RELATIVE PERFORMANCE OF DOWN CONDUCTOR FOR LIGHTNING PROTECTION SYSTEM

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To everyone that has supported me, Thank you .

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ABSTRACT

The continuous development of lightning protection system is very essential to mankind due to the severity of damages caused by lightning strike. The numbers of skyscraper in the world are keeping on increase day by day due to globalization. The higher the building goes the more vulnerable of the building being stroked by lightning. Lightning protection system has been improved dramatically with time from the earliest method of Franklin rod to present widely used three methods of Protection Angle Method (PAM), Rolling Sphere Method (RSM) and Mesh Method. Air Terminal and down conductor played an important roles in a lightning protection system. Air terminal will initiate an upward leader to meet with the lightning downward leader to form a path for the lightning to discharge it current. The current will than follow the path provided by the down conductor to safely discharge to ground. Arguments always occur that whether copper or steel will be the better down conductor. However, by using the structural steel as down conductor has become common practice, thermal breakdown might occur and damage the structural steel. In this work, the thermal effect caused by lightning on down conductor will be thoroughly studied through SolidWorks simulation and compared with the IEC standard as the benchmark. The simulation results will be observed and to determine the better down conductor between copper and steel. This work will also discuss the possibility of aluminium to replace copper as down conductor and conclude with some recommendations.

ABSTRAK

Kini, pembangunan berterusan sistem perlindungan kilat adalah sangat penting kepada manusia kerana tahap kerosakan yang disebabkan oleh kilat adalah sangat serius. Peningkatan bilangan bangunan yang tinggi secara berterusan disebabkan oleh globalisasi. Semakin tinggi bangunan, semakin terdedah bangunan kepada kilat semasa petir sedang berlaku. Sistem perlindungan kilat telah meningkat secara mendadak dengan masa daripada kaedah terawal iaitu Franklin rod kepada tiga kaedah yang digunakan secara meluas iaitu Protection Angle Method (PAM), Rolling Sphere Method (RSM) dan Mesh Method. Terminal udara dan konduktor keturunan memainkan peranan yang penting dalam system perlindungan kilat. Terminal udara akan memulakan suatu lalaun ke atas untuk bertemu dengan kilat laluan ke bawah untuk membentuk satu laluan untuk kilat menunaikan arus elektrik. Arus elektrik tersebut akan mengikuti laluan yang disediakan oleh konduktor keturunan untuk dikebumikan dengan selamat. Hujah sentiasa berlaku sama ada tembaga atau besi akan menjadi bahan yang tersesuai untuk konduktor keturunan dalam system perlindungan kilat. Walau bagaimanapun, dengan menggunakan keluli bangunan sebagai konduktor keturunana telah menjadi amalan biasa, kerosakan haba mungkin berlaku dan merosakkan keluli bangunan tersebut. Dalam kertas kajian ini, kesan haba yang disebabkan oleh kilat pada konduktor keturunan akan dikaji dengan teliti dengan menggunakan simulasi SolidWorks dan hasil simulasi akan dibandingkan dengan piawai IEC. Hasil simulasi tersebut akan diperhatikan dan dikaji dengan teliti untuk menentukan tembaga atau keluli lebih sesuai menjadi konduktor keturunan. Kertas teknikal ini juga akan berbincang tentang kemungkinan untuk aluminium menggantikan tembaga sebagai konduktor keturunana sistem perlindungan kilat.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In our today's modern world there are countless high rise buildings with different state of art design around the world. The continuous development and competition between countries to build higher buildings to showcase the world how developed their country are has made lightning protection system very essential. As higher the buildings goes as vulnerable the buildings prone to lightning strike. The continuous development of lightning protection system is very immense for high rise building.

In the 1700s Benjamin Franklin developed the first lightning conductor in the world. With the kite experiment that he performed, he successfully showed the electrical nature of lightning. At almost the same time, a Frenchman name Dalibard performed an experiment with a 40 foot tall metal rod which was electrified during thunder storms and ground the pole with a wine bottle. This experiment has supported the theory of Benjamin Franklin. Soon after that Franklin lightning rod has been widely used to protect buildings and homes[1]. In the nineteenth century, the very first mesh cage methods is developed by a Belgian physicist, named Mellsens.

Mesh cage protection method at that time is done by using metal wires connected to numbers of spikes on the roof of building and earthed it in ground. Rolling Sphere Method is developed by Ralph H. Lee in the year of 1977. Initially this method is used for protecting buildings and industrial plants. Later on this method has been extended to shielding substation by J.T. Orrell.

The revolution of the lightning protection system has been evolved to the main three types of method which are Rolling Sphere Method (RSM), Protection Angle Method (PAM) and Mesh Method. These three methods have been used as a standard for most of the lightning protection system and are inducted into the IEC standard. Due to all these revolutions and rapid developments of lightning protection systems, there are still gaps or weaknesses that occur in these particular three methods. However, by using the structural steel as down conductor has become common practice, thermal breakdown might occur and damage the structural steel. Thus this has encouraged me to take up the challenge to address the thermal performance of down conductor in a lightning protection system when being strike by lightning. In this project, a down conductor model will be developed using SolidWorks simulation software. The modeled down conductor will then be simulated with lightning strikes parameters and observe the results. In the same time this project will also study and compare whether copper or steel structure of the complex building are more suitable to act as down conductor of a lightning protection system by comparing the thermal effects. The thermal performance of aluminium will also be discussed in order for it to replace copper as down conductor of the lightning protection system in certain circumstances.

1.2 Problem Statement

By using the structural steel as down conductor has become common practice in all the construction sites, thermal performance of down conductor is very essential. With the high temperature of lightning, down conductor might be melted and will cause hazard to the constructions. Copper theft of down conductor in lightning protection system has also become an issue. Alternative material of down conductor besides copper has to be used in order to solve the copper theft issue.

1.3 Objectives

The main objective of this project is to critically investigate and compare the relative performance of down conductors in a lightning protection system. Comparing between copper or steel structure has the best thermal properties to become down conductor of a lightning protection system. The minimum distance for copper and steel to back to safe region of ambient temperature after it has been strike by lightning. Alternative material will also be tested on the thermal performance to replace copper and steel as down conductor of a lightning protection system.

1.4 Scope Of Works

The scope of works involved in order to achieve the objectives of this project can be divided into few parts. First, a critically study and investigate has to be carry out on the previous research papers and to identify the current challenges facing the related industry. The gaps and weaknesses of the finding will then be selected and find solution to tackle it. Suitable simulation software has to be selected in order to simulate the modeled down conductor and test under various thermal conditions. The simulated results will then be analyze and conclude the findings. Future development will be suggested in order for continuous development in this area.

1.5 Project Organization

This project is represented by five chapters as below :

Chapter 1 : Introduction of this project is being presented. The problem statement, objectives, scope of works and project outline is being elaborated.

Chapter 2 : Literature review on current lightning protection system and compare between the three common methods that are being recognized by IEC. Previous research paper and challenges faced by the industries in this project research area will be discussed and critically review.

Chapter 3 : Discussion about the methodology and the simulation software being used in this project.

Chapter 4 : Simulation run in different conditions will be analyzed and discussed in order to conclude the results.

Chapter 5 : Conclusion and future development of this research area will be elaborated in order for continuous future development in this research area.

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