The Electric Field Analysis of Bipolar Conventional Air Terminal and Conventional Air Terminal

Kangsoo Lee, Youngki Chung (OMNI LPS), Myungki Baek (Sungkyunkwan Univ.)

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I. INTRODUCTION

Conventional air terminals attract lightning to conduct it into ground on purpose of protection of human lives and facilities in buildings. However, in a highly information-oriented society, damages from lightning to equipments in a building cannot be avoided even if a lightning protection system with a conventional air terminal is perfectly functioning. Bipolar Conventional Air Terminal (BCAT) can solve this fundamental problem of conventional air terminals which is also called a Franklin lightning rod. It reduces probability of lightning strikes, whose technical principles are verified in a number of papers published in reputable academic journals. [1][2][3][4][5][6]

The purpose of this paper is to verify performance of BCAT which reduces probability of lightning strikes and its effect of reducing electric fields, for which actual buildings were modeled and installed with a conventional air terminal and BCAT on top of the building to compute electric fields. In this paper, the effect of lightning reduction is verified by computation of electric fields, and direction for further research is suggested.

II. MODELING AND COMPUTATION

A. Analysis of Finite Elements of Lightning Protection System for Buildings

Figure 1 shows a modeled building installed with a lightning protection system. Only the air terminals on top of a building were counted in order to simplify computation. For this research, 2 types of air terminals were applied on the modeling of buildings; one is a common type of conventional air terminal and the other is BCAT which is to reduce lightning strikes at grounded metallic structures on top of a building.

Figure 1 shows the dimension of structures with each air terminal. The height of the conventional air terminal in a structure (a) is 1 m and its diameter is 20 mm. The total area of analysis is 200 m in width, 60 m in length. (b) is a modeling applied with BCAT, OMNI Model No. B-140H whose height is 1.5 m. Figure 1 also shows the enlargement of ①, ②, ③ of (a) and (b).

Since ①, ②, ③ are the same model, only one of them was taken as a sample for electric fields analysis. In natural world, lightning occurrence is a complex mechanism including formation and development of thundercloud and step leader. However, in this simulation, a thunder cloud was modeled with a plate electrode.

![Image](image-url)

Figure 1. Modeling of Lightning Protection System for Buildings

Finite Element Method (FEM) was used for analysis of electric field distribution of each part of the building and a conventional air terminal and BCAT by charge quantity of thunder cloud.
(a) and (b) in Figure 2 show the analysis results of each air terminal.

(a) Conventional air terminal

(b) BCAT

Figure 2. Analysis of Electric Fields

The result indicates that the value of electric field at the tip of the conventional air terminal was \(2.7 \times 10^7\) V/m, and that of BCAT was \(8.0 \times 10^6\) V/m. To record for a reference, in case 2 BCATs were applied, the value of electric field at the top of BCAT was \(3.0 \times 10^6\) V/m.

**III. CONCLUSIONS**

From this simulation of lightning strikes to verify performance of BCAT which reduces probability of lightning strikes, the following were concluded by computation and comparison of electric fields at the conventional air terminal and BCAT.

1. It is possible to simulate lightning conditions for analysis of electric fields of a conventional air terminal or a metallic structure on a building and BCAT.

2. Analysis of this simulation shows that the value of electric field of BCAT was 0.3 times of that at the conventional air terminal and metallic structures, which implies that BCAT is expected to reduce probability of lightning strikes by 70%.

3. In an additional simulation with 2 BCATs, it is verified that application of 2 BCATs is expected to reduce probability of lightning strikes by 88% to compare with a conventional air terminal.

4. Currently, it is hard to find a reliable test method or to apply a certain verification method to prove the performance of BCAT. Therefore, it is urgent to develop appropriate standards to evaluate its performance.

**REFERENCES**


