ID 081

FDTD Calculation of LEMP Inside a Reinforced Concrete Building

Akiyoshi Tatematsu
Electric Power Engineering Research Lab.
Central Research Institute of Electric Power Industry
Yokosuka, Kanagawa, Japan

Farhad Rachidi
Electromagnetic Compatibility Laboratory
Swiss Federal Institute of Technology
Lausanne, Switzerland

Marcos Rubinstein
University of Applied Sciences Western Switzerland
Yverdon-les-Bains, Switzerland

***Abstract*—In this paper, using a GPGPU-based three-dimensional finite-difference time-domain (FDTD) simulation code, we calculate lightning electromagnetic fields inside a full-scale reinforced concrete building.**

Keywords-buildings; electromagnetic fields; reinforced concrete; lightning; FDTD method

I. INTRODUCTION

The protection of electronic devices inside a building from lightning electromagnetic pulse (LEMP) effects is based on the concept of lightning protection zones (LPZ) [1], which requires to accurately evaluate lightning electromagnetic fields.

II. CALCULATION MODEL AND RESULTS

A. Calculation Model

Figure 1 shows a calculation model of a five-storey reinforced concrete building, which is composed of thin wires and a lossy dielectric to represent reinforcing bars and concrete, respectively. The conductivity and relative permittivity of the lossy dielectric are set to 0.0052 S/m and 8.6, respectively, which correspond to results at DC obtained by fitting the Debye model to measured results of concrete with a moisture content of 5.5 % [2]. The lightning channel is assumed to be straight and vertical and the transmission line (TL) model is adopted to represent the current distribution. In the direct-strike case, the channel is attached to the corner of the roof; while in the indirect-strike case, the channel is directly attached to the ground surface 30 m away from the building.

B. Calculation Results

Using the subsequent lightning return-stroke current specified in [1], we calculated electric and magnetic fields inside the building model for the direct and indirect strike cases to analyze the effect of the concrete. Figures 2 and 3 show the waveforms of the electric and magnetic fields on the fifth floor for the direct and indirect strikes, respectively. These results confirm that the concrete structure significantly reduces the electric fields. The magnetic field, on the other hand are virtually not affected by the concrete.

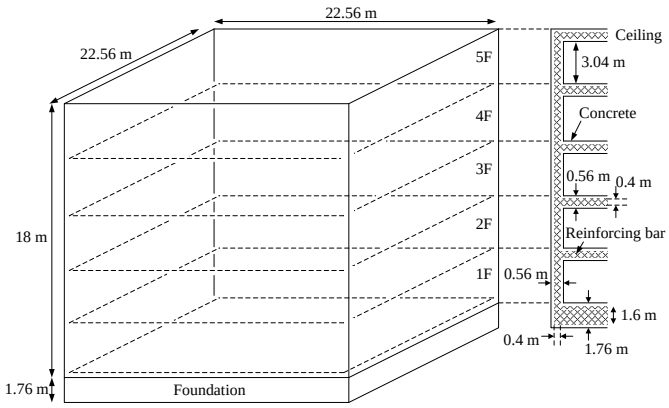
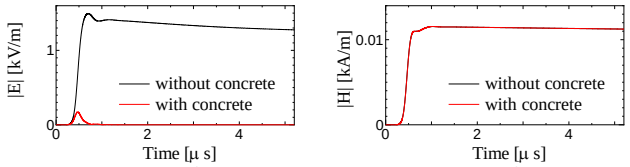
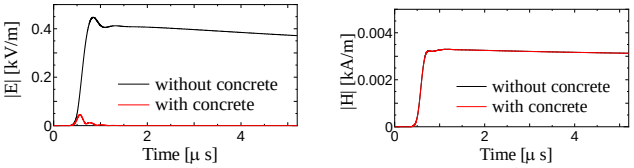


Figure 1. Calculation model of a reinforced concrete building.



(a) Electric field (b) Magnetic field

Figure 2. Calculated results of electric and magnetic fields on the fifth floor in the case of the direct strike.



(a) Electric field (b) Magnetic field

Figure 3. Calculated results of electric and magnetic fields on the fifth floor in the case of the indirect strike.

REFERENCES

[1] Protection against lightning. Part 4: Electrical and electronic systems within structures., IEC Standard 62305-4, 2010.

[2] A. Ogunsola and L. Sandrolini, "Modelling shielding properties of concrete," Proc. 17th Int. Zurich Symp. Electromagn. Compat., 2006, pp. 34-37.