The Analysis of Electromagnetic Field Impact of Mobile Communication Antennas: The Case Study of Lombardy, Italy

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Abstract

The analysis of electromagnetic field of mobile communications antennas is a very widespread method in the technology of telecommunications systems and it is closely connected with the laws in force of E.U regarding impact of these waves on human health. It makes possible the assessment of the field of electromagnetic waves created by cellular antennas. The study in question in this paper deals with a specific case of a project implemented in Bergamo, Italy. In this project, it was made possible, through the program AutoCad and EMLab simulator, the designing of buildings within a radius of 150 m from the tower where the antennas stay and the simulation the electromagnetic waves that penetrate in the building in question. This study treats the case, where current electromagnetic waves penetrate through areas where people stay for more than 4 hours, and where the size of the electromagnetic wave magnitude is bigger than 6V / in conflict with the current EU law on the issue of electromagnetic non-ionizing waves. Once the problem is evidenced, we have given the necessary recommendations to avoid as much as possible the penetration of electromagnetic according the directives mentioned above.

Keywords: antenna, electromagnetic field, simulator, technology, mobile communication, law, non-ionizing, wave
JEL classification: L96

Introduction

The mobile communication systems consist on one of the telecommunications systems and they constitute one of the most important entities in the life of humans. The mobile communications, especially cell phone ones, are realized through the signal transmission antennas which play the role of electromagnetic signal generators, as mediator of these signals or conductors of this signal among antennas and other transmission systems of information "Bruce. et. al. (2001)".

The electromagnetic wave is electric size that has its respective physical properties and in the past 50 years, these waves have been subject of exploitation for different purposes. After a long study of their theoretical and mathematical development of the concept of electromagnetic waves, nowadays they are widely used, mainly for communication between electronic equipments.

On the other hand, the electromagnetic waves have side effects on human health. Electromagnetic waves are divided into non-ionizing and ionizing. The former have a serious impact on human body systems and these side effects come after a relatively short period of exposure to them. "Boashash. Et. al. (1992)"

Electromagnetic waves to broadcast mobile, so those generated by wireless antennas are non-ionizing and practically have side effects but it is impossible to measure empirically the extent of the impact on human health, because it takes a relatively long exposure to them and this time is variable in persons different. "Jackson. et. al. (1991)"

Therefore, the E.U institutes, against non-ionizing radiation, have sets of guidelines that limit the size of the electromagnetic wave in order to avoid as much as possible the risks arising from the emission of these electromagnetic waves necessary balancing the needs of humans to communicate and the exchange of the information. "Ingle. et. al. (2000)" Specifically, according the laws of defending against non-ionizing radiation, the permissible limit of the size of the electromagnetic waves generated by the antennas of mobile communications is 6/m inside buildings and 20V/m outside the buildings, therefore in open environments. "Kak. et. al (1988)" The issue that arises in this paper, has to do with assessing the impact of electromagnetic field generated by a cellular antenna; This study provides current problematic situation of the case in question and then concludes a given alternative solutions as well as recommendations and limitations arising in order to found a trade-off between the need for transmission and side effects mentioned above.

Methodology

The study of the electromagnetic field is carried out in the city of Bergamo, Italy. It is about the installation of a system which is made up of three sectors; for each sector are installed two antennas and the transmission technologies are GSM900, UMTS900, DCS and UMTS2100.The modeles of the antennas are:

- Kathrein 80010202v02 (1934 mm x 259 mm x 99 mm)
- Kathrein 742234v01 (1959 mm x 323 mm x 71 mm)

The height of the antenna is 25 and the height of the electrical center is 25m+1/2*1.934m is 25.967m

After the studying of the environment where the system will be placed the Bergamo city cartography is taken in account and it is passed in the program Autocad; then the area of 200 m radius from the center of the antenna system is selected and we have designed vertically all the buildings that are in this range; this means we have calculated the heights of the buildings and we have designed them in Autocad in order to be subject by the lobbies generated from EMLab simulator;

Then, on 01.27.2017, starting at 15:00 to 16:00 8 measurements are carried out through the respective probe of the electromagnetic field level and the respective values are generated. Below are photos of points where measurements are made.

Figure 1- Point A

Figure 2 - Point B

Figure 3 - Point C

Figure 4 - Point D

Figure 5 - Point E

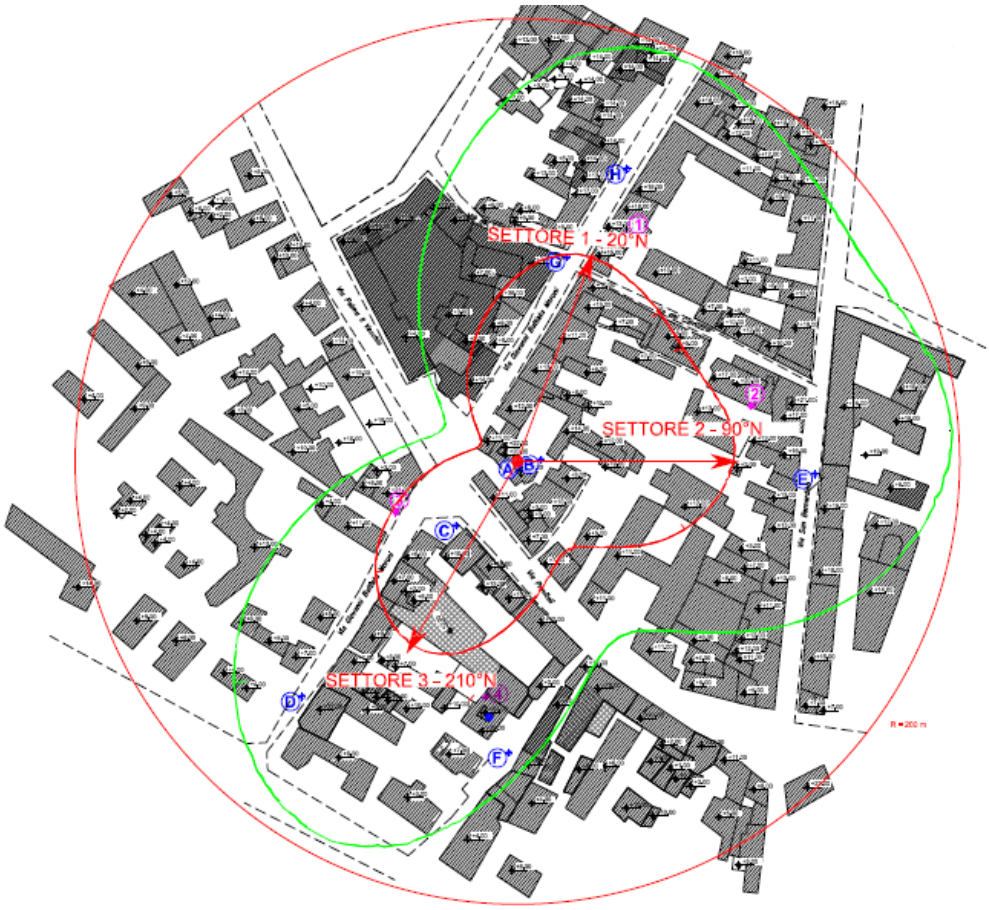
Figure 6 - Point F

Figure 7 - Point G

Figure 8 - Point H

In the photo below we have shown the projections of the buildings for the site. These projections are realized through Autocad.

Figure 9
The projection of the buildings



The results

With the current project, based on the simulations, it was showed that the electromagnetic waves of 6 V/m penetrate the buildings in question; this is unacceptable and a detailed study was needed to reconfigure the systems based on EMLab; the reconfiguration should lead to improving the case in such a manner that the lobby of 6 V/m not faced endangered buildings.

We have made the respective simulations were made for each sector: 20 degree, 90 degree and 210 degree. Due to problems arising from the current situation of the site, the solution given to avoid penetration of electromagnetic waves has consisted in reducing by 2 degrees in electrical tilt for each sector. So, for any electromagnetic wave emitting antenna, according to this solution, having 2 degrees of tilt increased, we have avoidance of the waves on buildings in the area that are exposed to these waves.

Below we have shown the three results of simulations for the relevant sectors.

Figure 10
The results of the simulations for the sector 1

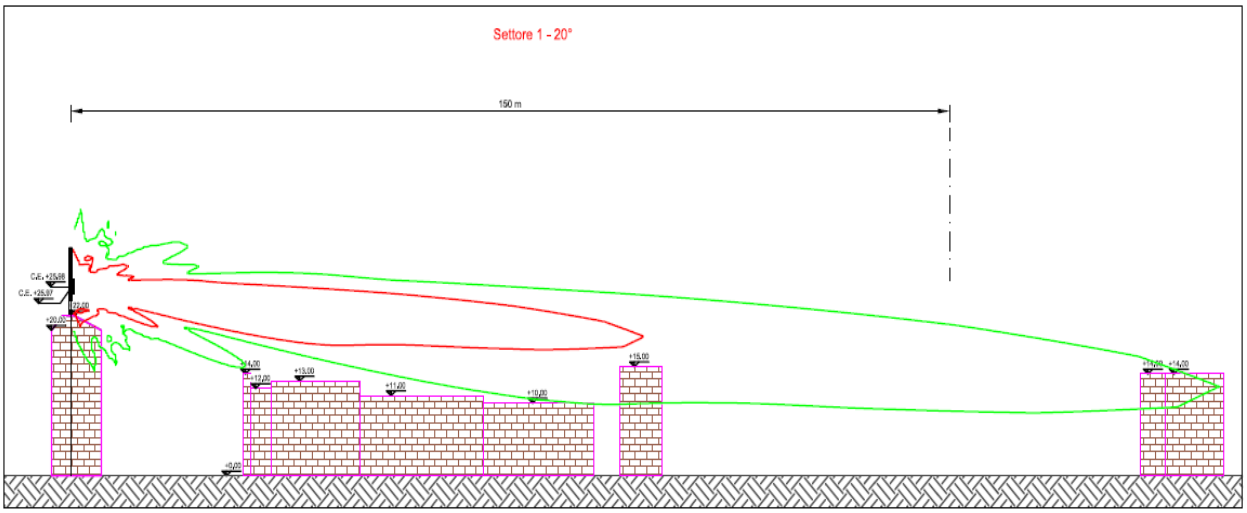


Figure 11
The results of the simulations for the sector 2

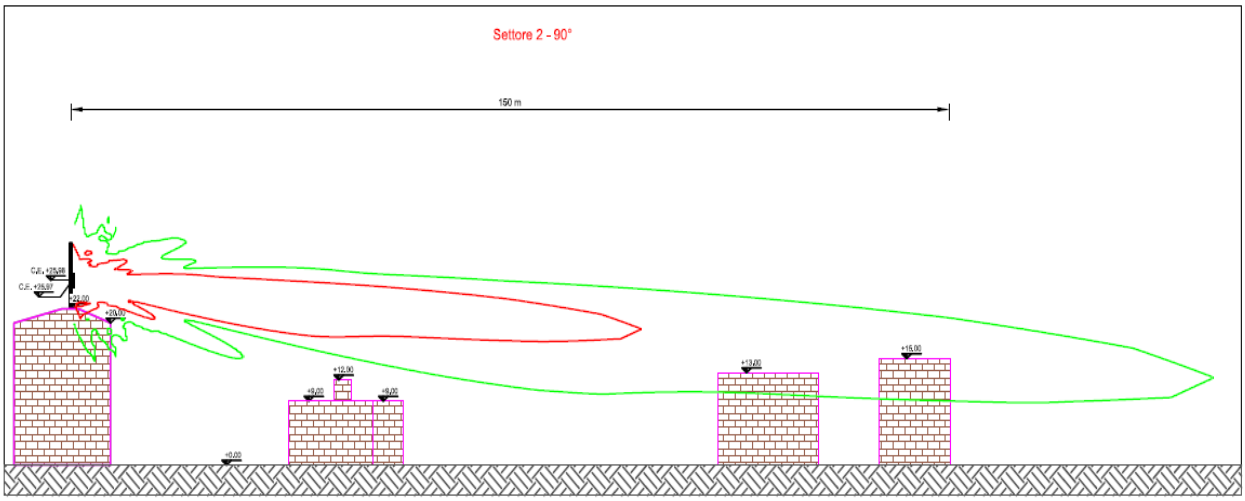
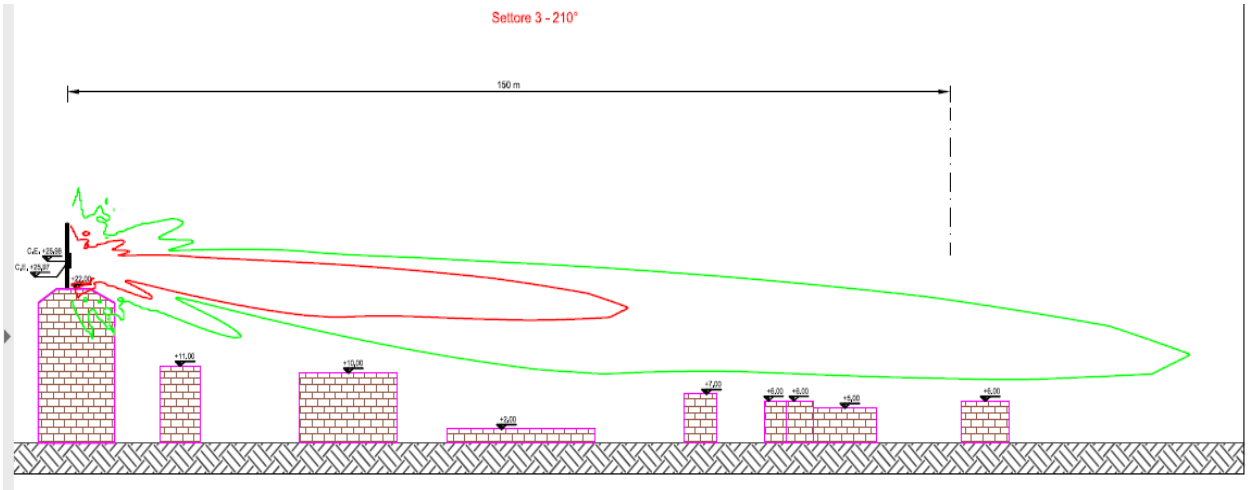


Figure 12
The results of the simulations for the sector 3



Conclusions

In this paper we discussed a case study for the analysis of the electromagnetic field generated from mobile communication antennas in the city of Bergamo, in the region of Lombardy, Italy. "Hyvarinen. et. al. (2001)" The study included a problematic arising as a result of the widespread use of mobile telephony and side effects arising from exposure to electromagnetic waves emitted from mobile antennas. "Shiavi. et. al (1999)". The study consisted of measuring 8 different points near the perimeter of 200 meters from the antennas in question. The measurements were performed by 01.27.2017, starting at 15:00 to 16:00; So, there were 8 points, eight zones where were subject electromagnetic field size measurements through the respective probe." Sonka. et. al. (1993)"

Once these measurements were taken into consideration, all buildings, in the range of 200 m from the center of the antenna, were designed in Autocad and were considered the height of each building. "Akansu. et. al. (1992)" Then the records of these buildings together with the tilt of each sector, the relative height of the antenna, antenna power of each sector and each respective frequency of each technology were included in EMLab simulator to generate the lobbies for each sector. "Strang". et. al. (1997)

From the simulations it was noted that the current situation was problematic; well the lobbies 6 V/m penetrate some of the buildings, which is not permissible. Therefore improve the situation, each electrical tilt for each sector was decreased by 2 degrees. The result of this situation has led to such reconfiguration that the lobby of 6 V/m should not penetrate at the tops of buildings and this is acceptable. "Marple. et. al. (1987)"

The discussions arising from this case study has to do with the alternative solutions about these situations. The usual method is generally a combination of electrical and mechanical tilt reduction and manipulation of the power of the antennas. "Haykin. et. al (1991)";"Boudreaux-Bartels. et. al. (1995)" This approach has resulted in effective although there are cases such that we cannot be perform a complete solution, so, to completely avoid the wave of 6V/m but only minimize it as much as possible. "Hubbard. et. al. (1998)"

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About the authors

Virtyt Lesha is electronics engineer specialized in digital signal processing, automatic control and mobile communications. Part of his experience is the scientific research that consists in publishing 3 monographs in Germany, 10 scientific papers in international conferences in Albania, Montenegro, Croatia, Slovak Republic, Bulgaria, 6 scientific papers in international journals in USA, Germany, United Kingdom, 1 technical report in India and finally 5 abstracts/presentations in Croatia and Albania. Author can be contacted at **virtytl@hotmail.com.**

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