URSI GASS 2020, Rome, Italy, 29 August - 5 September 2020

EMF Exposure Evaluation for Base Stations Installed Underground

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This paper presents the computation results to evaluate human exposure to electromagnetic fields (EMFs) from base stations installed underground (underground BS) using spherical formula and Finite Difference Time Domain (FDTD) simulation in order to consider the suitable computation formulas of RF exposure from underground BSs when evaluating product installation compliance.

Measurement and computation methods of human exposure to EMFs from fixed radio sources like mobile base stations have been standardized and published as IEC 62232 [1] by IEC. The spherical formula prescribed in IEC 62232 as a basic computation method to evaluate EMF strengths is useful and efficient for evaluating product installation compliance. However, the spherical formula has been basically assumed to be applied to radio sources installed above the ground, therefore suitable computation formulas for underground BS are needed. Fig.1 shows an image of general BS and underground BS.

In order to consider suitable computation formulas for underground BS, the electric field (E-field) distributions around the radio sources installed in the housing constructing an underground BS were computed by the spherical formula and FDTD simulation, and these results were compared. The FDTD calculation prescribed in IEC 62232 as an advanced computation method was used for estimating of E-field distribution. In the FDTD calculation, soil and the like around the housing were also included in the calculation conditions, and the multiple dielectric properties per a material were applied assuming changes in electrical characteristics of materials due to moisture. Fig. 2 shows a result of the comparisons of the E-field distributions using two computation method. The radio source was a half-wave dipole antenna installed 0.1 m below ground level and so that the radiated radio waves are horizontally polarized, the frequency was 1.5-GHz band. The horizontal axis shows the horizontal distance from the radio source along the antenna element. The vertical axis shows the square of the ratio of E-field value by the FDTD calculation to that using the spherical formula. The circles and the triangles show the spatial averaged and peak values using 20 point 0.1 m spacing method of the spatial averaging scheme prescribed in IEC 62232. Each circle and triangle show the maximum value in the values computed by multiple dielectric properties per a material. If the maximum value is greater than one, this indicates that the E-field level around underground BS can be higher than that computed using the spherical formula. Within a horizontal distance of 0.2 m from the radio source, both the spatial averaged and peak values by the spherical formula were not conservative values for those by the FDTD calculation, and the spatial averaged value by FDTD calculation was approximately 3-times higher than that by the spherical formula in the direction above the radio source. Therefore, the suitable computation formulas for underground BS should be considered based on the E-field elevation.

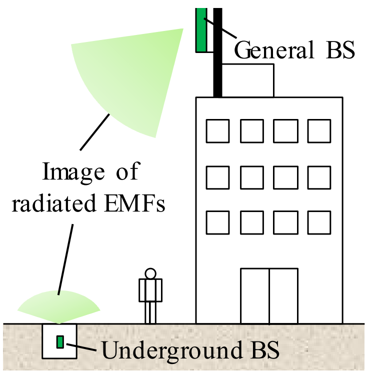

Figure 1. An image of General BS and underground BS.

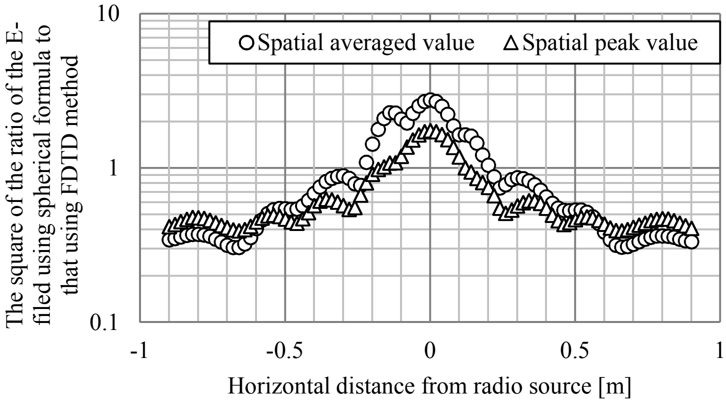

Figure 2. A result of the comparisons of the E-field distributions around underground BS using the spherical formula and FDTD method in the direction along the antenna element.

References

[1] IEC 62232, "Determination of RF field strength, power density and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure," Aug. 2017.