Characteristics of EWE Antenna Installed on Actual Earth at 1 MHz for Landslides Prediction

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***Abstract*—It has been found from our previous studies that the more the water content becomes in hydrated soil, the more the reflected wave from the air–hydrated soil boundary increases, whereas the transmitting wave decreases. Judging from this results, we focused on the bistatic radar technology which can measure the reflected wave from hour to hour. However, this technology needs unidirectional antennas, so that we have investigated a EWE antenna as a small and unidirectional antenna for the medium frequency band. Because the EWE antenna deteriorated by changing its position from on the ideal case to on the actual earth, we investigated to operate properly even on the actual earth this time.**

Keywords—EWE antenna; Medium frequency band; and Landslides prediction

I. Introduction

Landslides are tragic catastrophes which encompass extensively human and property suffering, and have recently been increasing along with increase of torrential rain. As also the whole world, the costly landslides occurred in the northern India, the southern Chile and Republic of Sierra Leone in the western Africa in 2017 [1] [2] [3]. Therefore, it is becoming serious and international problem. With this fact in mind, we have been developing the system which can measure the water content of the hydrated soil by using electromagnetic wave by focusing on a thing that landslides are caused by the increase of the water content in lands.

From our previous research, we have applied the bistatic radar technology, having only put emphasis on the reflected wave from the air-hydrated soil boundary because the reflected wave becomes a function of the water content, while the transmitting wave in the hydrated soil becomes unmeasurable tiny level [4]. Figure 1 shows our-investigating landslides prediction system using broadcasting radio station based on the bistatic radar technology. Because this system needs receiving antennas having highly F/B ratio to discriminate between the direct and reflected waves, we focused on the EWE antenna whose size was electrically small to be less than a tenth of wavelength considering the medium frequency band and investigated the radiation characteristics, the EWE antenna being located on the actual earth, in this paper.

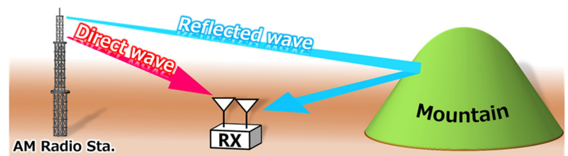


Fig. 1. Schematic view of bistatic radar technology.

II. Performance of EWE Antenna

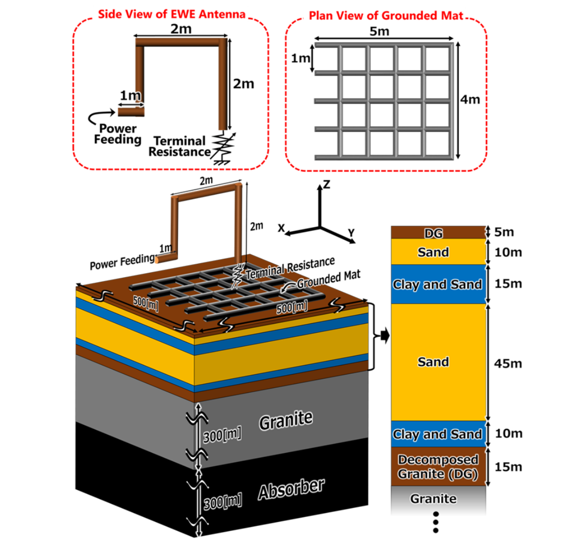
Figure 2 (a) shows the structure of the EWE antenna which features an unidirectional radiation pattern at a certain resistance. The calculated F/B ratio and the radiation pattern are shown in Fig. 2 (b) as a dotted curve and in Fig. 3 (a), where the EWE antenna was assumed to be located on the perfect conductor as the ideal case. The good F/B ratio to be 50 dB can be obtained although the antenna size having 3m in length and 2m in height was extremely smaller than a free space wavelength.

Next consideration is concerned with the radiation performance, the EWE antenna being located on the actual earth as shown in Fig. 2 (a), where the structure of the earth was modeled by referring the geological survey result at our hometown Hiroshima and the dimensions were set at 500m squares being longer than a free space the wavelength at 1 MHz [5]. Moreover, the calculation model has reduced by using the absorber because the granite as the earth's crust exists extremely-deeply.

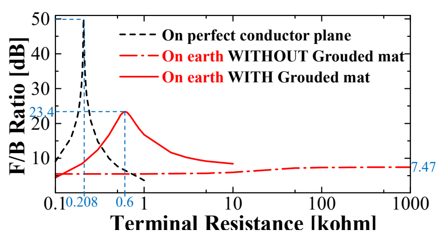
The calculated F/B ratio and the radiation pattern are shown in Fig. 2 (b) as a dot-and-dash curve and in Fig. 3 (b). It can be seen that the F/B ratio deteriorated [6].

To overcome such difficulty, the grid-like grounded mat having 5 m in the x direction and 4 m in the y direction with 1m interval was installed as shown in Fig. 2 (a).

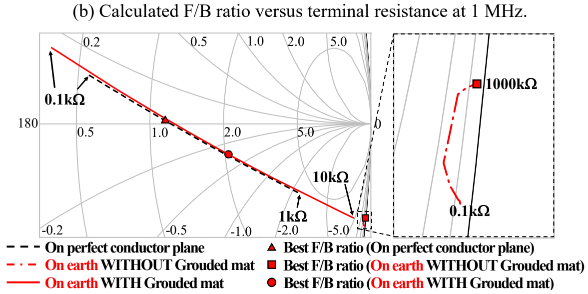
The calculated F/B ratio and input impedance are shown in Figs. 2 (b) as a solid curve and (c) and the radiation pattern is shown in Fig. 3 (c). It is obvious from the results that the F/B ratio was able to be improved from 7.45 dB to 23.36 dB by installing the grounded mat. Moreover, the return loss was also able to be improved from the figure (c).



(a) Schematic view of Calculation model.

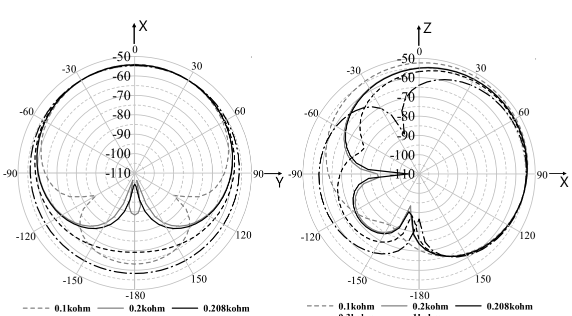


(b) Calculated F/B ratio versus terminal resistance at 1 MHz.



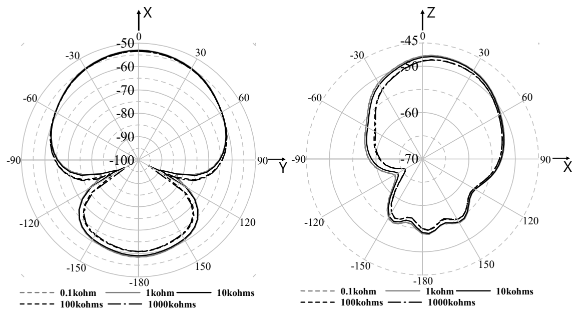
(c) Calculated input impedance on Smith chart.

Fig. 2. EWE antenna.



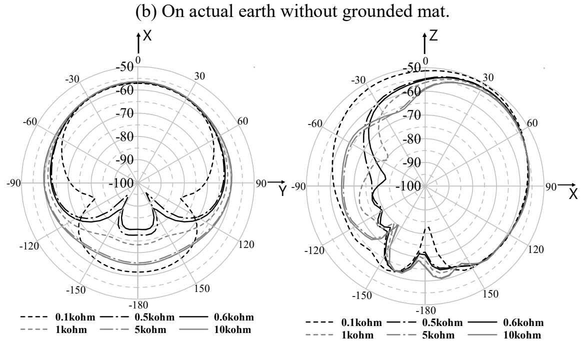
(i) Horizontal plane (ii) Vertical plane

(a) On perfect conductor.



(i) Horizontal plane (ii) Vertical plane

(b) On actual earth without grounded mat.



(i) Horizontal plane (ii) Vertical plane

(c) On actual earth with grounded mat.

Fig. 3. Summary of calculated radiation patterns of EWE antenna for each location at f = 1MHz.

III. Coclusion

Although the performance of the EWE antenna deteriorates when installed on the actual earth, loading the grounded mat could improve the F / B ratio and return loss even on the actual ground.

As the future issue, we will evaluate the bistatic radar technology using the EWE antenna installed with the grounded mat, conducting the experiment after fabricating the antenna.

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[3] http://edition.cnn.com/2017/08/18/africa/sierra-leone-mudslides/index.html

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[6] Kousei Kumahara, Futoshi Kuroki, Masanori Eguchi, Takeshi Yamakawa, "Radiation Characteristics of EWE Antenna on Actual Ground for Landslides Prediction Based on Bistatic Radar System Using AM Radio Broadcasting", Proceedings of EuCAP, (April 2018 in UK).