3 Meters Site Attenuation above the Earth Ground

— In the Case of Biconical Antenna for Both Transmitting and Receiving —

Ryoji Wakabayashi†, Kazuo Shimada†, Haruo Kawakami†† and Gentei Sato††

† Department of Electronics Eng., Tokyo Metropolitan College of Aeronautical Engineering, Tokyo, 116 Japan

†† Antenna Giken Co., Ltd. Radiating System Division, Omiya, 330 Japan

1. Introduction

Recently site attenuation is often measured automatically with broad band antenna such as biconical antenna or LPDA.

A few calculating results of site attenuation in the case for biconical antenna or LPDA above the infinite conductor plane have been reported[1,2]. And Sugiura et, al. calculated the value of site attenuation in the case for dipole antenna above the earth ground. However the correct site attenuation above the earth ground with biconical antenna have not been calculated ever.

In this paper the value of site attenuation in the case when biconical antenna is used both for transmitting and receiving is analyzed by reflecting coefficient method. Calculated results are shown and are compared with the value of the site attenuation in the case when tuned dipole antenna is used for transmitting or short dipole antenna that is tuned on 80 MHz is used for both transmitting and receiving above the earth ground.

2. Analyzing method

Fig. 1 illustrates the model of antenna system to measure site attenuation in the case when biconical antenna is used both for transmitting and receiving.

Site attenuation S is defined as

$$S = 10\log_{10}\frac{|P_1|}{|P_2|} \quad \text{(dB)}, \qquad (1)$$

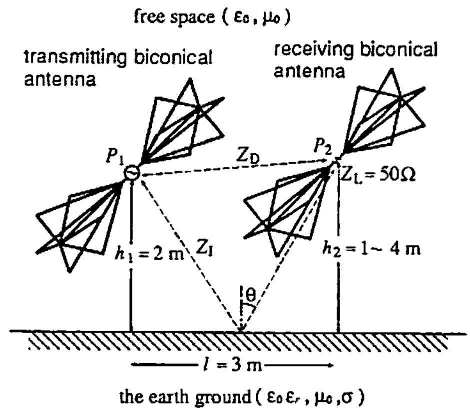


Fig. 1 The antenna system for measuring the 3 meters site attenuation above the earth ground.

where P_1 is the input power of transmitting antenna, P_2 is the output power of receiving antenna.

The mutual impedance Z between the transmitting and the receiving antenna is the sum of Z_D and Z_I, where Z_D is the mutual impedance in free space and Z_I is the mutual impedance yielded from the reflection by the earth ground between the transmitting and the receiving antenna. Z_D can be calculated by the standard moment method. Then Z_I can be calculated by the reflection coefficient method with the reflection coefficient of the earth ground

$$\Gamma_{TM} = \frac{\varepsilon\cos\theta - \sqrt{\varepsilon - \sin^2\theta}}{\varepsilon\sin\theta + \sqrt{\varepsilon - \sin^2\theta}} \qquad (2)$$

$$\Gamma_{TE} = \frac{\cos\theta - \sqrt{\varepsilon - \sin^2\theta}}{\sin\theta + \sqrt{\varepsilon - \sin^2\theta}}, \qquad (3)$$

where Γ_{TM} and Γ_{TE} are respectively TM and TE reflection coefficient for incident angle is θ. ε is complex permittivity of the earth ground

$$\varepsilon = \varepsilon_r + \frac{\sigma}{j\omega\varepsilon_0}, \qquad (4)$$

where ε_r is relative permittivity, σ is conductivity of the earth ground, θ is incident angle and ω is angle frequency. We use ε_r and σ values shown in Fig. 3[4].

3. Results

Fig. 2 shows the dimension of the biconical antenna used for calculating site attenuation, which is generally used for EMI measurements.

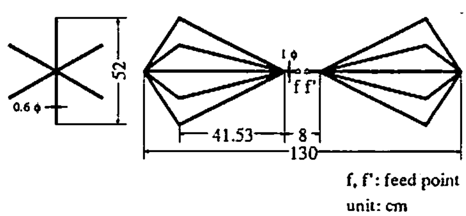


Fig. 2 Biconical antenna for calculating.

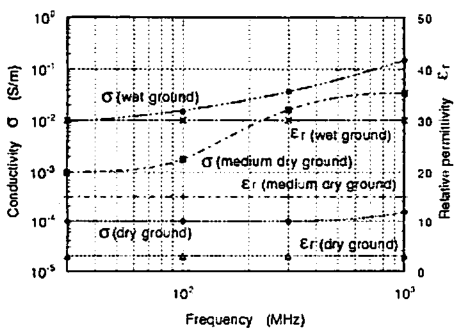
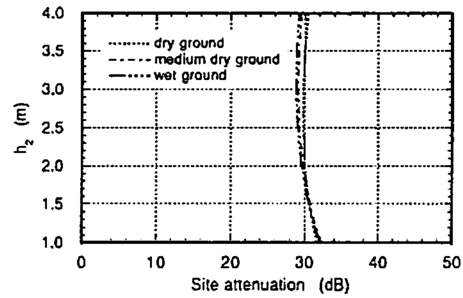
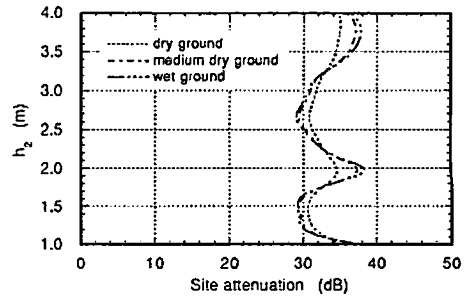


Fig. 3 ε_r and σ values of the earth ground.

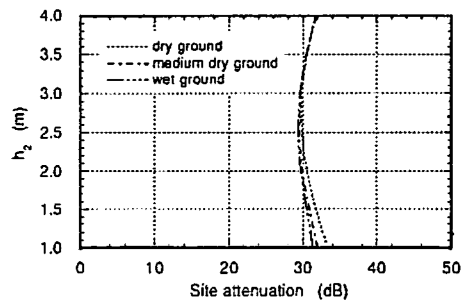


(a) f = 30 MHz

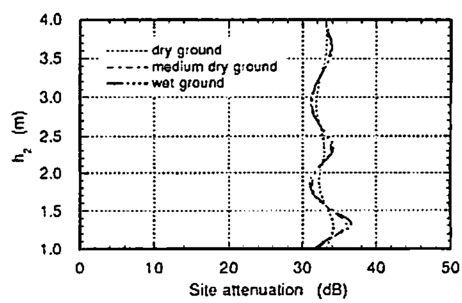


(b) f = 300 MHz

Fig. 4 Height pattern for horizontal polarization.

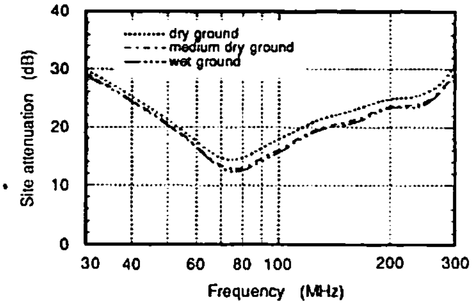


(a) f = 30 MHz

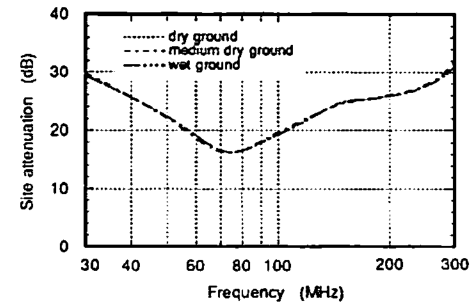


(b) f = 300 MHz

Fig. 5 Height pattern for vertical polarization.

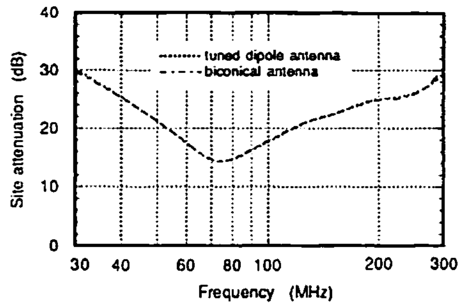


(a) for horizontal polarization

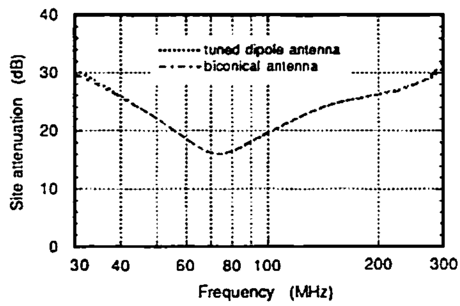


(b) for vertical polarization

Fig. 6 Site attenuation.



(a) for horizontal polarization



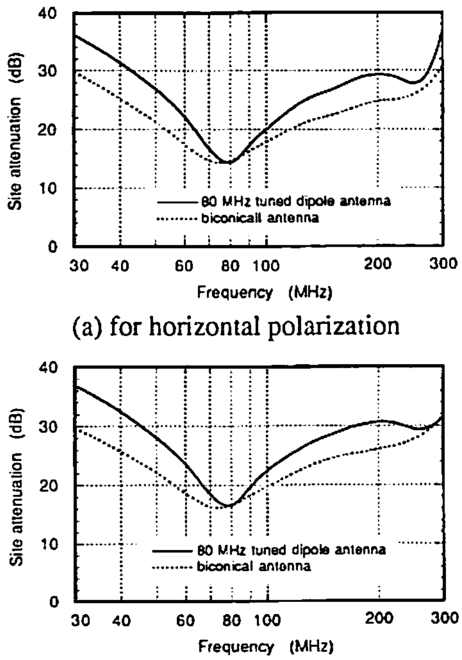
(b) for vertical polarization

Fig. 7 The comparison of site attenuation by the difference of the transmitting antenna above the dry earth ground in the case of biconical antenna for receiving.

Figs. 4 and 5 show the calculated height pattern of 3 meters site attenuation of the antenna system shown in Fig. 1 by eqs. (1) ~ (4) and by the moment method with triangle testing and weighting functions for horizontal and vertical polarization respectively. Fig. 6 shows frequency characteristics of the site attenuation for horizontal and vertical polarization. From Figs. 4 ~ 6 it is found that height patterns of site attenuation above the earth ground depend on humidity of the earth ground for both horizontal and vertical polarization, however characteristics of site attenuation is independent on the earth ground for vertical polarization.

The calculated value of site attenuation above the earth ground in the case when tuned dipole antenna is used for transmitting and biconical antenna is used for receiving is shown in Fig. 7 compared to the value of Fig. 6 for the dry ground. It is found that the values of site attenuation in the case when biconical antenna is used for both transmitting and receiving are the same as the values in the case when tuned dipole antenna and biconical antenna are used for transmitting and receiving respectively from Fig. 7. So it is guessed that the site attenuation in the case when biconical antenna is used for receiving antenna may be characterized by only the receiving antenna. In other words it is thought that site attenuation may be independent on the difference of the kinds of transmitting antenna.

From Fig. 6, as the value of site attenuation increases with frequency being down less than about 80 MHz, it is guessed that the



(a) for horizontal polarization

(b) for vertical polarization

Fig. 8 The comparison of site attenuation by difference of transmitting and receiving antenna.

value of Fig. 6 less than 80 MHz is similar to the value in the case when short dipole antenna, which have the lower gain on the lower frequency, is used both for transmitting and receiving. Then we calculate site attenuation above the earth ground in the case when the short dipole antenna that is tuned on 80 MHz is used for both transmitting and receiving above the dry ground and show the calculated results in Fig. 8 with comparison to the value for the dry ground in Fig. 6. Fig. 8 shows that the value of site attenuation with short dipole antenna has a similar caracteristics with the value of that with biconical antenna. So we cannot find out the reason why biconical antenna is used as broad band antenna to measure site attenuation from the point of view of the site attenuation value. Then we think dipole antenna tuned on 80 MHz may be better to measure site attenuation rather than biconical antenna from simplicity of the structure of dipole antenna.

4. Conclusions

The site attenuation in the case when biconical antenna is used for both transmitting and receiving antenna is calculated. As the results, it is found that site attenuation in the case when biconical antenna is used for receiving antenna is independent on the kind of transmitting antenna and it is suggested that short tuned dipole antenna may be able to used to measure site attenuation instead of biconical antenna.

We will calculate the site attenuation above the ground in the case when LPDA used for transmitting and receiving antenna.

References

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