FDTD-Based Lightning Surge Simulation of Grounding Structures with a Coaxial Cable

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Abstract—Using the finite-difference time-domain method (FDTD) combined with the transmission line (TL) theory, we calculate voltages induced on a coaxial cable whose metallic sheath is grounded at two grounding structures when a lightning impulse current is injected into the grounding grid, and compare the calculated results with measured results for validation purpose.

Keywords-*grounding structures; control cables; lightning; induced voltages; FDTD method*

I. INTRODUCTION

Shielded control cables are used for suppressing induced voltages due to lightning surges in low-voltage control circuits in power stations and substations, and, in some cases, shielded control cables are placed over some grounding structures which are connected to one another by grounding wires. When the metallic sheaths of the control cables are grounded at both ends, lightning currents flow into the metallic sheaths and the currents may induce voltages on the control cables. Consequently, it is important to evaluate the effectiveness of grounding the metallic sheaths of cables for reducing induced voltages.

II. CALCULATED AND MEASURED RESULTS

Fig. 1 shows a configuration of a grounding grid and a ring earth electrode which are connected to each other by a grounding wire. The ring earth electrode has a deep earth electrode with a length of 65 m. A coaxial cable (3D-2V) to simulate a control cable is placed over the grounding grid and earth electrode, and its metallic sheath is grounded at both ends. Injecting a lightning impulse current with a pulse generator, we measured the ground potential rises (GPRs) of the grounding grid, the current flowing through the metallic sheath of the cable, and the voltage induced on the cable. Note that the GPRs were measured in the absence of the coaxial cable. FDTD-based surge simulations are performed using a surge simulation code VSTL REV (Virtual Surge Test Lab. Restructured and Extended Version) developed by CRIEPI (Central Research Institute of Electric Power Industry) [1]. In this code, a coaxial cable is represented using the technique on the basis of the combination of the FDTD method and TL theory to take into account the effect of the surface transfer impedance [2]. Fig. 2 shows the calculated and measured results of the current injected into the grounding grid, the GPR of the grounding grid at position A, the current flowing through the metallic sheath of the cable at position B, and the voltage induced on the cable at position B. From these results, we confirmed that the calculated results agree well with the measured results.

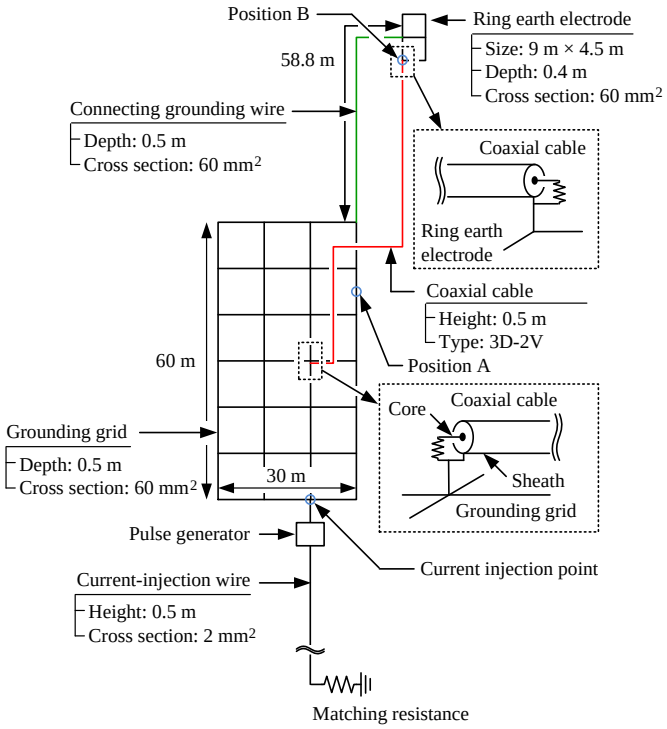
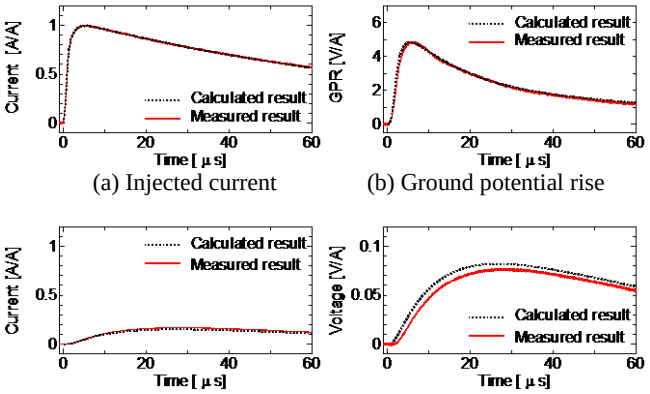


Figure 1. Configuration of grounding structures with a cable



(a) Injected current (b) Ground potential rise

(c) Sheath current (d) Induced voltage

Figure 2. Calculated and measured results.

REFERENCES

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