AN APPROACH TO THE UNIFYING EXPRESSION OF ENVIRONMENTAL STRUCTURE EFFECT IN MOBILE PROPAGATION

Yoshihisa OKUMURA

Department of Electronics, KANAZAWA Institute of Technology

1. Introduction

Prediction of the field strength for various terrains and environmental conditions is essential for designing a land mobile radio system. A method and a set of curves for predicting the field strength over the quasi-smooth terrain and the irregular terrain have been presented by Y.Okumura et al, which is widely used as so-called "OKUMURA MODEL".[1]

However, more precise analysis is needed to improve the prediction accuracy and to express quantitatively the effect of environmental structure such as the classification of "open-area", "suburban-area" and "urban-area".

This paper analyzes new controlling factors for environmental structure based on the density of occupied buildings, the distribution of building stories and street width over a sampled-area, and proposes a new prediction method of the correction factor for the median field strength over the local-area.

2. Factors affecting environmental structure effect

New factors proposed for predicting the local-area median of the field strength, aiming at an approach to the unifying expression of environmental structure, are as follows;

(1) "Area factor of occupied buildings" (α%) defined as the percentage of the area covered by buildings over a sampled-area.[2]

(2) "Mean building story" ($\bar{F}$) defined from the distribution of building volume over a sampled-area.[3]

(3) "Mean building width" ($\bar{t}$) which relates to mean building story.[3]

(4) "Mean street width" ($\bar{W}$) over a sampled-area.

3. Correction factors of the local-area median

The resultant "median correction factor" S(dB) is given by the following equation;

$$S = S_1(\alpha) + S_2(\bar{F}) + S_3(\bar{W}) \qquad (dB)$$

where; $S_1(\alpha)=E_m(\alpha)/E_{mu}$, $E_m(\alpha)$ is the local-area median level of receiving field strength within a sampled-area (of the order of 0.25 - 0.4 km^2) as a function of α (%) for the reference values of $\bar{F}$ and $\bar{W}$. E_{mu} is the basic median field strength derived from the prediction curves given by "OKUMURA MODEL", using the same propagation parameters as that of $E_m(\alpha)$. Here, $S_1(\alpha)$ is determined by field measurement data.

$S_2(\bar{F})$ is the correction factor due to the mean building story ($\bar{F}$) over a sampled-area. This factor is given as relative value by theoretical calculation of diffraction loss due to thick building[4], comparing with experimental results. $S_3(\bar{W})$ is the correction factor due to the mean street width ($\bar{W}$) in a sampled-area, and derived from experimental data.[5] Fig.1 shows $S_2(\bar{F})$ and $S_3(\bar{W})$ drawn by the above analyses.

4. Experimental results and prediction curves

In order to analyze more precisely the correction factor, measurements of the local-area median were made in Kanazawa City and surrounding areas in 150, 470, 620 and 870 MHz bands, radiated at three different sites. Each sampled-area is defined as a 500x 650 m^2 section derived from community map. About 40 sampled-areas were selected for each frequency.

The measured medians of the correction factor $S_1(\alpha)$ for each frequency are plotted against α (%) in Fig.2. Though the measured values are somewhat scattered, every tendency for each frequency are almost similar. This result seems to indicate that the median correction factor $S_1(\alpha)$ is normalized for the measuring frequencies and other propagation parameters. Consequently, this result may be used as the reference value of $S_1(\alpha)$ corresponding to $\bar{F}$= 2.5 and $\bar{W}$= 8 m (moderate urban).

Further inspection of other data is shown in Fig.3, which was measured in Tokyo area.[2]

The data in Musashino area indicates almost same tendency against α (%) as that of Fig.2 because of similar environmental structure conditions. While, the data obtained in Chiyoda area shows considerably lower than that of Musashino area because of higher building height. The curve ② in Fig.3 corresponds to the prediction curve derived from Fig.1 for the values of $\bar{F}$= 7 and $\bar{W}$= 20 meters.

From the above discussion, the prediction curves of the median correction factor S(dB) in the local-area, normalized by the basic median field strength in "OKUMURA MODEL", can be given as shown in Fig.4 as a function of α, $\bar{F}$ and $\bar{W}$ for actual city structure.

5. Conclusion

The above result is expected to enable one to predict the effect of environmental structure in mobile radio propagation, quantitatively, continuously and more accurately.

Acknowledgment

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References ;

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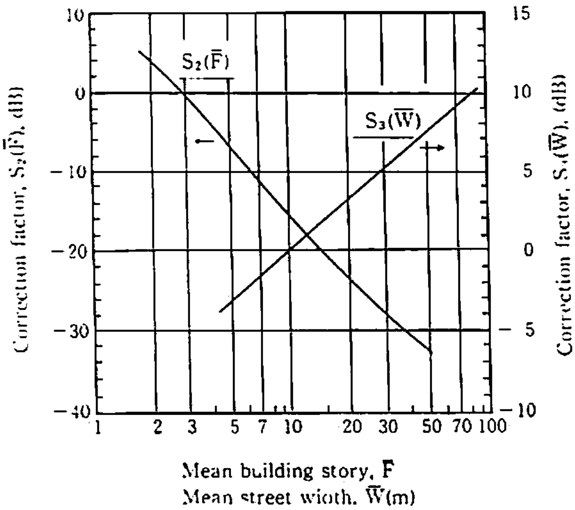

Fig. 1 Correction factor, $S_2(\bar{F})$, $S_3(\bar{W})$

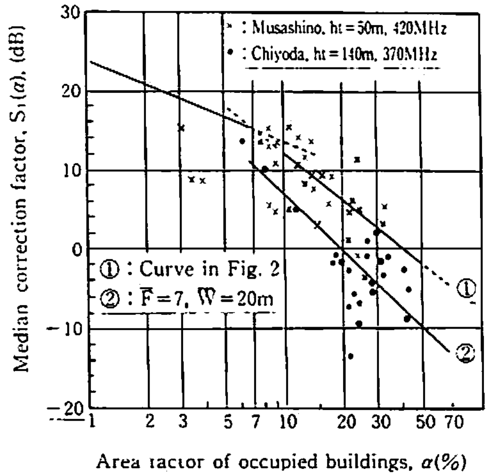

Fig. 3 Measured values of $S_1(\alpha)$ at two frequencies. (Tokyo area)

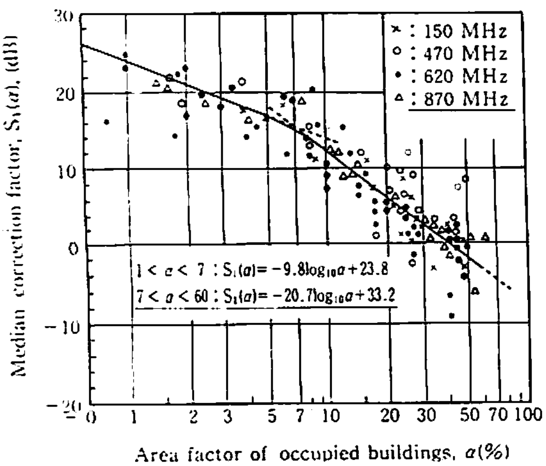

Fig. 2 Measured values of $S_1(\alpha)$ vs. α, at four frequencies. (Kanazawa City)

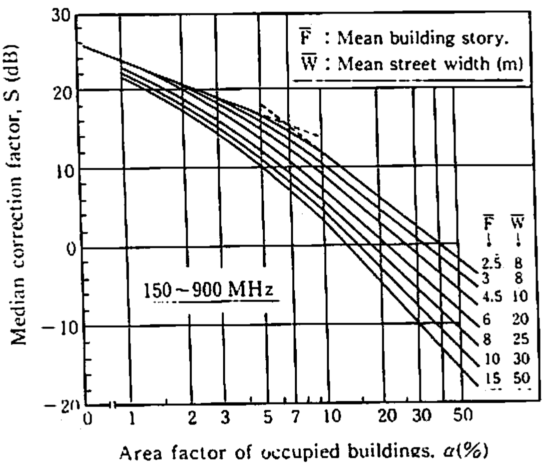

Fig. 4 Prediction curves of median correction factor, S, as a function of α, $\bar{F}$ and $\bar{W}$