed up the investment in the sector issued an ordinance, creating the Bangladesh Power Development Board (BPDB). BPDB, from 1972 to 1995, has increased the generation capacity in the country from 475 MW to 2818 MW, and the length of its 230 kV and 132 kV transmission networks to 419 km and 2469 km respectively. For the first time in December 1982, the eastern and western halves of the country were electrically connected through the commissioning of double circuit 230 kV transmission line across the Jamuna River energized at 132 kV between Ishurdi and Tongi called the first East-West Inter-connector. Thus 230 kV and 132 kV inter-ties linked the distribution networks of all major towns and cities had been through.

But from 1986 onwards, the commercial performance of the BPDB deteriorated and in 1991, BPDB's average gross systems loss was about 42 percent and accounts receivables in excess of 6.5 months of billing. This performance was not found reasonable to the covenants agreed by the Government and BPDB with the Asian Development Bank and the World Bank.

So in 1990, another ordinance was issued, which was subsequently enacted as an Act transferring the 132 kV, 33 kV transmissions and distribution system in the Greater Dhaka Area including the Metropolitan City to a newly created Government agency called the Dhaka Electric Supply Authority (DESA). This was done to lessen the administrative burden on BPDB's management by relieving it of the burden of managing about 50 percent of the energy distribution of the entire country.

With the economy performing very well during 1992–95, the demand for electricity grew substantially. Faced with a grim possibility of serious electricity shortages during the next few years and to enable the sector to be financially self-sustaining and also attract private capital, the cabinet approved in principle, the inter-ministerial committee report named "Power Sector Reforms in Bangladesh (PSRB).

2.3. Importance of Construction Management

Construction management is designed to control the main important elements that provide practical information for achieving project objectives
In an efficient way. Walker defined project management as "*The use of resources in the company on a certain activity within time, cost and performance. A fourth key factor is good customer relations*". Walker added customer relations as a fourth important factor with time cost and performance.

But still we need to know the main drivers for project success, which are the most important elements for companies to make a difference in this highly competitive environment. However, in Bangladesh there are particular success factors that must be studied; Bangladesh has unique attributes that make it different from other places, and this research will focus on those, and will highlight the failure signs in managing construction projects in Bangladesh.
The construction sector is a vital part of substation and in the gross income;

In order to understand construction management we first need to define what a project is? And what does it consist of?

A substation is an electrical system with high-voltage capacity and can be used to control the apparatus, generators, electrical circuits, etc. The Substations are mainly used to convert AC (alternating current) to DC (direct current). Some types of substations are tiny in size with an inbuilt transformer as well as related switches. Other types of substations are very huge with different types of transformers, equipment, circuit breakers, and switches.

The different types of substations mainly include Step-up Type Substation, Step-down Transformer, Distribution, Underground Distribution, Switchyard, Customer Substation, and System Station.

2.4. List of Substations in Bangladesh

400 KV STATION

Sl. No	Name of Grid Substation	Transformer Capacity (MVA)	Total Capacity (MVA)	GMD	Grid Circle
1	Bangladesh India Power Transmission Center	2 x 500 MW	1000	HVDC	HVDC

400/230 KV SUBSTATIONS

Sl. No	Name of Grid Substation	Transformer Capacity (MVA)	Total Capacity (MVA)	GMD	Grid Circle
1	Bhulta	2 x 520	1040	Narsindhi	Dhaka South
2	Kaliakoir	2 x 520	1040	Kaliakoir	Dhaka North
3	Bibiyana	2 X 520	1040	Sreemangal	Cumilla

400/132 KV SUBSTATIONS

Sl. No	Name of Grid Substation	Transformer Capacity (MVA)	Total Capacity (MVA)	GMD	Grid Circle
1	Kaliakoir	2 x 250/325	650	Kaliakoir	Dhaka North
2	Gopalganj (N)	2x325	650	Faridpur	Khulna

230/132 KV SUBSTATIONS

Sl. No	Name of Grid Substation	Transformer Capacity (MVA)	Total Capacity (MVA)	GMD	Grid Circle
1	Maniknagar	2x300	600	Dhaka(Center)	Dhaka South
2	Rampura	3x225(10x75)	675	Dhaka(Center)	Dhaka South
3	Haripur	3x225(10x75)	675	Dhaka(East)	Dhaka South
4	Meghnaghat Switching			Dhaka(East)	Dhaka South
5	Siddhirganj	2x300	600	Dhaka(East)	Dhaka South
6	Hasnabad	3x225(10x75)	675	Dhaka(South)	Dhaka South
7	Shyampur	2x225/300	600	Dhaka(South)	Dhaka South
8	Tongi	3x225(10x75)	675	Dhaka(North)	Dhaka North
9	Agargaon	2x300	600	Dhaka(North-West)	Dhaka North
10	Aminbazar	3x225	675	Dhaka(North-West)	Dhaka North
11	Hathazari	4x150	600	Chattogram (North)	Chattogram
12	Shikalbaha	2x225/300	600	Chattogram (South)	Chattogram
13	Cumilla(N)	2x225	450	Cumilla	Cumilla

14	Fenchuganj	1x300	300	Sylhet	Cumilla
15	Barishal (N)	2x300	600	Barishal	Khulna
16	Khulna (South)	2x225(7x75), 1x300	750	Khulna (South)	Khulna
17	Bogura	2x225(7x75), 1x225/300	750	Bogura	Bogura
18	Sirajganj (Switching)			Bogura	Bogura
19	Barapukuria	2x225, 1x225/300	750	Dinajpur	Bogura
20	Baghabari	1x225(4x75)	225	Ishwardi	HVDC
21	Ishwardi	3x225	675	Ishwardi	HVDC

132/33 KV SUBSTATIONS

Sl. No	Name of Grid Substation	Transformer Capacity (MVA)	Total Capacity (MVA)	GMD	Grid Circle
1	Gulshan	2x80/120	240	Dhaka(Center)	Dhaka South
2	Maniknagar	2x50/75	150	Dhaka(Center)	Dhaka South
3	Ullon	3x35/50	150	Dhaka(Center)	Dhaka South
4	Siddhirganj	2x80/120	240	Dhaka(East)	Dhaka South

5	Sonargaon	2x50/75	150	Dhaka(East)	Dhaka South
6	Haripur	2x80/120	240	Dhaka(South)	Dhaka South
7	Hasnabad	3x66/100	300	Dhaka(South)	Dhaka South
8	Munshiganj	2x80/120	240	Dhaka(South)	Dhaka South
9	Shyampur	2x80/120, 2x50/75	390	Dhaka(South)	Dhaka South
10	Nawabganj	2x50/75	150	Dhaka-South	Dhaka South
11	Keraniganj	2x50/75	150	Dhaka-South	Dhaka South
12	Bhulta	2x80/120	240	Narsindhi	Dhaka South
13	Narsindhi	3x50/75	225	Narsindhi	Dhaka South
14	Dhamrai	2x50/75	150	Aricha	Dhaka North
15	Manikganj	3x35/50	150	Aricha	Dhaka North
16	Joydebpur	2x50/75, 1x80/120	270	Dhaka(North)	Dhaka North
17	Kodda	5x50/75	375	Dhaka(North)	Dhaka North
18	New Tongi	2x80/120	240	Dhaka(North)	Dhaka North
19	Tongi	3x50/75	225	Dhaka(North)	Dhaka

					North
20	Agargaon	2x80/120	240	Dhaka(North-West)	Dhaka North
21	Cantonment	2x80/120	240	Dhaka(North-West)	Dhaka North
22	Kallyanpur	3x50/75	225	Dhaka(North-West)	Dhaka North
23	Mirpur	1x80/120, 2x50/75	270	Dhaka(North-West)	Dhaka North
24	Satmasjid	2x80/120	240	Dhaka(North-West)	Dhaka North
25	Savar	3x50/75	225	Dhaka(North-West)	Dhaka North
26	Rajendrapur	2x80/120	240	Dhaka-North	Dhaka North
27	Kabirpur	3x80/120	360	Kaliakoir	Dhaka North
28	Tangail	2x80/120, 1x50/75, 1x25/41	356	Kaliakoir	Dhaka North
29	Bhaluka	2x80/120	240	Mymensingh	Dhaka North
30	Jamalpur	2x25/41, 2x50/75	232	Mymensingh	Dhaka North
31	Kishoreganj	1x25/41, 2x50/83.3	207.6	Mymensingh	Dhaka North
32	Mymensingh	3x80/120	360	Mymensingh	Dhaka North
33	Netrokona	1x50/75, 2x25/41	157	Mymensingh	Dhaka North

34	Sherpur	2x35/50, 1x50/75	175	Mymensingh	Dhaka North
35	Bakulia	2x48/64, 1x50/75	203	Chattogram (Central)	Chattogram
36	Halishahar	2x44.1/63, 1x48/64	190	Chattogram (Central)	Chattogram
37	Juldah	2x25/41	82	Chattogram (Central)	Chattogram
38	Shahmirpur	2x48/64	128	Chattogram (Central)	Chattogram
39	Baroaulia	2x80/120	240	Chattogram (North)	Chattogram
40	Baroirhat	2x50/75	150	Chattogram (North)	Chattogram
41	Hathazari	1x50/75, 1x80/120	195	Chattogram (North)	Chattogram
42	Khagrachori	2x30/39	78	Chattogram (North)	Chattogram
43	Kulsi	2x80/120	240	Chattogram (North)	Chattogram
44	Rangamati	2x25/41	82	Chattogram (North)	Chattogram
45	Chandraghona	2x25/41	82	Chattogram (South)	Chattogram
46	Cox's bazar	2x25/41, 1x50/75	157	Chattogram (South)	Chattogram
47	Dohazari	2x50/75	150	Chattogram (South)	Chattogram
48	Madunaghat	2x48/64	128	Chattogram	Chattogram

				(South)	
49	Matarbari	2x25/41	82	Chattogram (South)	Chattogram
50	Chandpur	3x50/75	225	Cumilla	Cumilla
51	Chauddagram	2x50/75	150	Cumilla	Cumilla
52	Chowmuhoni	1x80/120, 2x50/75	270	Cumilla	Cumilla
53	Comilla(N)	2x50/75	150	Cumilla	Cumilla
54	Comilla(S)	4x50/75	300	Cumilla	Cumilla
55	Daudkandi	3x50/75	225	Cumilla	Cumilla
56	Feni	2x80/120	240	Cumilla	Cumilla
57	Ramganj	2x50/75	150	Cumilla	Cumilla
58	Brahmanbaria	2x80/120, 1x25/41	281	Sreemangal	Cumilla
59	Kulaura	2x25/41	82	Sreemangal	Cumilla
60	Shahjibazar	1x25/41, 1x50/75, 1x80/120	236	Sreemangal	Cumilla
61	Sreemangal	1x25/41, 3x15/20	101	Sreemangal	Cumilla
62	Beanibazar	2x50/75	150	Sylhet	Cumilla
63	Chhatak	2x15/20, 1x25/41	81	Sylhet	Cumilla
64	Fenchuganj	2x15/20, 1x25/41	81	Sylhet	Cumilla
65	Sunamganj	2x30/39	78	Sylhet	Cumilla
66	Sylhet	1x80/120, 1x50/83, 2x25/41	285	Sylhet	Cumilla
67	Barishal	2x50/75	150	Barishal	Khulna
68	Barguna (N)	2x80/120	240	Barishal	Khulna

69	Bhandaria	2x25/41	82	Barishal	Khulna
70	Patuakhali	2x50/75, 1x25/41	191	Barishal	Khulna
71	Faridpur	2x80/120, 1x25/41	281	Faridpur	Khulna
72	Gopalganj	1x25/41, 1x80/120	161	Faridpur	Khulna
73	Madaripur	2x50/75, 1x25/41	191	Faridpur	Khulna
74	Shariatpur	2x80/120	240	Faridpur	Khulna
75	Benapole	2x50/75	150	Khulna (North)	Khulna
76	Goalpara	2x25/41	82	Khulna (North)	Khulna
77	Khulna	3x48/64	192	Khulna (North)	Khulna
78	Narail	2x50/75	150	Khulna (North)	Khulna
79	Noapara	2x40, 1x44.1/63	143	Khulna (North)	Khulna
80	Bagerhat	2x25/41, 1x50/75	157	Khulna (South)	Khulna
81	Gallamari	2x25/41	82	Khulna (South)	Khulna
82	Mongla	2x25/41	82	Khulna (South)	Khulna
83	Satkhira	1x80/120, 1x25/41	161	Khulna (South)	Khulna
84	Bogura	2x80/120, 2x50/75	390	Bogura	Bogura
85	Joypurhat	4x25/41	164	Bogura	Bogura
86	Mahastanghar	2x80/120	240	Bogura	Bogura

87	Palashbari	2x25/41, 2x50/75	232	Bogura	Bogura
88	Sherpur(Bogura)	2x50/75	150	Bogura	Bogura
89	Sirajganj	2x50/75, 1x35/50, 1x25/41	241	Bogura	Bogura
90	Panchagorh	4x25/41	164	Dinajpur	Bogura
91	Purbasadipur	1x25/41,1x15/20,2x50/75	211	Dinajpur	Bogura
92	Thakurgaon	2x50/75, 1x25/41	191	Dinajpur	Bogura
93	Amnura	3x35/50	150	Rajshahi	Bogura
94	Chapai Nawabganj	1x15/20,1x25/41, 2x50/75	211	Rajshahi	Bogura
95	Naogaon	3x50/75	225	Rajshahi	Bogura
96	Natore	1X35/50, 2x15/20, 2x50/75	240	Rajshahi	Bogura
97	Niymatpur	2x35/50, 1x25/41	141	Rajshahi	Bogura
98	Rajshahi	2x80/120, 1x35/50	290	Rajshahi	Bogura
99	Rajshahi(N)	2x80/120	240	Rajshahi	Bogura
100	Barapukuria	3x25/41	123	Rangpur	Bogura
101	Jaldhaka	2x50/75	150	Rangpur	Bogura
102	Kurigram	2x50/75	150	Rangpur	Bogura
103	Lalmonirhat	2x15/20, 1x25/33, 2x50/75	223	Rangpur	Bogura
104	Rangpur	2x80/120, ,1x25/41	281	Rangpur	Bogura
105	Saidpur	2x25/41,1x35/50, 1x50/75	207	Rangpur	Bogura
106	Ishwardi	2x50/75	150	Ishwardi	HVDC

107	Pabna	2x25/41, 2x50/75	232	Ishwardi	HVDC
108	Shahajadpur	2x50/75, 2x35/50	250	Ishwardi	HVDC
109	Bheramara PGCB	1x15/20, 2x25/41	102	Jhenaidah	HVDC
110	Chuadanga	2x50/75	150	Jhenaidah	HVDC
111	Jessore	1x50/83.3, 2x80/120	323.3	Jhenaidah	HVDC
112	Jhenaidah	2x80/120	240	Jhenaidah	HVDC
113	Kushtia	2x80/120	240	Jhenaidah	HVDC
114	Magura	2x25/41	82	Jhenaidah	HVDC

CHAPTER III

CONSTRUCTION ACTIVITIES OF 132/33KV SUBSTATION, KERANIGANJ

3.0. Introduction

We have described the construction activity of 132/33KV Keraniganj Substation. Which is situated in char galgalia, abdullahpur, keraniganj, Dhaka. The substation owner is **Power Pac Holdings Ltd**. The company distributes 100MW power by the substation to national grid of Bangladesh with **Bangladesh Power Development Board**. The area of the substation is 68,855 sft. (1.6 Acres).

3.1. Site Selection

For site selection, specific investigations have to be conducted to compare various factors at each location or the project's environmental impact.

The following are key factors:

- Labor market
- Suitable harbor conditions
- Sufficient land space
- Power options available
- Water supply
- Transportation
- Natural hazards
- Environmental aspects
- Political climate
- Security requirements

The process includes the following steps:

- Study of project criteria.
- Evaluation of communities.
- Create a short list of communities based upon project criteria.
- Substation analysis.
- Negotiate tax incentives.
- Site acquisition.

3.2. Topographical Survey

A topographical survey or land survey is an accurate representation of the area of interest showing all natural and manmade features with levels. Shown as three dimensional points all features including the property, land features and physical boundary details are presented on a scaled survey drawing. Using the latest surveying equipment one of our land survey teams will visit the site to capture the site features and then process the information at our office.

METHODOLOGY:

This Methodology of Topographical Survey covers the following works
(1) Installation of Benchmarks
(2) Topographical survey at with scale 1: 500 and grid every 10 m interval.
(3) Topographical surveys for pipeline route, with scale 1: 500 and grid every 100 m interval.

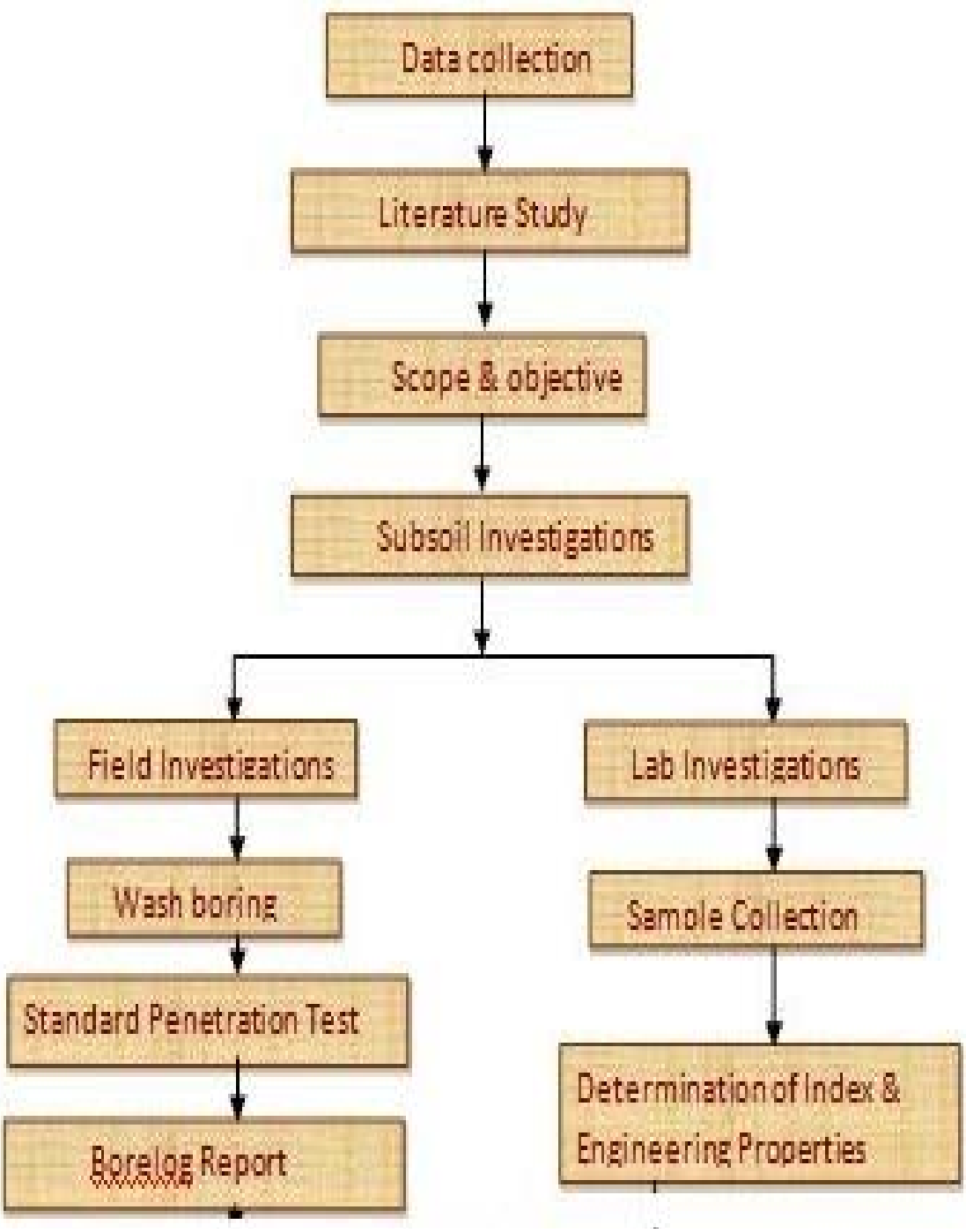
A typical topographical survey process includes:

- Gathering information
- Planning the time schedule and pricing.
- Gathering survey data on site.
- Processing data and preparing the final survey output.
- Internal quality assurance by a senior member of the staff
- Delivery of the final survey output

3.3. Sub Soil Investigation

The subsoil investigation is the exploration of soil with the help of standard field experiments that are commonly performed. With the help of above performed test, we are comfortable to find the exact picture of soil profile. The most commonly performed field tests were Standard penetration test and wash boring. The standard penetration test is the most commonly used in-situ test. The test is most commonly used for determining the relative density and the angle of shearing resistance of cohesion less soils. It can also be used for determining the unconfined compressive strength of cohesive soils. Wash boring mainly used for advancing hole in the ground.

METHODOLOGY:



3.4. Design and Drawing

After getting topographical survey report and soil investigation report, the consultants of the project prepared the drawings and design for the project.

Some drawings of the project:

- Master plan of the project
- Cross sectional drawings of the substation
- Layout plan for piling
- Cross sectional drawing of pile
- Layout plan for foundations/pile caps
- Cross sectional drawings of foundations/pile caps
- Detail drawings for pedestal/short columns
- Detail drawings for anchor bolts
- Detail drawings for steel structures
- Detail drawings for earthlings
- Detail drawings for cable trench
- Detail drawings for cable connection
- Detail drawings for fencing
- Detail drawings for control room
- Detail drawings for transformer's foundation
- Detail drawings for foundation of CT, PT, DS, LA, IVT, gantry tower, Bus tower, CB etc.
- Detail drawings for stone laying
- Detail drawings for internal, external road and walkway
- Detail drawings for beautification of the substation

The layout plan of pile for the substation is below:

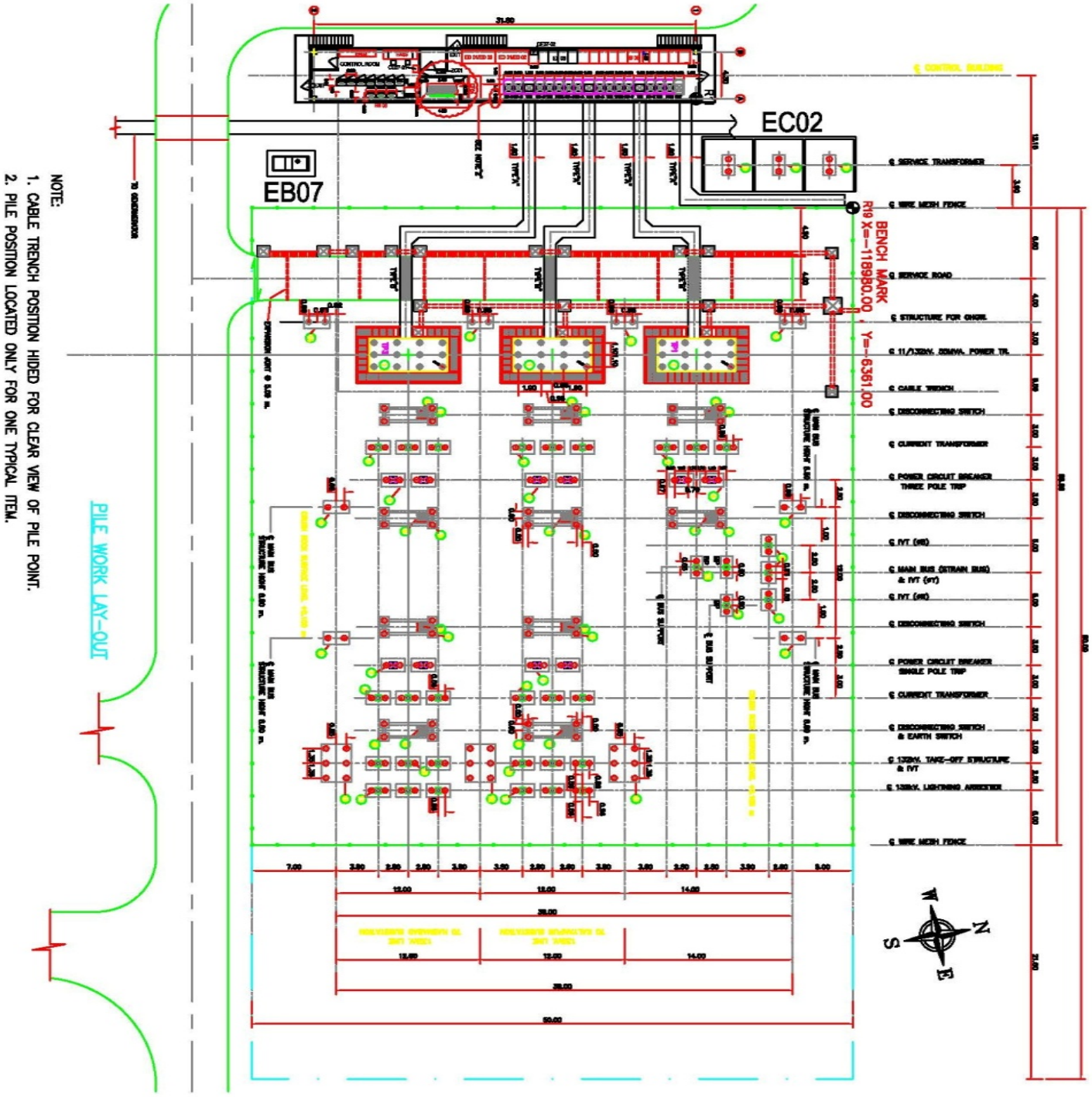


Fig.: 3.1. Layout plan of pile of 132/33KV substation, Keraniganj

3.5. Piling Work

Pile foundations are the part of a structure used to carry and transfer the load of the structure to the bearing ground located at some depth below ground surface. The main components of the foundation are the pile cap and the piles. Piles are long and slender members which transfer the load to deeper soil or rock of high bearing capacity avoiding shallow soil of low bearing capacity. The main types of materials used for piles are Wood, steel and concrete. Piles made from these materials are driven, drilled or jacked into the ground and connected to pile caps. Depending upon type of soil, pile material and load transmitting characteristic piles are classified accordingly.

After getting detail drawings for piling of the substation, the surveyor demarked the pile point by total station as per drawing and design. After demarked the pile point the contractors start the piling work as per drawings.

Why we use pile foundation

One or more of the followings:
(a) Transfer load to stratum of adequate capacity
(b) Resist lateral loads.
(c)Transfer loads through a scour zone to bearing stratum
(d) Anchor structures subjected to hydrostatic uplift or overturning

In the substation used cast in situ piles and the pile layout drawing of power transformers are below:

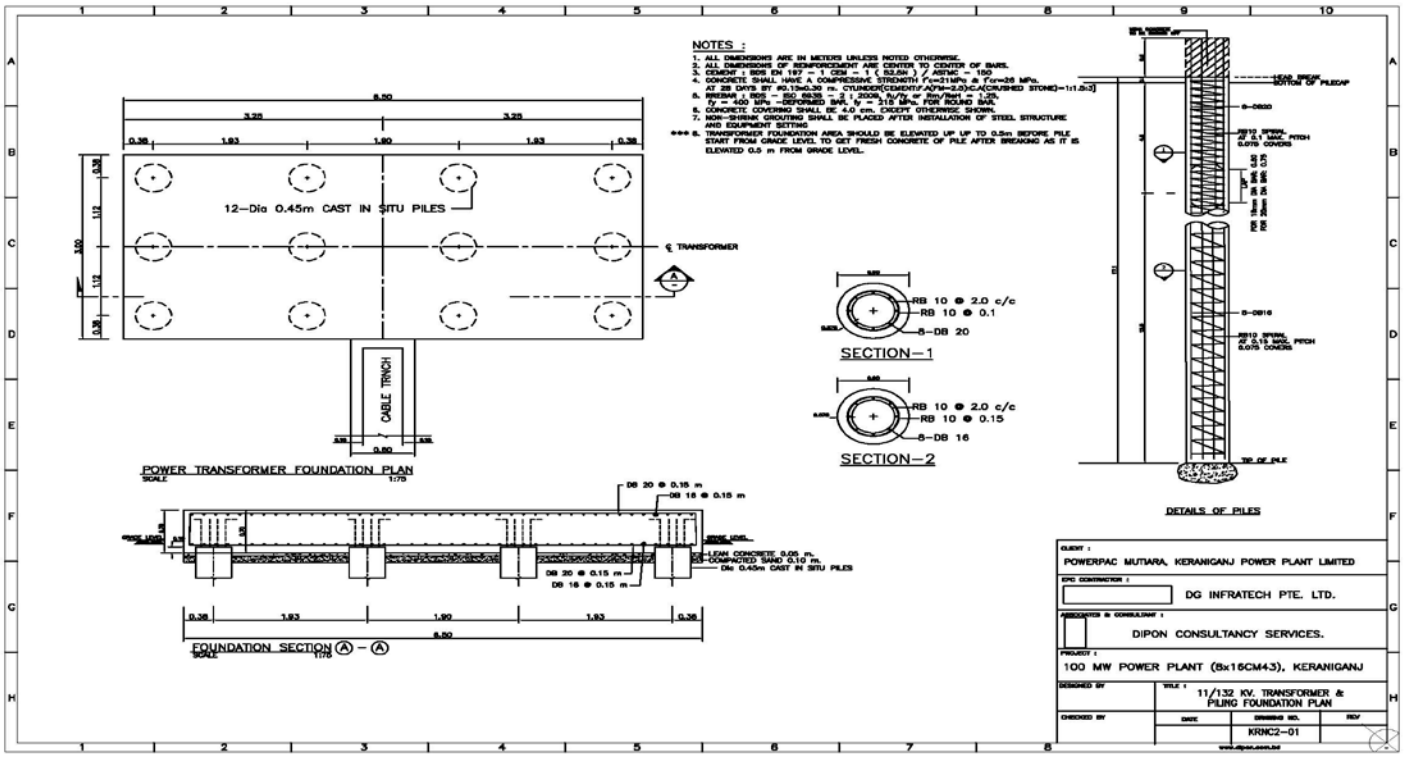


Fig.: 3.2. Pile layout drawing of power transformers foundation

Construction Procedure of cast in situ pile:

For any construction, soil should be tested at first. Therefore, for this, a sample of soil is being sent to lab for soil investigation. Sub soil investigation is done in four steps:
a) Boring operation b) Sample collection c) Field test d) Laboratory test
From the report an engineer calculates the depth of the borehole for the pile which is to be driven later and which type of pile foundation is needed.
There are many processes for pile driving but among them boring is suitable and also economical. Therefore, after getting the soil test report, we need to do boring.

Among various types of boring process, wash boring is commonly preferred type. In this process a hollow steel pipe known as casing pipe or driven pipe is firstly driven. Then a water jet pipe is lower into the casing pipe to produce jet action. When water under considerable pressure is forced down in the water jet pipe, it displaces the soil. The slurry is formed and collected in mud tank.

In Bangladesh, there is another process of boring which is widely used known as percussion boring. In this method, at first soil is being chopped by a drilling bit/chisel for a certain depth without any cage by attaching the boring assemblies with the rig. Then a temporary steel cage is lowered in the borehole to protect loose soil from falling in the borehole at locations where the soil is in loose state and there is a tendency of collapse of borehole. After driving the casing its verticality will be checked by plumb bob

Fig: 3.3. Steel casing for piling

Fig: 3.4. Drilling bit/chisel for piling

Again, soil is chopped by drilling bit for the required depth and at a time drill fluid is pumped through the drill rod. These clears the cutting materials from the borehole and the suspended particles are contained in the mud tank.

A circular cage known as pile reinforcement cage shall be fabricated as per the details given in drawing and Bar Bending Schedule. Lapping should be welded. When the reinforcement cage is transported, the alignment should be correct. It is lowered inside the borehole, hanging it on the upper part of the steel pipe, by lowering with the rig assemblies. Concrete wheels are attached on the whole reinforcement cage which maintains clear cover for the pile.

Fig: 3.5.Reinforcement cage

Fig: 3.6.Core/tremie pipe

Then core/tremie pipe is lowered through the reinforcement cage, keeping gap between the tremie pipe and the bottom level of borehole of minimum 6 inches. In the mixer machine, sand, cement, shrinkle chips and water is poured and blended. Then it is poured in the core pipe for concreting. After that the core pipe is removed. During this time the pipe is vibrated so that there will be less void space.

Fig: 3.7. Concrete mixing

Fig: 3.8.Pouring concrete in the tremie pipe

After some days, a hard simplex pile is made for the structural purpose.

Limitations:

Construction of cast in situ piling during the forma, limitations appeared some obstacles and such as:

1) Theoretically pouring of Concrete and withdrawing of steel tube gradually but Steel tube is withdrawn after 28 days.
2) As the concrete has to be dumped from great height, the quality of work is not appreciably good.
3) Transporting the reinforcement cage may bend at any point because of its long length.
4) When a piling is done, within 20 days there should not be done another piling close to the previous piling. This may damage that pile.
5) During piling work reinforcement cage can be displaced.
6) Piling cannot be done under water. Because boring can be filled with water and causes harm in piling.
7) In the practical construction work pile shoes are not used. It is used in pre-cast piling for big structural purposes.

Cast in situ piling is favorable than other piling processes. Because there is no waste of time and materials so it is economical and can be cast into exact length. It can bear heavier load and transfer it to the ground soil. Also the transportation cost is not high.

It is not necessary to reinforce the pile in normal cases or in places where the pile is completely submerged in the soil. But for more stability and durability of structure we use reinforcement. Over all, cast in situ is preferable for bearing huge amount of load as it can be cast deep inside the ground.

3.6. Soil Excavation

In construction terms, excavation is the process of removing earth to form a cavity in the ground.

On small sites or in confined spaces, excavation may be carried out by manual means using tools such as picks, shovels and wheelbarrows. Larger scale excavation works will require heavy equipment such as excavators and bulldozers.

This involves the removal of the exposed layer of the earth's surface, including any vegetation or decaying matter which could make the soil compressible and therefore unsuitable for bearing structural loads. The depth will vary from site to site.

This involves the removal of the layer of soil directly beneath the topsoil. The removed material (referred to as 'spoil') is often stockpiled and used to construct embankments and foundations.

In this substation, excavation of soil for pile cap shuttering and casting as required in drawing. Depth of excavation is different for different pile cap.

The pile cap drawings of transformer foundation are below:

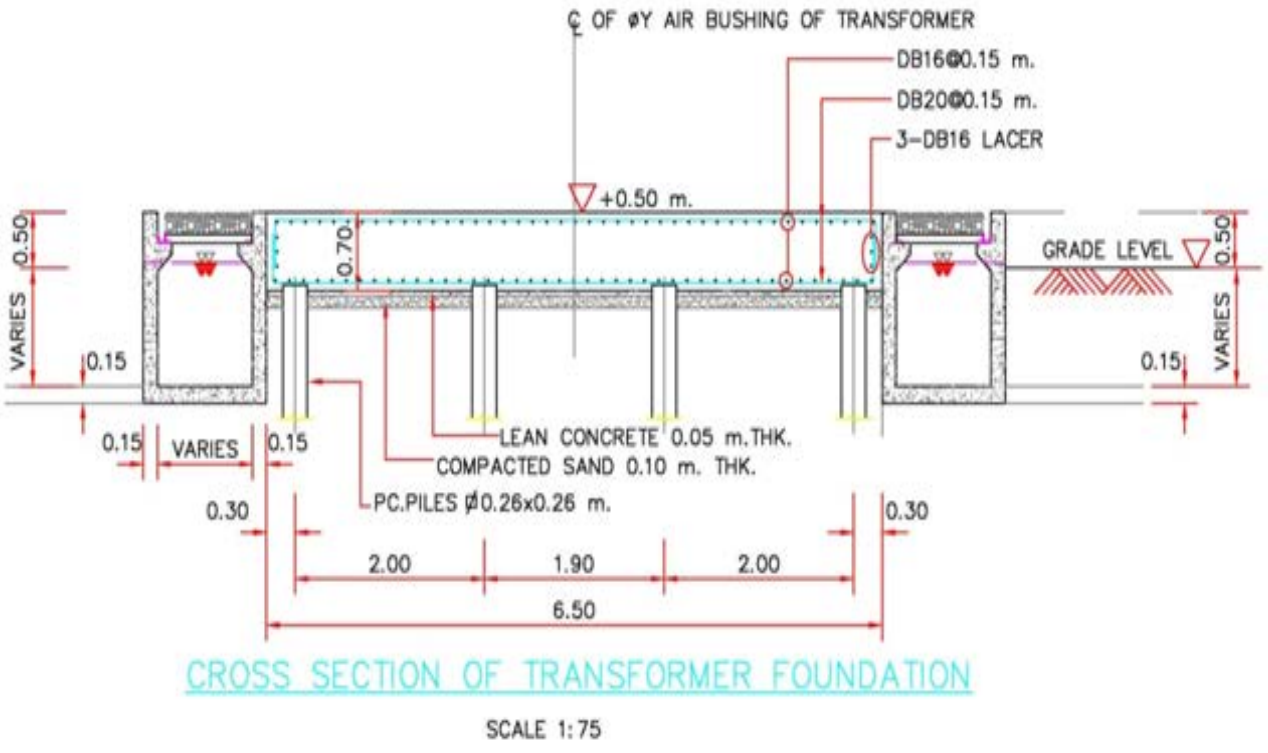


Fig.: 3.9. Cross section of transformer foundation

3.7. Head Breaking of Pile

Removal of reinforcement in a prefabricated concrete pile or in-situ head-bored pile is known as pile breaking. The art of hydraulic pile breaking is to complete the work so neatly that it looks like it was done by hand.

The dissection of concrete piles is considered as a vital part of the construction process. The selection of a proper pile breaking method can lead to financial and programme savings as well as approach and minimize probable health and safety issues in regard to this stage of the works.

It is always recommended that bored cast in place concrete piles should have been cast to a level over the certain cut-off with the intention that as soon as the trimming is completed, a strong concrete connection with the pile is formed.

While developing the concrete pile foundations, it is necessary to build up or crop the piles to the perfect level to facilitate the sequential construction of pile caps or capping beams.

Pile Cropping Method:

The pile cropping method is vital to separate all concrete to the defined level, whilst parting reinforcing bars protruding to the plotted length to facilitate sufficient lap and/or anchorage into sequential construction.

Precaution should be taken while extraction of concrete to the exact level so that there is no damage to the pile concrete underneath the cut off level since it can impact the load bearing strength of the pile. The method should eliminate all damaged or poorly compacted concrete and laitance. The subsequent surface should be properly level to facilitate settling of reinforcing bar in the pile caps and leave an exposed aggregate finish to develop a proper construction joint.

The pile head drawings are below:

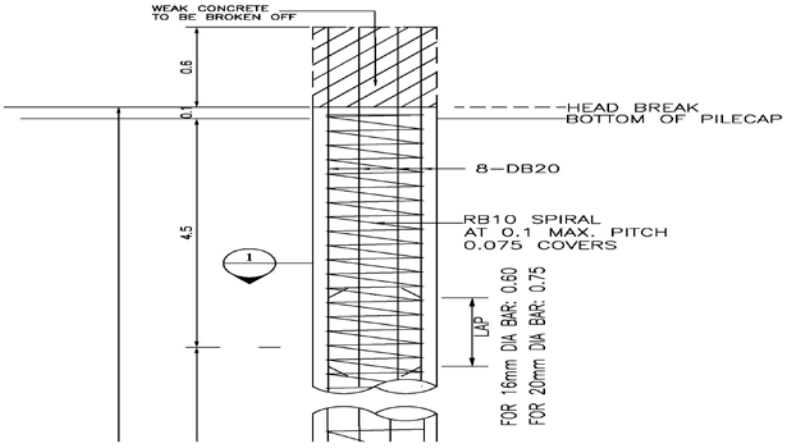


Fig.: 3.10. Pile head drawing

3.8. Lean Concrete Casting

Lean concrete is a mix where the amount of cement is lower than the amount of liquid present in the strata.

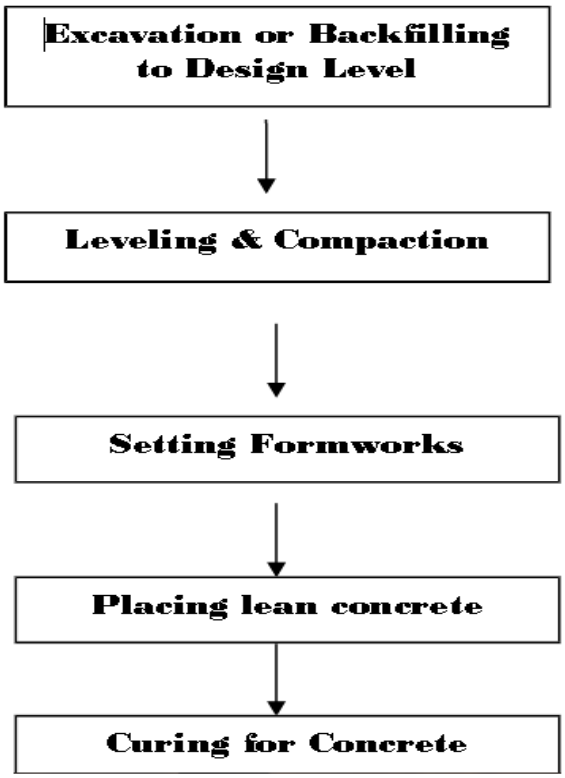
The higher the Aggregate or cement ratio, the leaner the concrete. In lean concrete, less quantity of paste is available for providing lubrication, per unit surface of aggregate and hence the mobility of aggregate is restricted.

Advantages of lean concrete:-

1. Main function of the lean concrete is to provide the uniform surface to the foundation concrete and to prevent the direct contact of foundation concrete from the soil.
2. Lean concrete is used under the foundations.
3. Lean concrete is used to provide a level surface, where main foundation (raft, isolated or any other type) can be placed.
4. Another purpose is protection of main foundation from soil below, as moisture or other chemicals in soil like sulphates may attack concrete and can weaken it.

If you need a quality foundation and the entire structure as a whole, then use lean concrete.

Sequence of Lean Concrete Casting Works:



Lean concrete casting drawing of DS foundation is below:

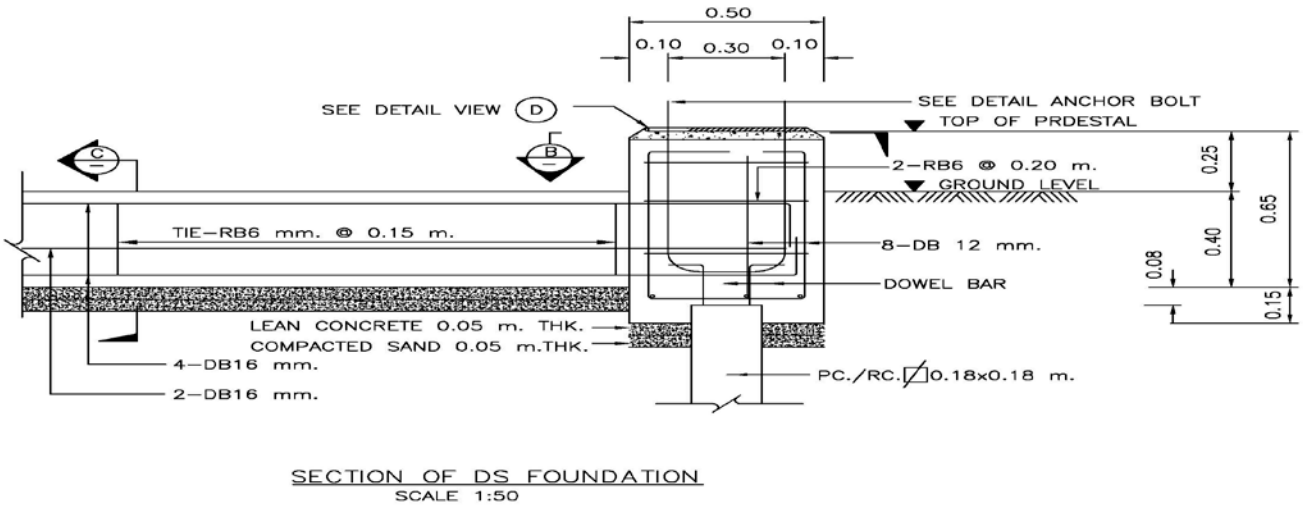


Fig.: 3.11. Lean concrete casting drawing of DS foundation

3.9. Pile Cap Casting

Pile caps are constructed by excavating an area around the group of piles to enable formwork to be inserted. The pile tops may be trimmed to ensure they are at the same height. A reinforcement cage is then built and positioned in the formwork cast box and fastened to the piles. The concrete is then poured and left to cure, after which the formwork is removed.

Pile cap used to transfer the loads from superstructure to the piling. The pile cap is thick concrete mat rests on piles. It is part of the foundation and used to distribute the loads over the piles. Piles used when the soil bearing is not enough to carry loads of the structure.

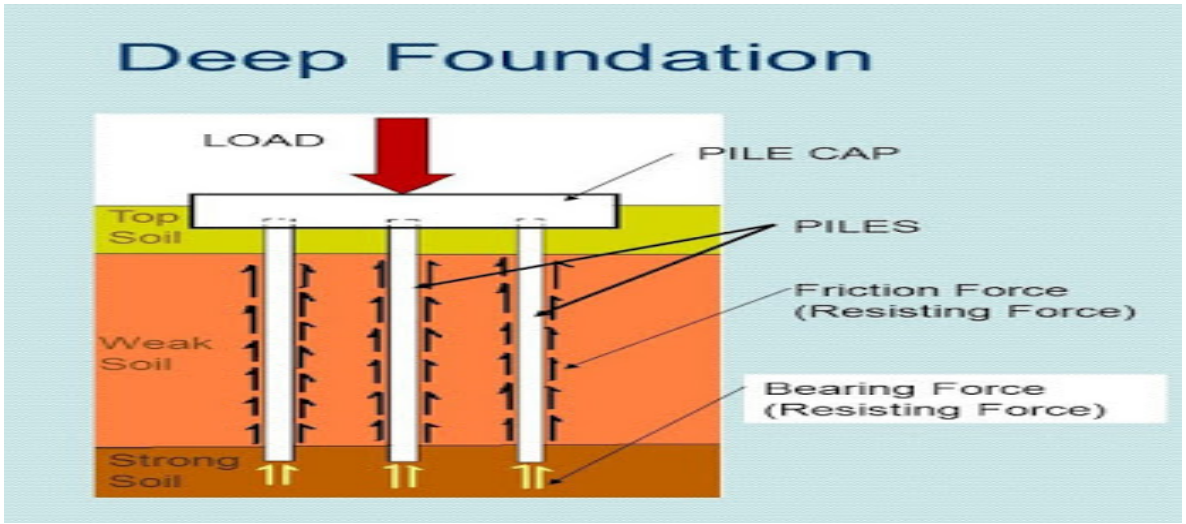


Fig.: 3.12. Pile cap construction

Excavation around piles:

After 7 days of the casting of the pile the concrete will gain approximately, 70% of it is compressive strength. The soil around piles will be removed to the required levels and dimension that allows construction of the pile cap. A step shall be made if the excavation is more than 1.5 m to prevent soil collapse.

Fig.: 3.13. Excavation around piles

Pile head breaking:
Concrete will be removed up to cut off level. If concrete under the cut off level is unsound. It shall be removed, and the pile will be repaired. Pile must be free from cracks and unsound concrete.

Fig.: 3.14. Pile head breaking

Blinding Concrete:

After completion of concrete cutting for piles, Blinding concrete shall be cast. Following points illustrating the procedure for pile cap blinding concrete.

1. Soil shall be removed and leveled to the formation level. The formation for blinding concrete shall be compacted properly and tested for field density test.
2. Two layers of polyethylene sheet will be laid above the formation layer.
3. Now you can cast the blinding concrete. The thickness and dimension should be matching to shop drawing.
4. Termination grooves (2x2 cm x cm) shall be provided to blinding concrete to terminate the waterproofing for pile cap and blinding concrete.
5. The blinding concrete will be cured for a minimum of 24 hours.

Fig.: 3.15. Preparation for lean concrete casting

Waterproofing for blinding concrete:

To prevent groundwater ingress from the pile cap bottom. It is recommended to waterproof pile cap blinding, especially in areas of the high water table and harsh environment. The sequence of waterproofing is as follow.

1. To obtain strong adhesive, it is essential to clean the blinding concrete thoroughly from any dirt or debris.
2. A chamfer shall be cast around piles head to provide a smooth transition between piles head and pile cap.
3. The surface of blinding concrete shall be painted with primer. Primer shall cover the area evenly.
4. Before lying of the waterproofing membrane. The surface of the primer shall be cleaned thoroughly to enhance the adhesive of the waterproofing membrane. The membrane shall be overlapped sufficiently to prevent water flowing from weak joints.

Protection of waterproofing:

Waterproofing shall be protected to avoid damages during the construction process. The protection depends on the alignment of waterproofing.

1. Screed: screed will be provided for horizontal waterproofing such as blinding concrete waterproofing. To protect the waterproofing from any damage during fixing reinforcement and shutter for pile cap.

2. Protection board: This board will be used for vertical waterproofing such as waterproofing for pile cap.

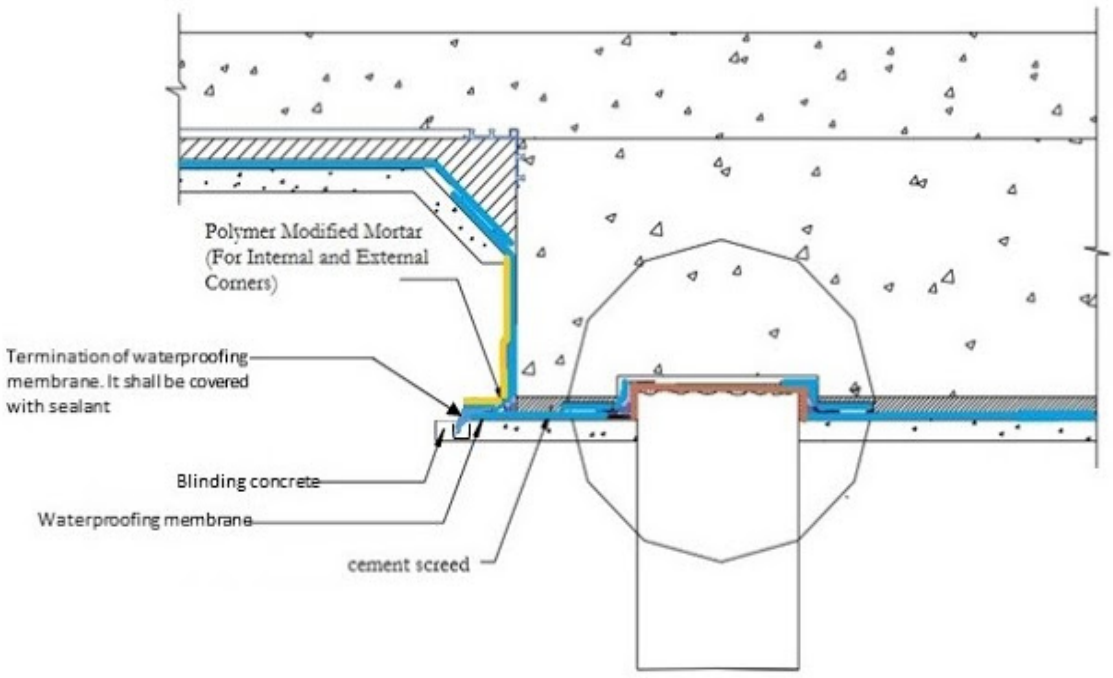


Fig.: 3.16. Protection of waterproofing

Reinforcement fixing for pile cap:

Pile cap reinforcement shall be fixed as per approved drawing. At the field, the designer will provide you with the shop drawing for each structural element. These drawing shall consider as a guide. However, there are some important points. That should not be ignored.

1. Enough cover blocks should be provided to maintain the required cover. Maintaining the needed cover is very important, and ignoring cover requirement can lead to reducing structure durability. Importance of cover can be briefed in the following points.
2. The concrete cover will form a barrier between reinforcing steel and corrosive agents such as chloride.

3. Protect reinforcing steel from concrete carbonation. Concrete carbonation can cause steel corrosion.

4. Fire Protection: concrete cover will protect the steel from fires and prevent steel melting.
5. Enough chairs shall be provided to maintain reinforcement rigid and avoid movement and deformation during concreting.
6. Dowel (starter) bars shall be provided for pier column. Dowel bars shall be adequately braced to avoid movement during casting. Also, dowel bars shall be maintained vertical.

Fig.: 3.17. Reinforcement fixing for pile cap

Formwork installation for pile cap:

1. The engineer will provide a detailed drawing for pile cap shutter and the required supports such as jacks, tie road. At the field the fabricated shutter shall be identical to the provided drawing.
2. Corner chamfer shall be fixed on all side and top of shutter to provide a smooth edge.
3. The concrete cover should be maintained after fixing of the shutter as shown on the drawing.

4. The alignment and verticality of shutter shall be checked by the surveyor.

5. The kicker and shear key shutter for pier shall be fixed and location checked by the surveyor. Thermocouples shall be fixed before the concreting of pile cap to measure the temperature difference between top, middle, and bottom of pile cap concrete. Thermocouples used to monitor the differential temperature between different concrete layers in case of mass concrete. The differential temperature should be less than 20 C. If the differential temperature increased more than 20 C, this could cause tensile stress more than concrete strength, which can lead to internal cracks.

6. Prior to the concreting the area should be clean and free from any dirt's.

Fig.: 3.18. Formwork installation for pile cap

Concreting of the pile cap:

Before the concrete pile cap area should be cleaned again. In the events of dust or sand accumulation, the blower should be used to assure removing all dirt's. If the temperature during casting of pile cap is high, then shutter shall be sprinkled with water to prevent the plywood from absorbing concrete moisture. A sufficient number of vibrators and a competent person should be present during the casting process to produce a dense concrete surface free from honeycombs. Concrete shall be cured for a minimum period of two weeks. Concrete surface shall be covered with a hessian sheet, and it shall be kept wet all time during the curing period.

Fig.: 3.19. Concreting of the pile cap

3.10. Anchor Bolts Setting

Setting anchor bolts may sound like a simple task in preparing a slab or foundation for placement. But for industrial/commercial concrete contractors it can become a very complicated and important detail. Some contractors are selected specifically because they can accurately and efficiently set anchor bolts for heavy machinery and steel columns. Locating and installing anchor bolts can have a tremendous impact on the rest of the project. Here are some of the steps that professionals take.

Layout:

Layout work is increasingly being performed by using total stations. They're fast and very accurate and robotic total stations make it a one-person job.

Fig.: 3.20. Layout for anchor bolts setting

Positioning and securing:

Anchor-bolt assemblies are securely positioned with welded template supports. The bottom rebar is set before the anchor bolts are positioned, then the anchor bolts, and finally the top rebar.

Fig.: 3.21. Positioning and securing of anchor bolts

3.11. Short Column Casting

Reinforced Concrete column is a vertical member which transfers loads from slab and beam directly to subsequent soil.

A whole structure stands on columns. Most of the structure failure happens due to column failure. And most of the column failure happens not for design fault but for the poor construction practice. So, it is very important to know the construction process of the RC column properly.

Constructing Concrete Column involves following four stages of works –

1. Column layout work
2. Column reinforcement work
3. Column formwork, and
4. Pouring concrete into column.

Column layout work**:**

In this stage of works the location of columns are determined practically in field. It is done by laying rope according to grids shown in the drawing and then mark the location of columns related to rope. In drawing, column locations are shown related to grid-line with dimension. Practically, in field, ropes are our grid-line. So we place columns related to rope-line by measuring dimension shown in the drawing.

Column Reinforcement work**:**

After marking the column locations, we then start to place reinforcement as instructed in the structural drawing.

Column formwork**:**

In building, floor height is normally kept 3 m. If the slab has beam then we have to pour concrete up to beam bottom level. Suppose, beam height specified in drawing is 0.45 m. So, the casting height of our column will be 2.65 m. And our formwork height will be 2.65 m. But one thing should be considered here is that dropping concrete from above 1.5 m height isn't suggested during pouring. Because its leads to concrete segregation. So we should make one-side of column formwork within 1.5 m height range. After casting 1.5 m of column, we just lift the short side up to full-casting height of column next day. Another way to cast column without segregation is to keep a small window at 1.5 m level of full-

height formwork. After casting up to that level, close the window and cast the rest of the column.

Pouring concrete into column**:**

Casting column is easy. For small quantity of concrete volume we normally depend on machine-mix concrete and for large concrete quantity we order ready-mix concrete. I would suggest machine-mix concrete. Because, if you use moving pump with ready-mix concrete and if you want not to exceed 1.5 m height range for dropping concrete that would be difficult. If we don't use moving pump, yet there are some problems. Suppose, if we have decided to use ready-mix concrete without pump. In that case, you have to manually unload concrete on job site from ready-mix concrete truck and have to manually pour into column. That'll take long time and you'll exceed initial setting time of concrete. As a result, concrete will lose its quality. So it is better to cast column with machine-mix concrete.

3.12. Backfill the Foundations in Substation Yard

Once the foundations have been laid, we backfill them and level the yard with granular material (sand, gravel, rock, etc.) that is adapted to the site.

Fig.: 3.22. Backfill the foundations in substation yard

Fig.: 3.22. Backfill the foundations in substation yard

3.13. Assemble the Steel Structures

Once the concrete is set, steel structures are assembled to support the electrical equipment. Other structures will support the control building.

Fig.: 3.23. Assemble the steel structures

3.14. Install The Electrical Equipment

Once the framework is built, we install the equipment on the foundations and steel structures.

We installed different types of equipment as follows:

- Power Transformers
- Lightening Arresters (LA)
- Circuit Breakers (CB)
- Disconnecting Switches (DS)
- Buses Towers
- Potential Transformer (PT)
- Current Transformer (CT)
- Gantry Tower
- Earthling Switch (ES)

Each piece of equipment is then connected to the control room, which is under construction.

We permanently fence off the new installations to ensure everyone's safety. Our technicians test the equipment before the installations are connected to the power grid. Finally, we commission the substation and ensure that the electricity is flowing.

3.15. Landscaping and Carry out the Final Inspection

The project ends with landscaping: we plant trees, create mounds of earth and do more work if necessary.

We do earthwork, demobilize the site and carry out the final inspection to wrap up the project. Only the operating equipment is left at the substation.

Landscaping on the site ensures that the substation is seamlessly integrated into the environment.

Fig.: 3.24. Landscaping and carry out the final inspection

CHAPTER IV

CONSTRUCTION ACTIVITIES OF 132/33KV SUBSTATION, BARGUNA

4.0. Introduction

We have described the construction activity of Barguna 132/33 KV Grid Substation. Which is situated Khajurtola, Pouro bus stand, Barguna Sadar, Barguna The substation sub contractor is **Reverie Power and Automation Engineering Company limited** The Company distributes 132kv & 33 kv power by the substation to national grid of Bangladesh with **Power Grid Company of Bangladesh (PGCB)**. The area of the substation is 239,518sft. (5.49 Acres).

4.1. Site Selection

The site should be near the load center keeping in view the future load growth.

Some general factors to be considered are listed. It should be remembered that

Some of the factors are actually interdependent.

4.2. Technical aspects that can influence the site selection process could include the following:

Land: choose areas that minimize the need for earth movement and soil disposal.

Water: avoid interference with the natural drainage network.

Vegetation: choose low productivity farming areas or uncultivated land.

Protected areas: avoid any areas or spots listed as protected areas.

Community planning: avoid urban areas, development land, or land held in reserve for future development.

Community involvement: engage community in the approval process.

Topography: flat but not prone to flood or water stagnation.

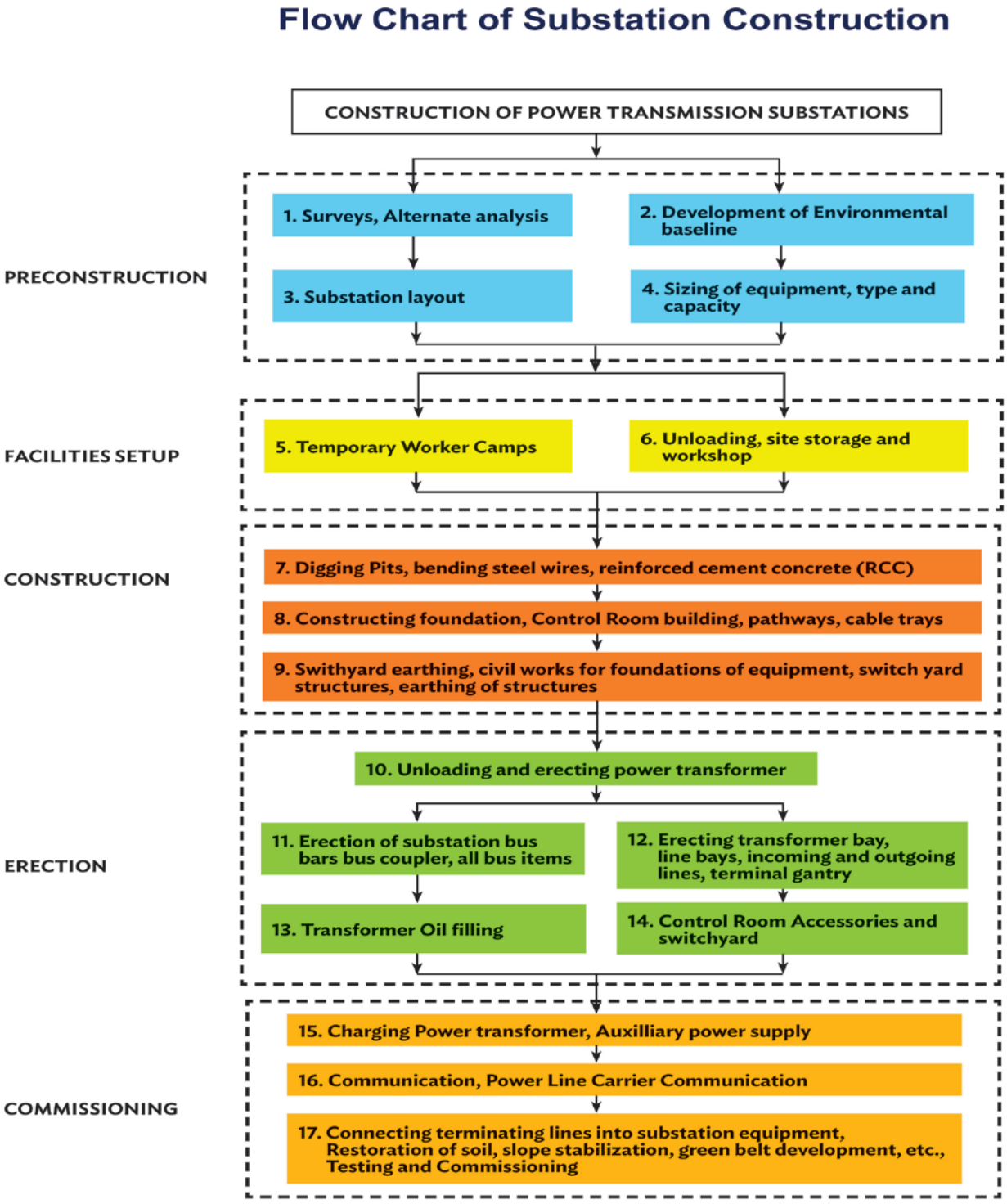
Soil: suitable for construction of roads and foundations; low soil resistivity is desirable.

Access: easy access to and from the site for transportation of large equipment, operators, and maintenance teams.

Line entries: establishment of line corridors (alternatives: multi-circuit pylons, UG lines).

Pollution: risk of equipment failure and maintenance costs increase with pollution level.

4.3. Flow Chart of Substation Construction



4.4. Survey:
Reconnaissance Survey: Information on field data required for substation design, distance from community resources – worship place, village common grounds, community center's schools, hospitals etc. Location of substation as compared to the direction of incomers and outgoing lines is an important factor in determining the site.

4.5. Activity causing Impact and Location:
Enumeration of trees for cutting, identification of- locations for digging of soil for foundations for equipment, buildings etc., stacking area for construction material etc.
(Location: Substation land)

Impact of activity and its type:
Potential impact on physical resources - Topography, possible loss of biodiversity in the area, interference with common property resources, public utilities such as roads, water, sewage facilities etc. (Type: Planning stage)

Impact Mitigation:
Avoid biodiversity areas such as location near water body etc. Consider better choice of location to avoid issues regarding common resources with community and public utilities.

4.6. Work Process:

Development of Environmental Baseline:
Air, water, noise, soil investigation is the important aspect of the substation land in any area – hilly, plain level area, or sandy areas. General characteristics of the soil formation to be included in the plan, giving details of weather, clay, gravel, rock etc. that exist in the area as this information has a direct influence on the type of foundation types.

Activity causing Impact and Location:
Collection of soil samples by using digging machines as well as collection of water from wells/water sources. (Location: Substation Land)

Impact of activity and its type:
Minor impact of collection of soil samples using digging machines on topography or pollution of water source during sample collection. Marshy areas, low-lying areas, riverbeds, earth slip zones that would involve risk to stability of the foundations. (Type: Temporary)

Impact Mitigation:
Development of baseline with no project situation a must for monitoring impact of project construction activities. Marshy areas are avoided. Care taken to ensure proper profiling of the ground rock formation and ground water.

4.7. Substation Layout:
Electrical layout of the site is finalized. Facilities layout, selection of benches for substation (various levels in hilly areas), Cutting and filling for levelling land Development of drainage, road and other facilities.

Activity causing Impact and Location:
Development of benches by cutting and filling inside the substation sites to ensure proper placement of all equipment. Benching allows voltage level separation by physically collocating similar equipment in one bench.

Impact of activity and its type:
Planned cutting and filling will lead to soil erosion, runoff of soil, potential water logging, suitable places to dispose excess soil, cutting of trees on the site. (Type: Planning)

Impact Mitigation:
Water logged/steep sloped/degraded sites must be avoided while selecting the location of substation. The layout of the site must be such that cutting of trees, soil must be minimized.

4.8. Design and Drawing
After getting topographical survey report and soil investigation report, the consultants of the project prepared the drawings and design for the project.

Some Drawings of the project:

- Master plan of the project
- Cross sectional drawings of the substation
- Layout plan for piling
- Cross sectional drawing of pile
- Layout plan for foundations/pile caps
- Cross sectional drawings of foundations/pile caps
- Detail drawings for pedestal/short columns
- Detail drawings for anchor bolts
- Detail drawings for steel structures
- Detail drawings for earthlings
- Detail drawings for cable trench
- Detail drawings for cable connection
- Detail drawings for fencing
- Detail drawings for control room
- Detail drawings for transformer's foundation
- Detail drawings for foundation of CT, PT, DS, LA, IVT, gantry tower, Bus tower, CB etc.
- Detail drawings for stone laying
- Detail drawings for internal, external road and walkway
- Detail drawings for beautification of the substation

The overall layout drawing of barguna 132/33 KV substation is given below:

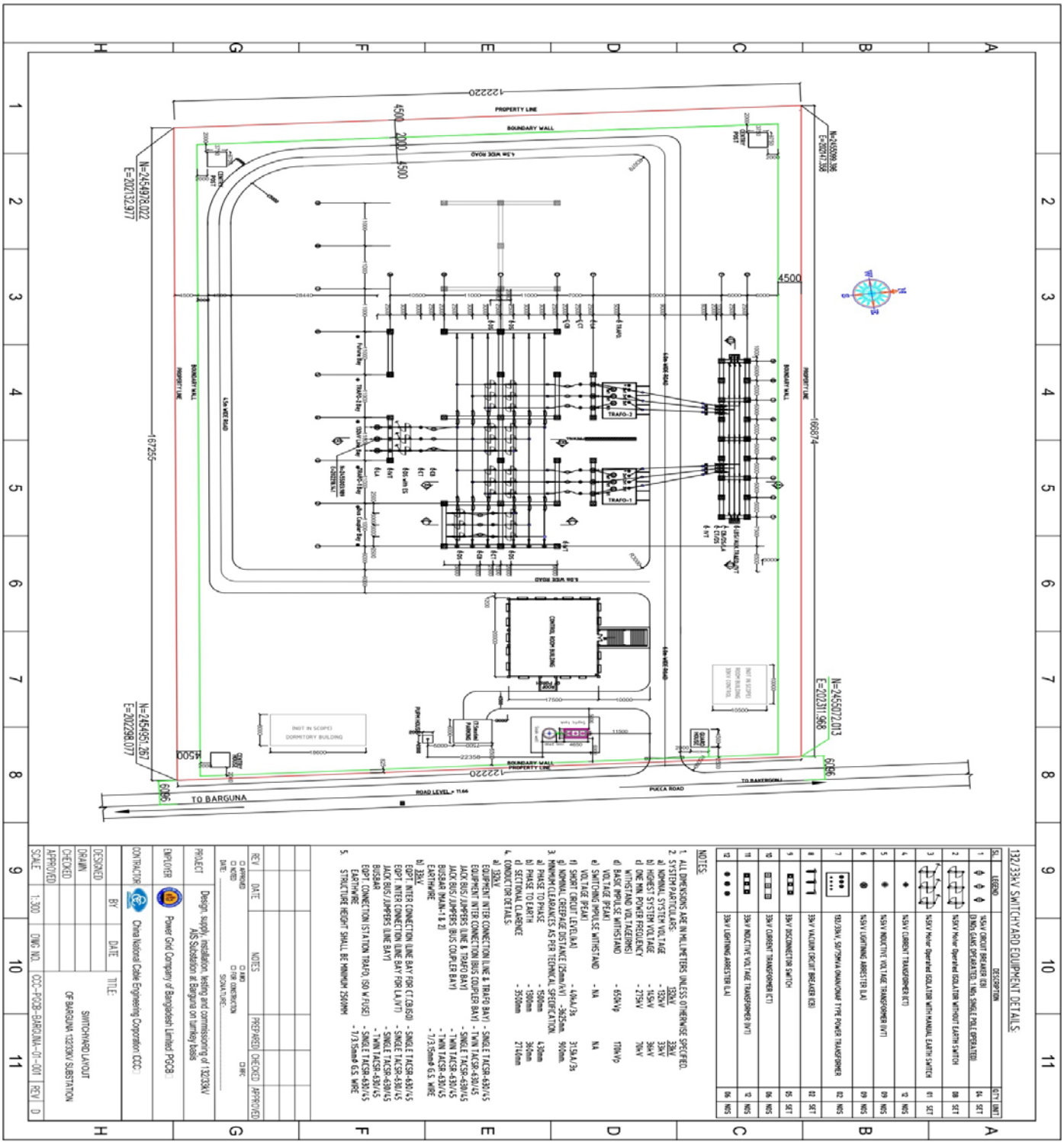


Fig: 4.1. Overall layout plan of 132/33 KV substation, Barguna

4.9. Civil Construction

* Sub-soil Investigation Work
* Pile Integrity & Pile Load
* Material, Slump and Compressive Strength of Concrete
* Complete Civil Design of Substation & Transmission Line Construction procedure and construction micro-schedule making

Fig: 4.2. Equipment base casting (LA, CT, CB)

Fig: 4.3. Equipment base casting (LA, CT, CB)

Fig: 4.4. Anchor bolt setting in short column

Fig: 4.5. Sand Compaction test

Fig: 4.6. Blast wall formwork setting & casting

Fig: 4.7. Concrete mixing for casting

Fig: 4.8. Rigid pavement rebar placement

Fig: 4.9. Rigid pavement rebar placement

Fig:4.10. Lime terracing work on CRB slab

Fig:4.11 Lime terracing work on CRB slab

Fig: 4.12. Cable trench wall shattering work

Fig: 4.13.Cable trench base & rebar binding

Fig: 4.14. Overview of ongoing project

Fig: 4.15. Gravel laying on transformer pad

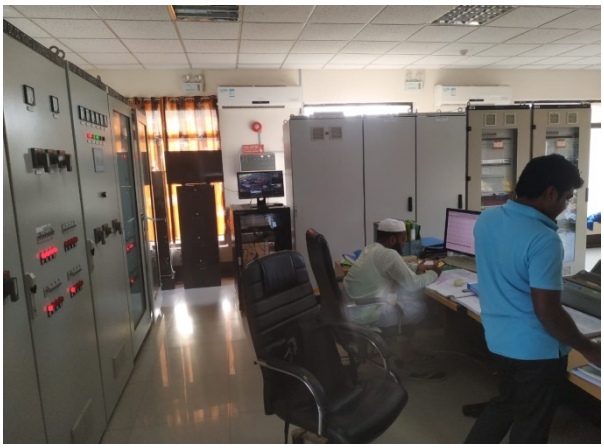


Fig: 4.16. Control room

Fig: 4.16. Control room

CHAPTER V

PROCUREMENT MANAGEMENT

5.0. Introduction

Procurement management is the strategic approach to managing and optimizing organizational spend. It involves acquiring quality goods and services from preferred vendors within a stipulated budget, on or before the deadline. The procurement management process includes sourcing, requisitioning, ordering, expediting, inspection, and reconciliation.

5.1. Procurement

Procurement refers to techniques, structured methods, and means used to streamline an organization's procurement process and achieve desired results while saving cost, reducing time, and building win-win supplier relationships. Procurement can be direct, indirect, reactive, or proactive in nature.

5.2.Difference Between Indirect, Direct, and Services Procurement

Direct, indirect, and services procurement are subsidiaries of the overarching procurement process and differ in aspects like definition, assignments, and more. By taking a deeper look at the difference between these processes and understanding what they comprise; stakeholders will have an easier time taking appropriate measures to fulfill the need.

Direct Procurement	Indirect Procurement	Services Procurement
Acquisition of goods, materials and services manufacturing purposes	Sourcing and purchasing materials, goods, or services for internal use	Procuring and managing contingent workforce and consulting services
Ex: Raw materials, machinery, and resale items	Ex: Utilities, facility management, and travel	Ex: Professional services, software subscriptions, etc.
Drives external profit and continuous growth in revenue	Takes care of day-to-day operations	Used to plug process and people gaps
Comprises of stock materials or parts for production	Used to buy consumables and perishables	Used to purchase external services and staff
Establish long-term, collaborative supplier relationships	Resort to short-term, transactional relationship with suppliers	Maintain one-off, contractual relationships with suppliers

5.3 Procurement Process

It's the series of processes that are essential to get products or services from requisition to purchase order and invoice approval. Although we use procurement' and purchasing' interchangeably, they slightly differ from each other.

Process:

The list of rules that need to be followed while reviewing, ordering, obtaining, and paying for goods/services. Checkpoints/steps increase with the complexity of the purchase.

People:

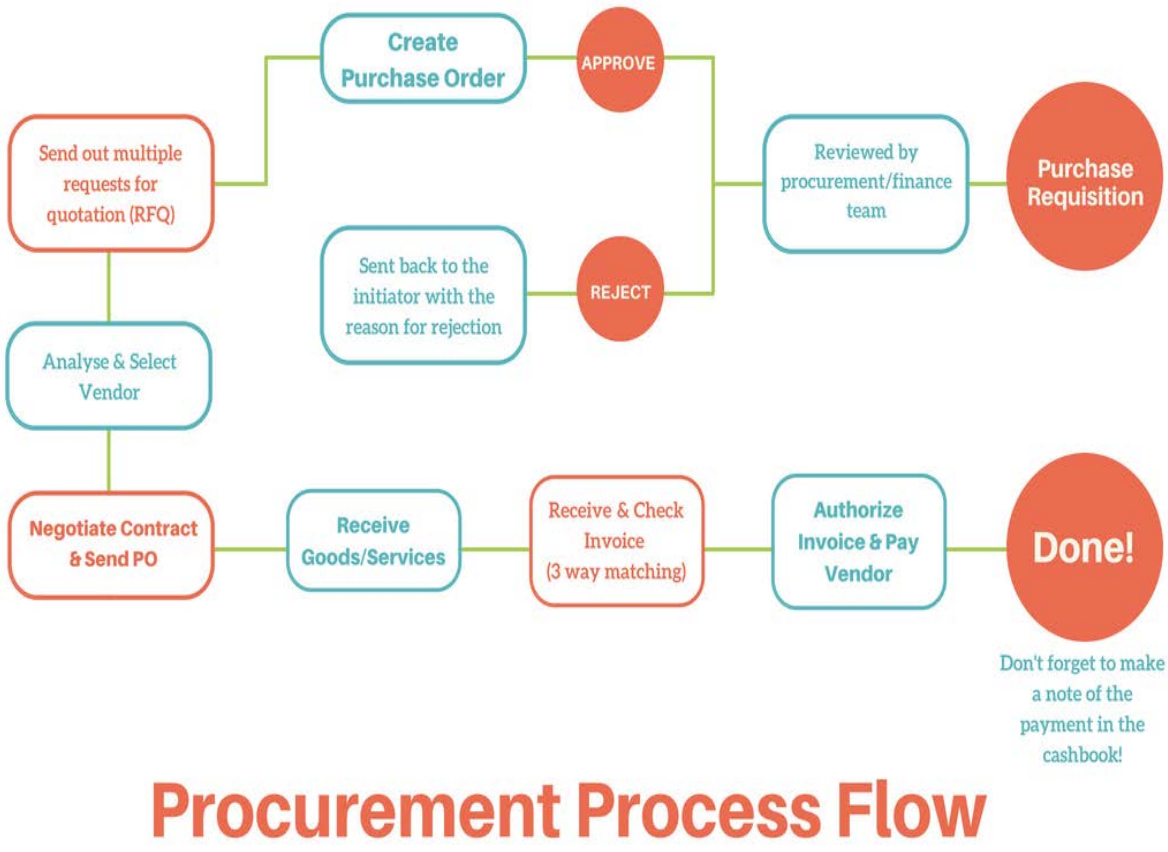
These are stakeholders and their specific responsibility in the procurement cycle. They take care of initiating or authorizing every stage of the process. The number of stakeholders involved is directly proportional to the risk and value of the purchase.

Paper:

This refers to the paperwork and documentation involved in every stage of the procurement process flow, all of which are collected and stored for reference and auditing reasons.

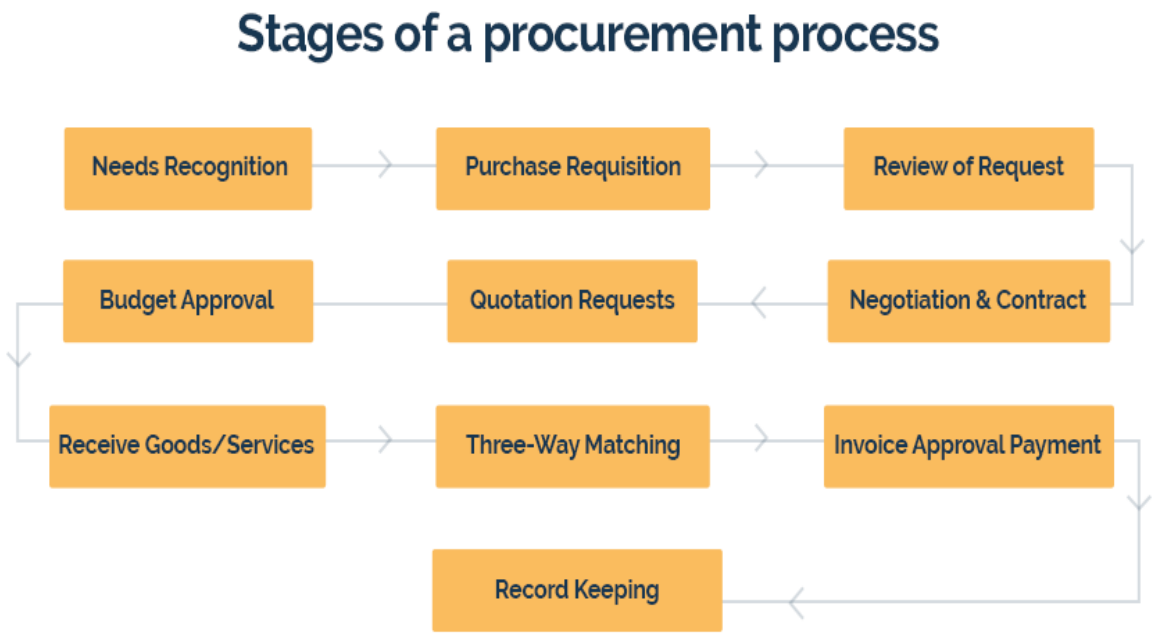
5.4 Procurement Process Flow

To keep the procurement management process fair, transparent, and efficient, a good understanding of the procurement process flow is keys. Although the procurement process of organizations differs from each other, the flowchart below sums up the important steps in a procurement process.



5.5. Steps Involved in a Procurement Process

Every procurement management process involves several elements, including requirements determination, supplier research, value analysis, raising a purchase request, reviewal phase, conversion to purchase order, contract administration, monitoring/evaluation of received order, three-way matching, payment fulfillment, and record keeping. These are the important stages in the procurement process flow:



5.6 Automate the Procurement Management Process

A solid procurement software can streamline the cluttered procurement process and keep it transparent. No information is lost and stakeholders can raise, approve, or reject items on time. A streamlined procurement process offers better control over every stage of the procurement lifecycle.

Furthermore, efficient procurement automation software:

- Minimizes the chaos made by paperwork
- Shortens the procurement lifecycle
- Reduces human dependency intervention and errors
- Lessens the workload of all stakeholders
- Keeps the process accurate and consistent
- Injects transparency into the process flow
- Sticks to the predefined procurement cycle

Choosing automated procurement management software rather than depending on emails and excel sheets will speed up the procurement process, ensure accuracy, enhance efficiency, and save time and resources.

5.7 Summary

Cloud-based procurement automation tools like Kissflow are suitable for both SMBs and enterprises. Kissflow procurement cloud allows organizations to create a dynamic procurement management process that provides them with a tactical advantage.

Organizations can resolve procurement hurdles they face with archaic procurement tools. Today's e-procurement tools are capable of straightening the procurement process flow in a jiffy. Kissflow offers tools and resources every business needs to automate end-to-end procurement and scale it up or down to meet their business needs.

CHAPTER VI

MATERIAL MANAGEMENT

6.0. Introduction

Materials Management is a method for planning, organizing and controlling the activities that are related to the flow of materials in a company. This can lead to the control of the location, movement and time of those materials from their introduction, production, manufacturing process and final delivery.

Materials management makes sure the materials available are aligned with the customer demands, thus giving a schedule of costs and resources that the company has or needs. Materials management controls the flow of materials with demand, prices, quality and delivery schedules.

The supply chain is linked to materials management as this method is used to plan and supply the organization. Inventory goes hand in hand with this in order to keep track of raw materials and specific products. This helps minimize costs to the organization and ensures maximum return on working capital.

It should be noted that materials are classified by direct materials and indirect materials. Direct materials are those that process and give a finished product, indirect materials are those that do not generate a final product.

Direct Materials:

Direct materials are those materials or raw materials in which value and importance are identified in order to make the product that is needed and they also represent the cost and benefit of the process. These direct materials are essential for the quality of the product because without them the product could lose value in the market. They are vital in the inventory and it is not possible to get out of them.

Indirect Materials:

These are those materials that are part of the production of the product but do not make a difference to the final product. These cannot be calculated or measured, so their presence is not of high relevance in the delivery of the final result.

6.1. Materials Manager Does

They fulfill the responsibility of sustaining the supply of materials so as not to stop production. Ensure that inventories at each storage location in the supply chain are up to date. Improves operational efficiency and minimizes material management costs to satisfy customers. It also gets involved in purchasing decisions that are necessary for production.

Other material management roles:

- Materials Manager
- Inventory Control Manager
- Inventory Analyst
- Materials Planner

6.2. Importance of Materials Management

Materials Management is vital for the process that is received from raw materials, machinery, production processes, maintenance, among others, because with this management you can order and classify the inventories in the most accurate way.

With the Management of Materials, one is responsible for the planning, movement, storage and control of materials to enhance and provide excellent customer service with a predetermined cost that is minimal.

6.3. Objectives of Materials Management

One of the objectives is to provide an interrupted chain of components for production in time for customers. The materials department takes care of the supplies by ensuring the on-time delivery of these.

Materials Management also takes care of the procurement of materials by connecting with suppliers. In some organizations they have a separate department that takes care of this called the purchasing department.

The main objective of this method is the provision and monitoring of appropriate processes of the materials at the lowest cost.

Selection of the Material:

Correct selection of the required material, evaluation of this in sales with the sales department.

Low Cost Operation:

Low operating costs and maintain profits without neglecting the quality offered to the customers. Receive and control the material in a safe way and the good condition it must have. Identify the stock and take the production process to get the final product.

The result of the objectives of Materials Management can be the following:

- Constant supply of raw materials to continue production
- Economic purchase value can lead to increased productivity
- Minimize storage and stock control
- Minimize the cost of production to increase profits
- Buy better quality items at the most competitive price

6.4. Fundamental Objectives of Materials Management

These objectives are called the 5 R's of Materials Management; they are the acquisition of materials and services.

1. The right material
2. At the right time
3. In the right amount
4. Of the quality that is
5. At the right price
6. From the right sources

6.5. Planning and Control

Planning and control of Materials Management is important in order to achieve the desired results. The planning and control is done with the areas that need to find the processes of the operations.

This means that it is necessary to have the necessary parts, budget the materials, inventories, schedule the orders and monitor their process in relation to production and sales because the costs will be of investment for the delivery of the final product.

Because of the economic control and the investment in the raw materials, it is necessary to have the inventories of the purchase and management of the materials that are needed for the processes of creating of the final product.

6.6. An Essential Part of the Materials Management

It is the collection of the materials that are needed to complete production, and the follow-ups of these. With this in order you can keep track of the performance that the company is having and also its finances.

With well managed inventories, the cost decision making can be much easier when it comes to purchases because you can see what is needed for the production and how much could be invested, trying to maintain a good cost with the balance that is needed.

It also helps to know the existence of what you have stored in the warehouse and the record of the process that has gone into production from arrival to delivery.

6.7. Inventory Control

It is vital that you identify three factors for the control of your company's inventories:

Maximum Stock:

This is the maximum amount of materials you wish to keep in storage or in the warehouse. Taking into account certain factors such as: the product has a very good acceptance by the customer, the cost of storage and transport, the time of the assortment by the supplier among others.

Minimum Security Stock:

This is the minimum amount of materials or products you want to keep in the warehouse or store. Taking into account: the supplier's delivery time, cost of the orders, prices etc.

Re-order Point:

This is the level of stock of the orders to be able to supply warehouse where the time with the suppliers is essential not to have problems of supply.

The benefits of inventory control are helpful to the operational areas that are in the organization giving priority to investment and cost of materials that are necessary for the productivity of the company, giving a follow-up flow to give positive results in the end of production and delivery to the customer.

6.8. Functions of Materials Management

Materials management is concerned with the costs of materials, supply and use. The following areas are involved such as production control, shipping, receiving and stores which we will explain below.

Production and Control of Materials:

The preparation of schedules is very important to carry out in order to hit the results. The requirements of parts or materials are determined according to the production schedules. This is prepared with orders that are requested by customers in advance. This is how production can be carried out without any problems.

Purchasing:

This is the purchase of the materials needed in the entire production process. The objective of this department is to maintain the flow of materials and services needed to operate in the company. To keep investments and losses in inventory to a minimum.

Choose the sources of supply, finalize the terms of purchase and their follow-up, maintain the relationships with the suppliers, approve payments for the suppliers, evaluate and qualify the development of the suppliers. This department fulfils the function of buying quality products at reasonable prices.

Stores:

When the material is delivered, physical control, conservation and maintenance of records, proper location and storage is done in the stores.

Transport:

It is important to be able to move the materials from the point of purchase to the company or to the customers or to the place where they are going to be stored. Ideally, you should hire cheap and fast transportation according to how often you need to move production materials around.

Material Handling:

It is the follow-up of the material process, to know that everything has the flow that is needed in the production of the products.

Receiving:

The reception is responsible for unloading the materials, counting the units and sending them to the stores.

6.9. Summery

Companies tend to use Materials Management to process productivity and follow up of these processes through inventories, thus having a logistic and even economic control of everything that is invested in order to have a step by step view of what has been done and what will be done in the future.

It also makes the Management of Materials the main factor to give a final product to the client, since being able to manage the quality, the purchase, the production of the product or service that is wanted to offer in the final straight of delivery, the Management makes that everything passes through the necessary filters to obtain the best results of delivery.

The Management of Materials began to be implemented in the industrial companies by the productive system of machinery, nevertheless nowadays still it is used by modern companies that have plans of work very different from the companies of the industrial age but that still guide themselves with the management of materials for the productivity of their processes, the fulfillment of deliveries and the economic pursuit of the raw material or the things that are necessary so that the processes do not stop and can follow the suitable flow for the final delivery

CHAPTER VII

PROBLEMS OF CONSTRUCTION ACTIVITIES

There are many problems encountered during construction activities of substations in Bangladesh. Major problems are described below:

7.1. Lack of Skilled Worker

There is a big problem facing the construction substation: not enough skilled workers to fill a growing demand. The younger generation is being pushed toward college, and not vocational trades. The benefits of a career in construction are not being sold to millennials, and much of today's existing workforce is closing in on retirement. At that time we needed skilled workers in substation work.

7.2. Lack of Communication

When things go wrong on a project, it is almost always due to a communication breakdown along the way.

7.3. Unreliable Subcontractors

Many contractors have problems finding reliable subs for their jobs.

7.4. Changing Minds of Substation Owners

Substation owners who want changes in the middle of a project may "forget" about the requests they've made when it comes time to pay the bill.

7.5. Availability of Cash

We have payments due to subs, employees, vendors, materials suppliers, and equipment renters… but they don't get paid until the project is complete. And unless we have enough available cash flow, this can be a major problem.

7.6. Document Management

Contracts, change orders, materials orders, receipts, invoices, employment applications, certificates of insurance etc. we probably have enough paper to fill an entire trailer of filing cabinets. It's time to go paperless.

7.7. The Blame Game

Nothing ever goes smoothly in construction 100% of the time. When there is a bump in the road, fingers start pointing. The general contractor blames the sub, the substation owner. Blames the general contractor, and the project manager blames the owner.

CHAPTER VIII

COMPARISON OF CONSTRUCTION ACTIVITIES

The following table gives comparison of two substations construction of substations in Bangladesh.

Table 7.0 Comparison of Kraniganj and Barguna Substation

Particular	132/33KV Substation, Keraniganj	132/33KV Substation, Barguna
(a) General		
Project Implementation Entity	Power Pac Holdings Ltd.	PGCB
Proposed Implementation Period	500 Days	600 Days
Actual Implementation Period	540 Days	677 Days
Civil Construction Cost	8, 35, 00,000.00 BDT.	9, 50, 00,000.00 BDT.
Environmental and Social Category	Category A	Category A
Risk (Low/Medium/High)	Medium	Medium
Substation Type	Step Up	AIS(Air insulated Substation)
Project based on	Turnkey basis	Turnkey basis
Land Area	68,855 sft. (1.6 Acres)	239,518 sft. (5.49 Acres)
Sub-Contractor	M/S Rob Construction Ltd.	Reverie Power and Automation Engineering Company limited
Main contractor	Harmonics Engineering	CCC (China Cables Corporation)
Project Location	Chor Golgolia, Abdullahpur, Keraniganj, Dhaka	Khajurtola, Pouro bus stand ,Barguna Sadar, Barguna
Total Pile of Fencing	72 Nos.	188 Nos.
Transformers & Gantries	184	96 Nos.
Internal Road Type	Flexible pavement	Rigid Pavement
External Road Type	Flexible pavement	Flexible pavement
Equipment Brand	Tirra Thai	Siemens & Xugang
Design Load in Transformer	96 Tons	150 Tones
Total Equipment Foundation	67 Nos.	84 Nos
Total Length of road	400 Meter	550 Meter
Length of Boundary wall	322 Meter	660 Meter
Constructed by	Harmonics Engineering	CCC & Reverie Power and Automation Engineering Company limited
Total Excavation	12500 m3	15550 Cubic Meter
Total Backfilling	48750 m3	80000 Cubic Meter
Total concrete Volume	5500 m3	4350 Cubic Meter
Man Power involvement per day	85 Nos.	100 Nos
Element of Substation	CRB, equipment (LA, CT, CB, CVT, DS, PI),	CRB, equipment (LA, CT, CB, CVT, DS, PI),

	Tower Blast wall, Transformer pad, road, cable trench, drainage, boundary wall, carport, pump house, main gate.	Tower Blast wall, Transformer pad, road, cable trench, drainage, boundary wall, carport, pump house, main gate.
Total cement consumption	15000 Bags	36500 Bags
Total sand consumption	1100 m3	1300 cubic meter
Total stone consumption	2100 m3	2200 cubic meter
Reinforcement	180 Tones	300 tones
Transformers	3 Nos.	3 Nos.
Transformer net weight	60 tones	68 tones
Oil	36 tons	22 tones
Key Covenants	The Borrower shall or shall cause PowerPac to ensure that the preparation, design, construction, implementation, operation and decommissioning of the Project and all Project facilities comply with: (a) all applicable laws and regulations of the Borrower relating to environment, health, and safety; and (b) all measures and Requirements set forth in the Initial Environmental Examination, Environmental Management Plan, Resettlement Plan and Corrective Action Plan. The Borrower shall: (a) ensure that Power Pac files a tariff application at least once a year to ensure Power Pac's financial sustainability; and (b) request and require the Bangladesh Electricity Regulatory Commission to review such tariff applications in a timely manner in accordance with the Bangladesh Energy Regulatory Commission Act.	The Borrower shall or shall cause PGCB to ensure that the preparation, design, construction, implementation, operation and decommissioning of the Project and all Project facilities comply with: (a) all applicable laws and regulations of the Borrower relating to environment, health, and safety; and (b) all measures and Requirements set forth in the Initial Environmental Examination, Environmental Management Plan, Resettlement Plan and Corrective Action Plan. The Borrower shall: (a) ensure that PGCB files a tariff application at least once a year to ensure PGCB's financial sustainability; and (b) request and require the Bangladesh Electricity Regulatory Commission to review such tariff applications in a timely manner in accordance with the Bangladesh Energy Regulatory Commission Act.

(b) Construction Activities		
1. Site Selection	6 Days	7 Days
2.Topographical Survey	13 Days	15 Days
3. Sub Soil Investigation	30 Days	25 Days
4. Design and Drawing	60 Days	30 Days
5. Piling Work	90 Days	120 Days
6.Soil Excavation	20 Days	30 Days
7.Head Breaking of Pile	25 Days	40 Days
8. Lean Concrete Casting	20 Days	150 Days
9. Pile Cap Casting	40 Days	35 Days
10.Anchor Bolt Setting	23 Days	30 Days
11.Short Column Casting	28 Days	30 Days
12.Backfill the Foundations in Substation Yard	30 Days	20 Days
13. Assemble/erection the Steel Structures	55 Days	60 Days
14.Install The Electrical Equipment	60 Days	55 Days
15. Landscaping and Carry out the Final Inspection	40 Days	30 Days

CHAPTER IX

CPM AND BAR CHART OF CONSTRUCTION ACTIVITIES OF THE SUBSTATIONS

9.1. CRITICAL PATH METHOD (CPM) FOR 132/33KV SUBSTATION, KERANIGANJ

Work Activities Duration for 132/33KV Substation, Keraniganj A. Site Selection=6 days B. Topographical Survey=13 days, C. Sub Soil Investigation=30 days D. Design and Drawing=60 days, E. Piling Work=90 days, F. Soil Excavation=20 days, G. Head Breaking of Pile=25 days H. Lean Concrete Casting=20 days,	I. Pile Cap Casting=40 days, J. Anchor Bolts Setting =23 days K. Short Column Casting =28 days, L. Backfill the Foundations in Substation Yard=30 days M. Assemble/erection the Steel Structures =55 days, N. Install the Electrical Equipment =60 days O. Landscaping and Carry out the Final Inspection=40 days

Activity	Immediate Predecessors	Duration
A	-	6
B	A	13
C	A	30
D	B	60
E	C	90
F	D	20
G	E	25
H	F	20
I	G	40
J	H	23
K	I	28
L	J	30
M	K	55
N	LM	60
O	MN	40

Edge and it's preceded and succeeded node

Edge	Node1 ⟶ Node2
A	1⟶2
A	1⟶13
A	1⟶14
B	2⟶3
C	2⟶4
d	2⟶14
D	3⟶5
E	4⟶6
F	5⟶7
G	6⟶8
H	7⟶9
I	8⟶10
J	9⟶11
K	10⟶12
L	11⟶14
M	12⟶14

The network diagram for the project, along with activity time, is

			B(13)	3	D(60)	5	F(20)	7	H(20)	9	J(23)	11	
		2										L(30)	
	A(6)		d(0) C(30)	4	E(90)	6	G(25)	8	I(40)	10	K(28)	L(30) 12	
1	A(6)	13	d(0)									L(30) M(55)	
	A(6)		d(0)									L(30) M(55)	
		A(6)	A(6)	d(0) A(6)	d(0) A(6)	d(0) A(6)	d(0) A(6)	d(0) A(6)	d(0) A(6)	d(0) A(6)	d(0) A(6)	14	

Forward Pass Method

$E_1=0$

$E_2=E_1+t_{1,2}\ [t_{1,2}=A=6]=0+6=6$

$E_3=E_2+t_{2,3}\ [t_{2,3}=B=13]=6+13=19$

$E_4=E_2+t_{2,4}\ [t_{2,4}=C=30]=6+30=36$

$E_5=E_3+t_{3,5}\ [t_{3,5}=D=60]=19+60=79$

$E_6=E_4+t_{4,6}\ [t_{4,6}=E=90]=36+90=126$

$E_7=E_5+t_{5,7}\ [t_{5,7}=F=20]=79+20=99$

$E_8=E_6+t_{6,8}\ [t_{6,8}=G=25]=126+25=151$

$E_9=E_7+t_{7,9}\ [t_{7,9}=H=20]=99+20=119$

$E_{10}=E_8+t_{8,10}\ [t_{8,10}=I=40]=151+40=191$

$E_{11}=E_9+t_{9,11}\ [t_{9,11}=J=23]=119+23=142$

$E_{12}=E_{10}+t_{10,12}\ [t_{10,12}=K=28]=191+28=219$

$E_{13}=E_1+t_{1,13}\ [t_{1,13}=A=6]=0+6=6$

$E_{14}=Max\left\{E_i+t_{i,14}\right\}\ [i=12,11,12,]$

$=Max\left\{E_1+t_{1,14};E_2+t_{2,14};E_{11}+t_{11,14};E_{12}+t_{12,14}\right\}$

$=Max\ \{0+6;6+0;142+30;219+55\}$

$=Max\ \{6;6;172;274\}$

274

Backward Pass Method

$L_{14}=E_{14}=274$

$L_{12}=L_{14}-t_{12,14}$ $[t_{12,14}=M=55]=274-55=219$

$L_{11}=L_{14}-t_{11,14}$ $[t_{11,14}=L=30]=274-30=244$

$L_{10}=L_{12}-t_{10,12}$ $[t_{10,12}=K=28]=219-28=191$

$L_{9}=L_{11}-t_{9,11}$ $[t_{9,11}=J=23]=244-23=221$

$L_{8}=L_{10}-t_{8,10}$ $[t_{8,10}=I=40]=191-40=151$

$L_{7}=L_{9}-t_{7,9}$ $[t_{7,9}=H=20]=221-20=201$

$L_{6}=L_{8}-t_{6,8}$ $[t_{6,8}=G=25]=151-25=126$

$L_{5}=L_{7}-t_{5,7}$ $[t_{5,7}=F=20]=201-20=181$

$L_{4}=L_{6}-t_{4,6}$ $[t_{4,6}=E=90]=126-90=36$

$L_{3}=L_{5}-t_{3,5}$ $[t_{3,5}=D=60]=181-60=121$

$L_{2}=\text{Min}\left\{L_{j}-t_{2,j}\right\}$ $[j=144,3,]$

$=\text{Min}\left\{L_{14}-t_{2,14};L_{4}-t_{2,4};L_{3}-t_{2,3}\right\}$

$=\text{Min}\{274-0;36-30;121-13\}$

$=\text{Min}\{274;6;108\}$

6

$L_{1}=\text{Min}\left\{L_{j}-t_{1,j}\right\}$ $[j=1413,2,]$

$=\text{Min}\left\{L_{14}-t_{1,14};L_{13}-t_{1,13};L_{2}-t_{1,2}\right\}$

$=\text{Min}\{274-6;274-6;6-6\}$

$=\text{Min}\{268;268;0\}$

0

(b) The critical path in the network diagram has been shown. This has been done by double lines by joining all those events where E-values and L-values are equal.
The critical path of the project is : 1-2-4-6-8-10-12-14 and critical activities are A, C, E, G, I, K, M

The total project time is 274
The network diagram for the project, along with E-values and L-values, is

			B(13)	3	D(60)	5	F(20)	7	H(20)	9	J(23)	11	E_{11}=142 L_{11}=244
		2		E_3=19 L_3=121		E_5=79 L_5=181		E_7=99 L_7=201		E_9=119 L_9=221		L(30)	
	A(6)	E_2=6 L_2=6	d(0) C(30)	4	E(90)	6	G(25)	8	I(40)	10	K(28)	L(30) 12	E_{12}=219 L_{12}=219
1	A(6)	13	d(0)	E_4=36 L_4=36		E_6=126 L_6=126		E_8=151 L_8=151		E_{10}=191 L_{10}=191		L(30) M(55)	
E_1=0 L_1=0	A(6)	E_{13}=6 L_{13}=274	d(0)									L(30) M(55)	
		A(6)	A(6)	d(0) A(6)	d(0) A(6)	d(0) A(6)	d(0) A(6)	d(0) A(6)	d(0) A(6)	d(0) A(6)	d(0) A(6)	14	E_{14}=274 L_{14}=274

For each non-critical activity, the total float, free float and independent float calculations are shown in Table

Activity	Duration	Earliest time Start			Latest time Finish	Earliest time Finish	Latest time Start	Total Float	Free Float	Independent Float
(i,j)	(t_{ij})	(E_i)	(E_j)	(L_i)	(L_j)	(E_i+t_{ij})	(L_j-t_{ij})	$(L_j-t_{ij})-E_i$	$(E_j-E_i)-t_{ij}$	$(E_j-L_i)-t_{ij}$
-1	-2	-3	-4	-5	-6	(7)=(3)+(2)	(8)=(6)-(2)	(9)=(8)-(3)	(10)=((4)-(3))-(2)	(11)=((4)-(5))-(2)
13-Jan	6	0	6	0	274	6	268	268	0	0
14-Jan	6	0	274	0	274	6	268	268	268	268
03-Feb	13	6	19	6	121	19	108	102	0	0
14-Feb	0	6	274	6	274	6	274	268	268	268
05-Mar	60	19	79	121	181	79	121	102	0	-102
07-May	20	79	99	181	201	99	181	102	0	-102
09-Jul	20	99	119	201	221	119	201	102	0	-102
11-Sep	23	119	142	221	244	142	221	102	0	-102
14-Nov	30	142	274	244	274	172	244	102	102	0

9.2. CRITICAL PATH METHOD(CPM) FOR 132/33KV SUBSTATION, BARGUNA

Work Activities Duration for 132/33KV Substation, Barguna

A. Site Selection=7 days
B. Topographical Survey=15 days,
C. Sub Soil Investigation=25 days
D. Design and Drawing=30 days,
E. Piling Work=120 days,
F. Soil Excavation=30 days,
G. Head Breaking of Pile=40 days
H. Lean Concrete Casting=20 days,
I. Pile Cap Casting=35 days,
J. Anchor Bolts Setting =30 days
K. RCC work=160 days,
L. Backfill the Foundations in Substation Yard=20 days
M. Assemble/erection the Steel Structures =60 days,
N. Install the Electrical Equipment =55 days
O. Landscaping and Carry out the Final Inspection=30 days

Activity	Immediate Predecessors	Duration
A	-	7
B	A	15
C	B	25
D	C	30
E	D	120
F	E	30
G	F	40
H	G	20
I	H	35
J	I	30
K	J	160
L	K	20
M	L	60
N	KL	55
O	MN	30

Edge and it's preceded and succeeded node

Edge	Node1 → Node2
A	1→2
A	1→14
A	1→15
B	2→3
d	2→15
C	3→4
D	4→5
E	5→6
F	6→7
G	7→8
H	8→9
I	9→10
J	10→11
K	11→12
L	12→13
M	13→15

The network diagram for the project, along with activity time, is

		2	B(15)	3	C(25)	4	D(30)	5	E(120)	6	F(30)	7	G(40)	8	H(20)	9	I(35)	10	J(30)	11	K(160)	12	L(20)	13
	A(7)		d(0)																					M(60)
1	A(7)	14	d(0)																					M(60)
	A(7)		d(0)																					M(60)
		A(7)	A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	15

Forward Pass Method

$E1=0$

$E2=E1+t1,2\ [t1,2=A=7]=0+7=7$

$E3=E2+t2,3\ [t2,3=B=15]=7+15=22$

$E4=E3+t3,4\ [t3,4=C=25]=22+25=47$

$E5=E4+t4,5\ [t4,5=D=30]=47+30=77$

$E6-E5+t5,6\ [t5,6-E=120]-77+120-197$

$E7-E6+t6,7\ [t6,7-F=30]-197+30-227$

$E8=E7+t7,8\ [t7,8=G=40]=227+40=267$

$E9=E8+t8,9\ [t8,9=H=20]=267+20=287$

$E10=E9+t9,10\ [t9,10=I=35]=287+35=322$

$E11-E10+t10,11\ [t10,11-J=30]-322+30-352$

$E12=E11+t11,12\ [t11,12=K=160]=352+160=512$

$E13=E12+t12,13\ [t12,13=L=20]=512+20=532$

$E14=E1+t1,14\ [t1,14=A=7]=0+7=7$

$$E15-Max\left\{E_i+t_{i,15}\right\}[i-12,13,]$$

$$-Max\left\{E1+t1,15;E2+t2,15;E13+t13,15\right\}$$

$=Max\{0+7;7+0;532+60\}$

$=Max\{7;7;592\}$

592

Backward Pass Method

$L_{15}=E_{15}=592$

$L_{13}=L_{15}-t_{13,15}$ $[t_{13,15}=M=60]=592-60=532$

$L_{12}=L_{13}-t_{12,13}$ $[t_{12,13}=L=20]=532-20=512$

$L_{11}=L_{12}-t_{11,12}$ $[t_{11,12}=K=160]=512-160=352$

$L_{10}=L_{11}-t_{10,11}$ $[t_{10,11}=J=30]=352-30=322$

$L_{9}=L_{10}-t_{9,10}$ $[t_{9,10}=I=35]=322-35=287$

$L_{8}=L_{9}-t_{8,9}$ $[t_{8,9}=H=20]=287-20=267$

$L_{7}=L_{8}-t_{7,8}$ $[t_{7,8}=G=40]=267-40=227$

$L_{6}=L_{7}-t_{6,7}$ $[t_{6,7}=F=30]=227-30=197$

$L_{5}=L_{6}-t_{5,6}$ $[t_{5,6}=E=120]=197-120=77$

$L_{4}=L_{5}-t_{4,5}$ $[t_{4,5}=D=30]=77-30=47$

$L_{3}=L_{4}-t_{3,4}$ $[t_{3,4}=C=25]=47-25=22$

$L_{2}=\text{Min}\left\{L_{j}-t_{2,j}\right\}$ $[j=153,]$

$=\text{Min}\left\{L_{15}-t_{2,15};L_{3}-t_{2,3}\right\}$

$=\text{Min}\{592-0;22-15\}$

$=\text{Min}\{592;7\}$

7

$L_{1}=\text{Min}\left\{L_{j}-t_{1,j}\right\}$ $[j=1514,2,]$

$=\text{Min}\left\{L_{15}-t_{1,15};L_{14}-t_{1,14};L_{2}-t_{1,2}\right\}$

$=\text{Min}\{592-7;592-7;7-7\}$

$=\text{Min}\{585;585;0\}$

0

(b) The critical path in the network diagram has been shown. This has been done by double lines by joining all those events where E-values and L-values are equal.
The critical path of the project is : 1-2-3-4-5-6-7-8-9-10-11-12-13-15 and critical activities are $A,B,C,D,E,F,G,H,I,J,K,L,M$

The total project time is 592
The network diagram for the project, along with E-values and L-values, is

		2	B(15)	3	C(25)	4	D(30)	5	E(120)	6	F(30)	7	G(40)	8	H(20)	9	I(35)	10	J(30)	11	K(160)	12	L(20)	13	E_{13}=532 L_{13}=532
	A(7)	E_2=7 L_2=7	d(0)	E_3=22 L_3=22		E_4=47 L_4=47		E_5=77 L_5=77		E_6=197 L_6=197		E_7=227 L_7=227		E_8=267 L_8=267		E_9=287 L_9=287		E_{10}=322 L_{10}=322		E_{11}=352 L_{11}=352		E_{12}=512 L_{12}=512		M(60)	
1	A(7)	14	d(0)																					M(60)	
E_1=0 L_1=0	A(7)	E_{14}=7 L_{14}=592	d(0)																					M(60)	
		A(7)	A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	d(0) A(7)	15	E_{15}=592 L_{15}=592

For each non-critical activity, the total float, free float and independent float calculations are shown in Table

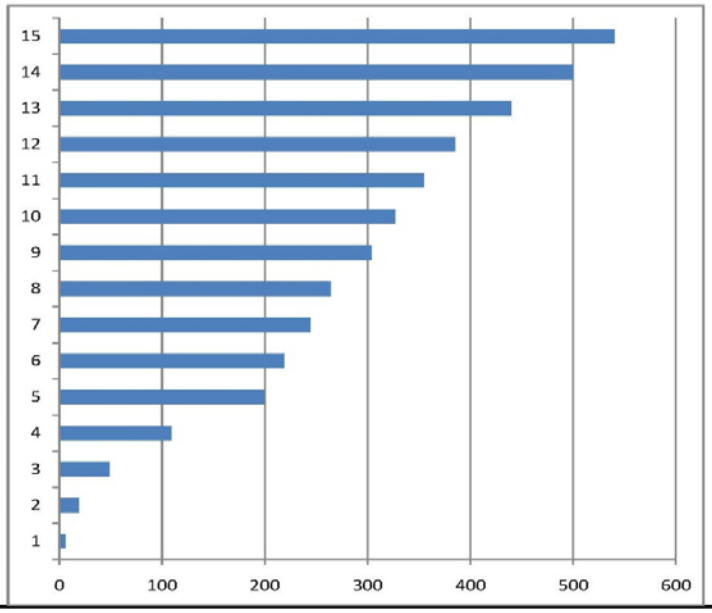
Activity (i,j) -1	Duration (t_{ij}) -2	Earliest time Start (E_i) -3	(E_j) -4	(L_i) -5	Latest time Finish (L_j) -6	Earliest time Finish (E_i+t_{ij}) (7)=(3)+(2)	Latest time Start (L_j-t_{ij}) (8)=(6)-(2)	Total Float $(L_j-t_{ij})-E_i$ (9)=(8)-(3)	Free Float $(E_j-E_i)-t_{ij}$ (10)=((4)-(3))-(2)	Independent Float $(E_j-L_i)-t_{ij}$ (11)=((4)-(5))-(2)
14-Jan	7	0	7	0	592	7	585	585	0	0
15-Jan	7	0	592	0	592	7	585	585	585	585
15-Feb	0	7	592	7	592	7	592	585	585	585

9.3. Bar chart of work activities for 132/33KV Substation, Keraniganj

Bar Chart of Work Activities for 132/33KV Substation , Keraniganj

	Work Activity	Duration (days)		
1	Site Selection	6	0	6
2	Topographical Survey	13	6	19
3	Sub Soil Investigation	30	19	49
4	Design and Drawing	60	49	109
5	Piling Work	90	109	199
6	Soil Excavation	20	199	219
7	Head Breaking of Pile	25	219	244
8	Lean Concrete Casting	20	244	264
9	Pile Cap Casting	40	264	304
10	Anchor Bolts Setting	23	304	327
11	Short Column Casting	28	327	355
12	Backfill the Foundations in Substation Yard	30	355	385
13	Assemble/erection the Steel Structures	55	385	440
14	Install The Electrical Equipment	60	440	500
15	Landscaping and Carry out the Final Inspection	40	500	540

Bar Chart

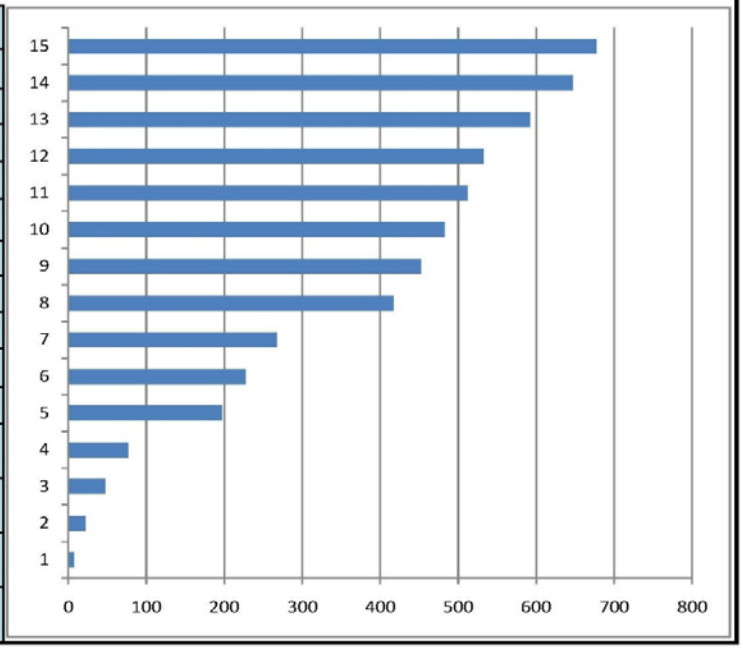


9.4. Bar chart of work activities for 132/33KV Substation, Barguna

Bar Chart of Work Activities for 132/33KV Substation , Barguna

	Activity Description	Duration (days)		
1	Site Selection	7	0	7
2	Topographical Survey	15	7	22
3	Sub Soil Investigation	25	22	47
4	Design and Drawing	30	47	77
5	Piling Work	120	77	197
6	Soil Excavation	30	197	227
7	Head Breaking of Pile	40	227	267
8	Lean Concrete Casting	150	267	417
9	Pile Cap Casting	35	417	452
10	Anchor Bolts Setting	30	452	482
11	Short Column Casting	30	482	512
12	Backfill the Foundations in Substation Yard	20	512	532
13	Assemble/erection the Steel Structures	60	532	592
14	Install The Electrical Equipment	55	592	647
15	Landscaping and Carry out the Final Inspection	30	647	677

Bar Chart



CHAPTER X

CONCLUSIONS AND RECOMMENDATIONS

Construction projects have been managed since old ages, but recently, the great revolution in technology, and the significant changes in the construction substations, forced changes in the way projects are managed.

The main aim of this research was to study the situation of project Management in West Bank and to identify the problems in managing construction projects. This research has suggested a framework to organize the managing of construction project, and to achieve the long and short-term goals, it provides a foundation for a successful management of construction. This research is made to help and develop the work of project managers to produce better work that is well-defined between the strategic and operational components.

Bibliography and References:

1. **Online**

- https://electrical-engineering-portal.com/electrical-substation-introduction-and-elements
- http://www.hydroquebec.com/learning/transport/construction-poste.html
- https://en.wikipedia.org/wiki/Site_selection
- http://uregina.ca/~sauchyn/geog411/topographic_surveying.html
- https://www.technicsgroup.com/2019/05/everything-you-need-to-know-about-topographic-surveys/
- https://www.ijirem.org/DOC/46_SUBSOIL%20INVESTIGATIONf13a7c3e-d04a-4f15-b9f6-18f32248e12e.pdf
- https://theconstructor.org/geotechnical/bored-cast-in-situ-concrete-piles-construction-applications/7080/
- https://kissflow.com/procurement/procurement-management-guide/
- https://www.toolshero.com/management/materials-management/
- https://web.pgcb.gov.bd/show_substations
- https://en.wikipedia.org/wiki/Dhaka_Electric_Supply_Company_Limited

2. **Power Pac Holdings Ltd. 132/33KV Substation , Keraniganj, Dhaka**

3. **PGCB, 132/33KV Substation, Barguna**