ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 6, Issue 2, February 2019

Investigation of Field Declination in the Premises of Buildings

Madaminov H.X., Likonsev A.N., Nazarov A.M.

Senior lecturer, Department of mobile technology, Tashkent University of Information Technologies named after Muhammad Al-Khwarizmi, Tashkent, Uzbekistan
Professor, Doctor of Technical Sciences, Department of Radio Devices and Systems,Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan
Associate professor, Doctor of Philosophy, Department of Radio systems and signals processing, St. Petersburg state university of telecommunications named after M.A.Bonch-Bruevich, St. Petersburg, Russia

ABSTRACT: The article presents the results of an experimental study of the weakening of the field in the walls of buildings made of concrete, brick, and also with an aluminum composite panel. The results of the study are presented in the form of graphs of field attenuation, with which you can predict various options for receiving mobile communication signals in rooms. Also given is a material on field prediction in rooms and corridor type. diffraction field indoor

KEYWORDS: electromagnetic wave, field level, room, absorption, mobile communication, wall reinforcement

I.INTRODUCTION

It is known that the quality of work of mobile communication and wireless Internet is primarily determined by the signal level at the receiving point. To predict it, it is necessary to know the regularities of the field level distribution. This is especially important for the case of indoor reception. Base stations of mobile communication located in the vicinity of the surveyed for the distribution of electromagnetic fields of the premises were used as the transmitting part.

II. SIGNIFICANCE OF THE SYSTEM

As for reinforced concrete walls, as noted by foreign authors, the information on obtainable values of the relative dielectric constant ε and the specific conductivity σ of the walls of reinforced concrete varies greatly.
At the same time, information on the ε and σ values of concrete walls difference little.
The magnitude of the wave absorption by the wall L is determined by the product of the attenuation coefficient and the wall thickness l_{wal}.

$$L = l_{wal} \cdot \alpha \text{ , дБ.} \qquad (1)$$

It is proposed to experimentally establish the value of losses in the reinforcement bars of a reinforced concrete wall $L_{wal..ger}$, add it to the absorption value of the concrete wall and divide this value by the value α, to obtain "equivalent wall thickness" $l_{толщ.экв}$

$$l_{толщ.экв.} = l_{wal} \cdot \alpha + L_{арм} = l_{wal} + L_{wal.ger} / \alpha. \qquad (2)$$

For these purposes, a laboratory setup was created for the experimental determination of the amount of metal reinforcement weakening by the grating.
The block diagram of the installation is shown in Figure 7. A Fluke 964OA generator and an R & S®HL562 antenna were used transmitting equipment, and an ESU spectrum analyzer from Rohde & Schwarz and an R & S®HE300 antenna were used as receiving equipment. The measurements were carried out in the anechoic chamber.

Figure 7. The structure of the laboratory setup.

The studies were conducted at frequencies f = 450 MHz, 900 MHz, 1800 MHz and 2600 MHz for valves of different sizes of lattice cells $l_я$.
For example, in Fig.8, the results of an experimental study of the magnitude of losses in the lattice $L_{wal..gr}$ from its angle of rotation φ relative to the wave fall are given for the valve cell size $l_я$ = 167mm for frequencies 450 MHz ($l_я/\lambda$ = 0,25), 900 MHz ($l_я/\lambda$ = 0,5), 1800 MHz ($l_я/\lambda$ = 1), 2600 MHz ($l_я/\lambda$ = 1,44).

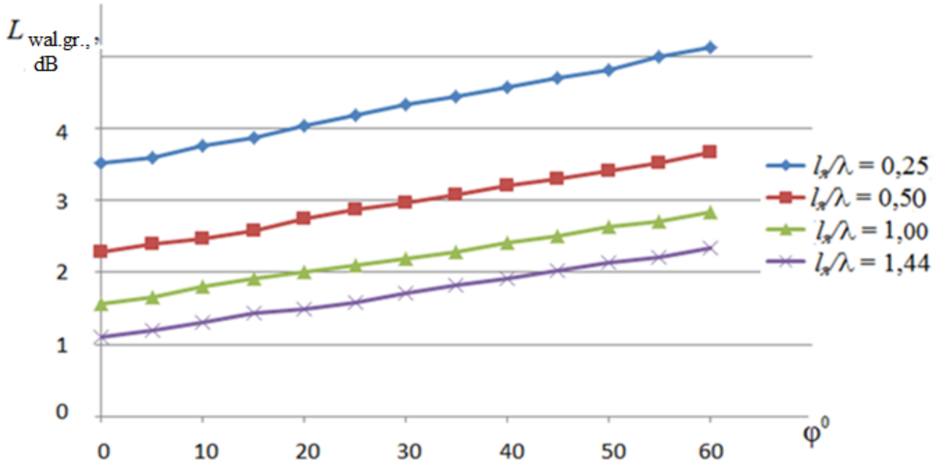

Fig.8. Dependence of losses in the armature lattice $L_{wal..gr}$ on the angle φ for different values of $l_я/\lambda$

III. LITERATURE SURVEY

As it can be seen from the graphs, the dependence of the increase in attenuation in the wall reinforcement lattice with increasing lattice angle φ and decreasing attenuation with increasing cell sizes is clearly seen.
The corridor in the building bears some resemblance to a rectangular waveguide, especially if its walls are of conductive or semiconducting material. Denote the width of the corridor by a , and its height by b.
The expression for the attenuation coefficient of type H_{10} waves in a rectangular hollow metal waveguide [1] is

$$\alpha_{H10} = \frac{\sqrt{\pi \cdot f \cdot \mu_a / \sigma}}{b \cdot Z_c \cdot \sqrt{1-(\lambda/2a)^2}} \cdot \left[1 + 2\frac{b}{a} \cdot \left(\frac{\lambda}{2a}\right)^2\right], \quad (3)$$

where σ - conductivity of the walls of the waveguide, C/m;
Z_c - medium impedance, Ohm;
μ_a - absolute magnetic permeability, Gn/m.
To calculate the values of the specific attenuation, a corridor was chosen with the dimensions of the wide and narrow walls of the cross section 4 by 3 meters. For the walls of the concrete corridor, the specific attenuation at the frequencies of 800 MHz, 1800 MHz and 2100 MHz, respectively, was 0.151 dB / m, 0.163 dB / m and 0.165 dB / m. For brick walls of the corridor, the linear attenuation at frequencies of 800 MHz, 1800 MHz and 2100 MHz, respectively, was 0.128 dB / m, 0.191 dB / m and 0.207 dB / m.

To unify the calculations in the corridors of the building, it is advisable to introduce the concept of "effective conductivity of the walls of the corridor" σ_{eff} eff, which takes into account both the conductive properties of the walls of the corridor, their irregularities, and a certain set of standard furniture in the corridor (clothes hangers, etc.).

$$\sigma_{eff} = \frac{2{,}512}{\lambda \cdot \alpha_{эксп}^2 \cdot b^2 \cdot [1-(\lambda/2a)^2]} \cdot \left[1 + 2\frac{b}{a} \cdot \left(\frac{\lambda}{2a}\right)^2\right]^2, \text{Cm/m}, \quad (4)$$

where $\alpha_{эксп}$ - the value of specific attenuation in dB / m, obtained experimentally.
In turn, knowing the value of the "effective conductivity of the walls of the corridor," we can predict the value of the specific attenuation in the corridor. By multiplying the value of $\alpha_{эксп}$ by the length of the corridor, one can find the magnitude of the attenuation of the radio wave. The magnitude of the attenuation (in times) in people in the corridor can be determined with the help of an additional factor $F_{чел}$

$$F_{man} = exp\left\{-\left(\frac{2\pi}{\lambda}\right) \cdot \left[0{,}5 \cdot \left(-\varepsilon_{man} + \sqrt{\varepsilon_{man}^2 + (60\lambda\sigma_{man})^2}\right)\right]^{0.5} \cdot l_{man}\right\} / N_{man}, \quad (5)$$

where ε_{man} is the relative dielectric constant and σ_{man} human conductivity.
This expression is an integral part of the field weakening model in corridor-type rooms.
Below is considered the diffraction of the beam from the base station for mobile communications (BSMS) on the window (door) opening, which can be represented as diffraction on the wedge-shaped obstacle. In Fig. 9, r is the distance from the antenna of the mobile base station to the window or door opening, r1 is the distance from the antenna of the mobile base station to the building, and r2 is the width of the room, l_1 + l_2 is the distance between the transmitting antenna and the calculation point fields, H is the height of the “screen” (wedge-shaped obstacle), l_1 is the distance from the base station antenna to the “screen”, l_2 is the distance from the “screen” to the field level calculation point, l_3 is the distance between the field calculation point and the normal to the base antenna mobile station.
The magnitude of the field weakening on a wedge-shaped obstacle (screen) can be determined by the approximate formula for a wedge-shaped obstacle.

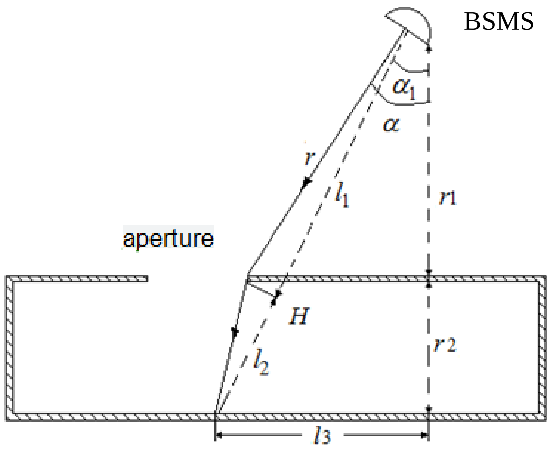

Fig.9. To the calculation of the diffraction field in the room

After a series of transformations, we obtain the expression for the magnitude of the field attenuation

$$F(u) \approx 9,476 + 5lg\, r_1 + 10lg \sin(\alpha - \alpha_1) + 5lg(r_1 + r_2) -$$
$$-10lg\lambda - 5lg\cos(\alpha - \alpha_1) - 5lg[1 + (r_2/r_1)\cos\alpha - \cos\alpha_1], \int \text{ dB.} \quad (6)$$

IV. METHODOLOGY

The measurement of the received signal power levels was carried out using an R&S®TSME scanner with a measuring antenna suspension height of 1 meter above the floor in order to determine the signal attenuation in the walls of concrete, brick, with an aluminum composite panel. The results of the study are presented in the form of graphs in Figure 1-6.

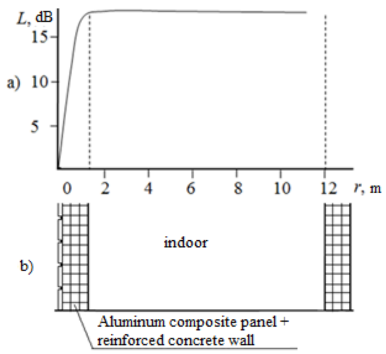

Fig. 1. a) the averaged dependence of the signal attenuation at a frequency of 1800 MHz on the distance r in an empty room;
b) the place of experimental research

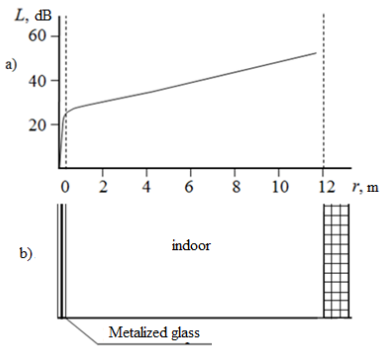

Fig. 2. a) the average dependence of the signal attenuation at a frequency of 800 MHz on the distance r in an empty room;
b) the place of experimental research

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 6, Issue 2, February 2019

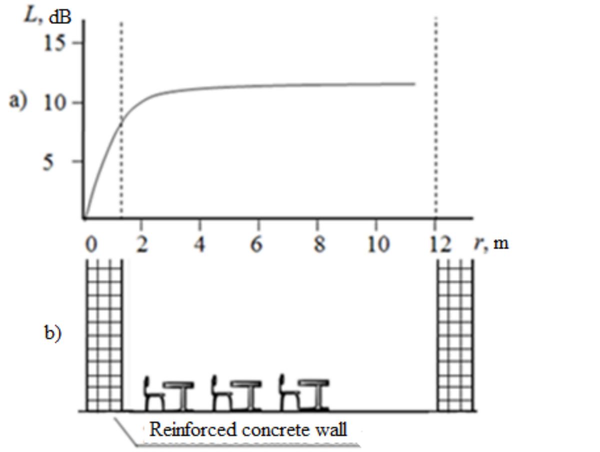

Fig. 3. a) the averaged dependence of the signal attenuation at a frequency of 1800 MHz on the distance r in an empty room;
b) the place of experimental research

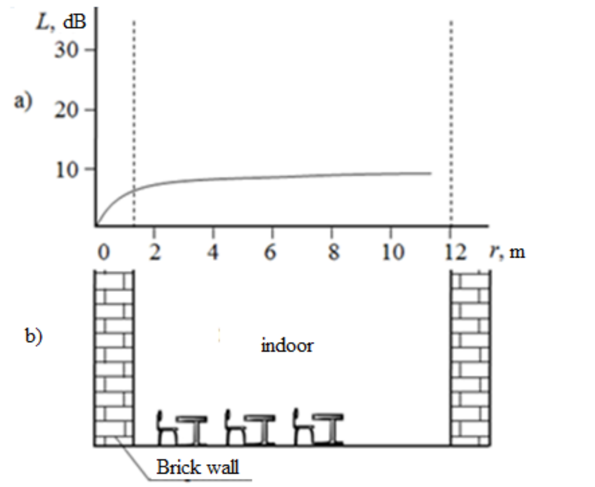

Fig. 4. a) the averaged dependence of the signal attenuation at a frequency of 1800 MHz on the distance r in an empty room;
b) the place of experimental research

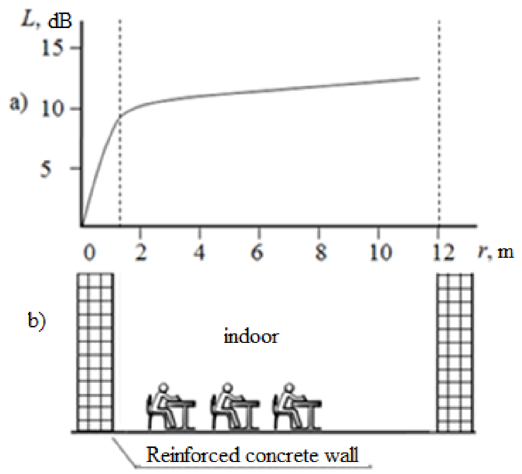

Fig. 5. a) the averaged dependence of the signal attenuation at a frequency of 2100 MHz on the distance r in the room (students sit);
b) the place of experimental research

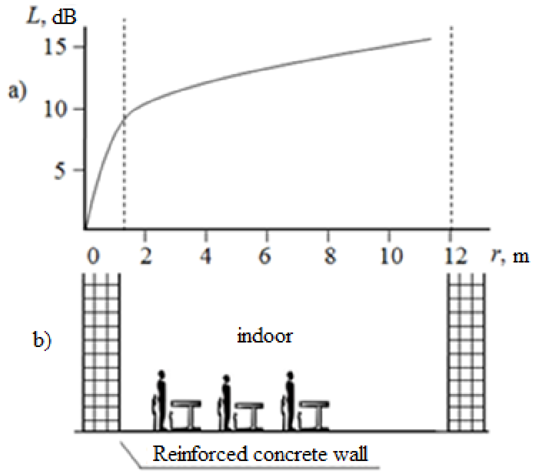

Fig. 6. a) the averaged dependence of the signal attenuation at a frequency of 2100 MHz on the distance r in the room (students are standing);
b) the place of experimental research

V. EXPERIMENTAL RESULTS

The analysis of the obtainable dependencies showed:

- a 30 cm thick reinforced concrete wall when a wave at an angle of 450 degrees falls on it gives an average attenuation of 12 dB;
- presence in the audience for 30 seats 27 students sitting at the tables (occupancy rate of 90%) gives an additional signal attenuation of 2 dB;
- 27 standing students in the same audience increase the signal attenuation by another 5 dB;
- when moving students are around the audience, the attenuation increases by another 1–2 dB;

- the presence of a student on the wave path near the measuring antenna increases the field attenuation by another 1.5 - 2 dB;
- a brick wall 55 cm thick when wave falls at an angle of 500 gives an average attenuation of 9.8 dB;
- the presence of 18 students sitting in an audience of 20 seats (occupancy rate of 90%) gives an additional 3 dB attenuation;
- 18 standing students in this audience increase signal attenuation by another 6 dB;
- when moving students around the audience, the attenuation may increase by another 2 dB;
- the presence of a student on the path of the wave near the measuring antenna increases the field attenuation by another 1 dB;
- brick wall 50 cm thick when a wave falls at an angle of 450 gives an average attenuation of 9.8 dB;
- the presence of 21 students are sitting in an audience of 26 places (occupancy rate of 81%) gives an additional attenuation of 2 dB;
- 21 student standing in this room increases the attenuation by another 4 dB;
- when students are moving around the audience, signal attenuation may increase by another 1 dB;
- the presence of a student on the wave path near then the measuring antenna increases the field attenuation by another 2 dB.

VI. CONCLUSION AND FUTURE WORK

This expression can be used in the calculation of the field using ray tracing, where the propagation of radio waves is represented as the propagation of a large number of independent rays that have the characteristics of both attenuation and reflection from the walls of the premises.

REFERENCES

1. Pimenov Yu.V.. Volman V.I.. Muravtsov A.D. Tekhnicheskaya elektrodinamika. Uchebnoye posobiye dlya vuzov. M.: Radio i svyaz. 2000.

AUTHOR'S BIOGRAPHY

Madaminov Haydar Xudayarovich - senior teacher of the department of "Mobile technology" of Tashkent University of Information Technologies named after Muhammad Al-Khwarizmi. Author of more than 20 scientific publications and a one software product.

NazarovAbdulazizMuminovich – Professor, Doctor of Technical Sciences, Head of the Department "Radio Devices and Systems"of the Tashkent State Technical University named after Islam Karimov.Author of two monographs and three textbooks, and more than 80 scientific publications, including 5 patents.

Likontsev Aleksey Nikolaeyich – doctor of philosophy in technics, associate professor of the department of "Radio systems and signals processing" in St. Petersburg state university of telecommunications named afterM.A.Bonch-Bruevich. The author of more than 30 scientific publications and one patent for invention.