APPROPRIATE SELECTION OF A TOWER FOR 275KV TRANSMISSION LINE

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10 March 2005

"I / ~~we~~ accepted that have been read this kind of report, In my / our opinion this kind of report suppose in the scope and quality for purpose to award the Degree of Bachelor In Electrical Engineer (Industrial Power)."

Signature : ....
Supervisor's name : MUSSE MOHAMUD AHMED
Date : 14/03/2005

"I admit this report is written by me except the summary and extraction for each I have been clearly presented"

Signature : ....

Writer Name : MOHD HAFIZ B. ABD RAHMAN

Date : 14.3.2005

To my parents

Abdul Rahman and **Safiah**

In appreciation of their patient and understanding.

ABSTRACT

In Malaysia over last two decades has resulted in increased demand for reliable electric power. The reliability in turn is greatly influenced by the grid system and its components being properly maintained. One of the important is the high voltage insulators used in the overhead lines, substations and power stations. The main objective of this project is to select the appropriate tower for 275kV transmission line. In order to select the appropriate tower, the characteristic, the advantages and the disadvantages for each type of tower will be research. Every tower will be analyzes with detail observation. Then the best tower will be selected. In Malaysia, transmission tower are designed to support the conductors and earth wires used for transmission of power from generating stations to load centres.

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CHAPTER 1

INTRODUCTION

Almost every type of transmission structure ever invented is in use today, and most types are still being used to build new transmission lines. That's because so many factors affect the selection of transmission structures, it's impossible to say one type is better than another. Therefore, it's necessarily advisable to select one type of tower for a given transmission line for a reasonable justification.

Parameters can vary so widely from one tower location to the next, that the transmission engineer often finalizes a specific design of tower using a mix of structures.

Design structures is influenced by perceived problems caused by electromagnetic fields (EMF), by varying opinions about visual impact, by environmental considerations, and by land-use regulations and zoning laws that change as the transmission line passes from one jurisdiction to another. All these factors influence-and sometimes dictate-the transmission structure that's chosen for practically every location.

CHAPTER 2

PROJECT OBJECTIVES

1. To study different types of towers.
2. To compare the design characteristics of different types of existing towers.
3. To use the findings of the project as the reference for the high voltage transmission line course and for the students.
4. To study different types of towers and select the best suitable tower for 275kV.
5. To do data analysis and design assessment for the selected tower of 275kV.
6. To use C++ programming language for the design of 275kV tower.

1.1 PROBLEMS STATEMENT

There are many types of towers in high voltage transmission line. Each type of tower used in the high voltage transmission line has different advantages and disadvantages from each other. Besides that, study of different design structures of these towers must be taken into consideration while selecting a specific tower for a given voltage level of a transmission line.This project will focus on selecting the best possible supporting structures (tower) for 275kV transmission line.

1.2 SCOPE OF THE PROJECT

The scope of project these project is to study how to select 275kV transmission line.

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1.4 PROJECT PLANNING

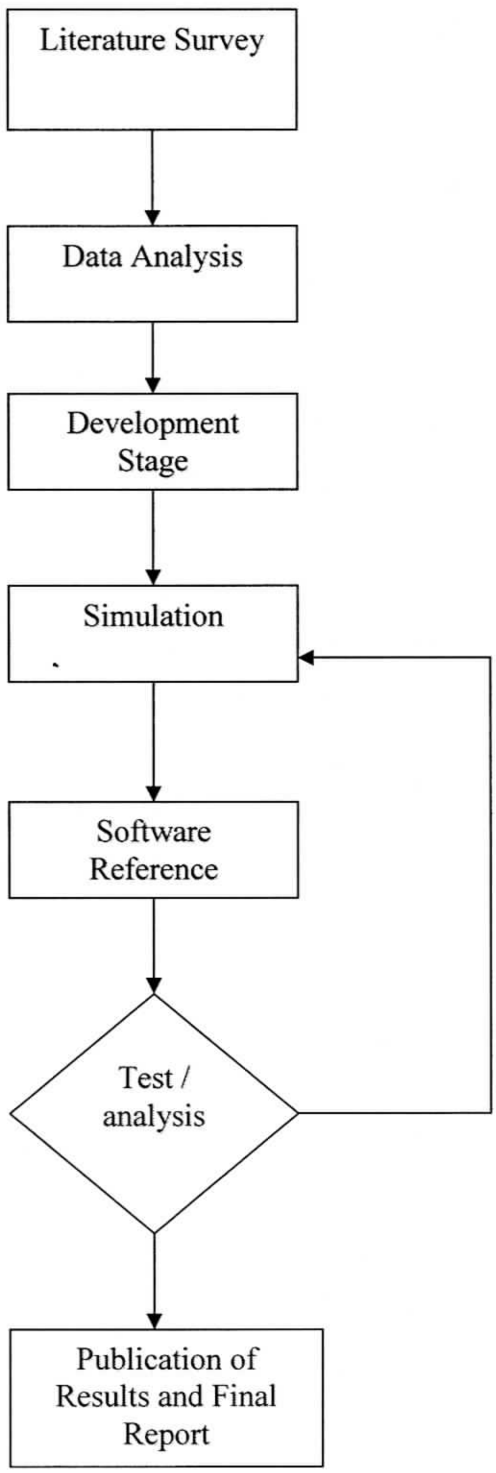

Figure 1.1: Flow Chart of Project

CHAPTER 2

2.1 LITERATURE REVIEW

There are plenty of literature materials about 275kV transmission line design in IEEE website whereby many researchers in the field present their research findings in IEEE proceedings and journals. Apart from that, other literature materials have also been reviewed such as books, CDs, and websites.

It has been reviewed and referenced some of those proceedings and journal in the literature part in this project. Those research papers and other materials which have been reviewed are listed below.

i)Eijiro Hongo [1] from the Kyoto, Japan have presented a research about the *Development of Lattice Tower Considered Harmony Scenery for 500kV.* This paper reviews 500kV transmission line tower . The paper discusses the reduction of investment amount of reinforcement that all Japanese electric power companies think that it is the most important problem and electric power companies have made effort to accomplish low cost tower as well as consideration to environment simultaneously.

ii) Yoshiro Baba[2], describes about Numerical electromagnet field analysis surge response of tower with shield wire. The paper presents the lightning surge characteristics of a transmission line focusing on the tower and shield wire

iii) G. J. Oberst, jr, PE [3], have contributed a research paper about the Lattice tower Ground line Corrosion and Mitigation. It presents the typical tower line and some examples of what happens to steel structures which let off without maintenance, repair and below ground line. It talks about lattice towers on grillage foundations.

iv) J Duncan Clover, Mulukutla [4] , Power system analysis and design. This book presents the type of towers, the line compensation and some research about foundation.

v) A.R. Hileman [5], "Insulation co-ordination for Power Systems," 1999. This paper presents Breakdown of insulation is one of the most frequent causes of interruptions. In addition to the normal operating voltage, which varies within quite narrow limits, the system has to endure a variety of overvoltages with a large range of magnitudes, durations and shapes.

vi) Dr Musse Muhammed Ahmed [6], gives a research paper about a Design of supporting structures. This paper discusses over head line insulators separated line conductors from each other and supporting structure leaving air gaps between them. The design of cross arm can generally be treated as two crossing arms fixed at the tower end. This paper concentrate on the design in 220kV line tower.

vii) Satoshi Matsuo [7], presents a paper titled 'The united design method of a transmission tower and the foundation'. A transmission tower is designed as the truss structures and four of the lowest points of tower members are fixed without considering displacement of foundations.

viii) A Bakirtzis [8], discusses a research paper that titled Comparison of two methods for long run marginal cost-based transmission use-of-system pricing. It presents a typical conductor, characteristics and its comparison among other conductors.

CHAPTER 3

THE PROPOSED DESIGN

3.1 PROJECT METHODOLOGY

- Study the types of existing towers currently in use.
- Study the different characteristics of towers.
- Study fabrication techniques of towers, materials used for their design purpose and technology used for their fabrication.
- Explore the best criteria of selection of the towers.
- Discussion on their designs
- How to select the best tower to be used for 275kV transmission line.
- Analyze the selected tower and do assessment of its design fabrication, technology in use and why it has been selected among others.
- Do critical design data analyses for the selected tower.
- Carry out final design and data fine tuning for the selected tower for 275kV transmission line.
- Use C++ programming language to come up very good output of the final design data.

3.2 TOWER COMPONENTS

Tower or supporting structure comprises of the following components:

1. Foundation and grounding
2. Conductor
3. Insulator
4. Overhead Ground wire (OHGW)
5. Tower
6. Protective devices and line compensation elements.
7. Support structures.

3.2.1 FOUNDATION AND GROUNDING

A foundation system is designed for Soil / Rock classifications to satisfy the following requirements[3] :

1)To safely transfer the applied loads continuously from the structure to the founding material (soil / rock).That is to convert loads to pressure acceptable for the soil / rock's functional capabilities.

2)To continue to function in a specified manner for at least the design life of the installation (transmission line).That is keeping settlements and displacements in limits of the structure's tolerance for the design life of the supporting structure.

There are two type of foundations[]:-

3.2.1.1 STEM AND PAD

Stem and pad foundation are typically used in areas where near surface soils have relatively good bearing capacity and where high water table is not a problem. The stem and pad is a basic spread footing foundation consisting of a base mat resting on a bearing stratum some depth below the ground surface and a square or round stem rising above grade. For lattice tower the foundation can be installed with a vertical pier or a pier battered to the same slope as the tower leg. The stub angle can be vertical as shown in the figure, but offset to allow the center of gravity of the stub angle to intersect the centroid of the pad.[9]

The stub angle should be adequate size ti resist the axial loads from the tower leg plus any secondary bending moment from the horizontal shear, if applicable. The stub angle must be embedded sufficiently to transmit the tower loads to the concrete. Welded shear connectors or bolted clip angles should be added to the end of the stub angle to ensure transfer of tower loads to the pier. Similarly a construction joint should be provided between the mat and pier for transfer of load and since the mat is required to resist both compression and uplift loads, top and bottom reinforcing steel should be provided.[9]

Stem and pad foundation resist compression and moment loads through soil below the mat while uplift loads and overturning are resisted by the foundation weight plus the mass of earth above the mat.[9]

3.2.1.2 DRILLED PIER

Drilled concrete piers are the most type of shaft foundations presently being used to support transmission structures. Drilled piers are constructed by the power augering a circular excavation, placing reinforcing, and pouring concrete to form a shaft foundation. In general drilled pier foundations are applicable for lattice towers and single shaft poles. Structures connection to drilled piers is accomplished in the foundation or by embedment of a stub angle.[9]

Drilled pier foundations resist compression loads through a combination of soil bearing below the pier plus, skin friction along the surface of the shaft. Uplift loads are resisted by the skins friction along the surface of the shaft, the weight of the pier, and the weight of the soil mass mobilized. Overturning moments and lateral shear loads are resists by the lateral interaction of the soils in which it is embedded.[9]

From all the information a foundation is designed and optimised for[3]:

a) a geotechnical condition
b) a tower type (loading)
c) a foundation type
d) for functionary performances
e) economy.

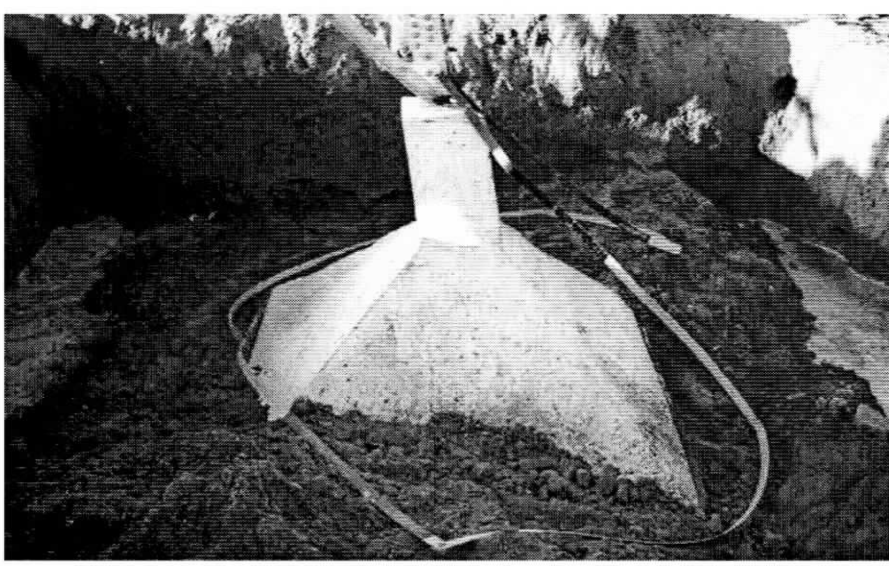

Figure 3.1: Foundation

Figure 3.2 : New and existing method of earthing in the foundation

3.2.2 CONDUCTOR

The most commonly used for materials for conductor are aluminum, copper, and steel. In the transmission line design process, the most important decision often involves the selection of the phase and ground conductor. Phase and ground conductors, usually consist of multiple strands of aluminum, copper or steel, even though today, the use of copper in the modern transmission lines is uncommon [8].

The use of copper in transmission line today is uncommon due to its weight and its high cost which is usually considerably more than aluminum conductor of the same resistance. Selection of the optimum conductor for transmission line depends on power requirements, terrain, ambient conditions, cost of conductors and structures, and environmental and regulator constraints[8].

Conductor types comprise 20 to 30% of the material and labor costs of a modern transmission line. The wind, ice and tension loads placed upon supporting structures are largely dependent upon the selection of the conductors, thus the selection process is critical. The height of the structures is governed by the properties of the conductor due to the maximum sag of phase conductors under extreme wind or extreme temperature for Malaysia. Other effects influenced by conductor selection are environmental, such as radio and audible noise. Conductors are generally of two types, standard and non-standard. The standard types are further broken down into the homogenous or non-homogenous conductor. The non-standard types include "self-damping conductor" (SDC), "aluminum conductor steel supported" (ACSS), "trapezoidal wire conductor" (TW), and (T2) conductor consisting of two sub conductors twisted about one another[9].

3.2.2.1 HOMOGENOUS CONDUCTORS

Homogenous conductors are those in which the individual strands are composed of the same type of material such as all aluminum conductors (AAC) and all aluminum alloy conductors (AAAC). AAC is low cost conductor that offers a conductivity of 61.2% International Annealed Copper Standard (IACS), or more and has good corrosion characteristics. It is usually selected for application requiring high conductivity and moderate strength. AAAC was developed as replacement for high strength aluminum conductor steel-reinforced (ACSR) and is made of aluminum alloy. It offers the combination of good conductivity, high tensile strength and excellent corrosion resistance such as along the seacoast and other areas severely impacted by corrosion [9].