# ESTIMATION OF EARTH ELECTRODE RESISTANCE OF ANTENNA STRUCTURES LOCATED IN NON-HOMOGENOUS GEOGRAPHIC TERRAIN USING FINITE ELEMENT ANALYSIS AND PREDICTIVE MODELLING

S.A.V.D. Subasinghe

(178637L)

Degree of Master of Science

Department of Electrical Engineering

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Thesis/Dissertation submitted in partial fulfilment of the requirements for the degree Master of Science in Electrical Engineering

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# DECLARATION OF THE CANDIDATE & SUPERVISOR

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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S.A.V.D. Subasinghe

1768337L

The above candidate has carried out research for the Masters Dissertation under my supervision.

Signature of the supervisor: Date :

**Dr. Asanka S. Rodrigo**

# DEDICATION

To my beloved parents, my wife & siblings and my workplace assisting co-workers for their endless guidance and support given throughout.

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# ABSTRACT

The telecommunication sector is consisting of firms that facilitates communication on a mass scale, through the phone or the web, as wired or wireless services. These firms created their infrastructure that permits sending voice, audio, or video and kinds of data or information to be sent anyplace in the world. These companies created their infrastructure that allows transmitting voice, audio, or video and forms of information or data to be sent anywhere in the world.

It is observing that the Telecom infrastructure growth is in an aggressive mode even in Sri Lanka due to increase of the user groups and their complex needs for information sharing. As mobile devises become the most attractive device for the customers, operators have to provide these services through higher number of tower structures considering the countries geography and population distribution. With the increasing number of tower constructions and deployment of sensitive equipment with advance features observed due to increasing demand.

The tower is a high-elevated structure in the environment. The typical height of the structure may be around sixty meters and may reach up to hundred meters. The towers act as direct grounding path for lightning strike. Providing a sufficient grounding path to such situation is important to mitigate the hazardous nature to the equipment and the livelihood around the structure. A proper earthing system with low earth resistance shall be recommended avoiding possible hazards by ground potential rise.

Due to the located small land-plots for tower structures, carefully designed earthing network shall be implemented to achieve a lower earth resistance measurement at the tower. Operators have to maintain the earth resistance at tower sites as per the regulator bench marking. Telecommunications Regulatory Commission Sri Lanka (TRCSL) guideline for antenna structures imposed a recommendation to maintain the resistance level below 5 ohms for classified zones.

In order to comply for the guidelines, telecom operators have to deploy optimized earthing networks depending on the tower sites. The tower earthing system consists with copper conductors such as tapes and number of conductive rods to maintain a lower earth resistance value.

Estimation of earth resistance is a complicated practice effected by multiple factors due non-homogeneity of soils. Key observations are the variance in resistivity and resistance readings. At the time of designing, design itself get complex due to parallel conductor formation and its

interconnection conductor's contribution to the results. In order to identify the earth networks effectiveness to surges and lightnings, the site's earth resistance measurement is the main parameter which we can be measured at a site.

This thesis specifically discusses the effects and reasons for directional deviations observed in measured and theatrical values. Site earth resistance measurements have taken along various directions associated with resistive values and assessed with the measurements in four main directions of the sites along the tower legs. Earth networks would be simulated thorough ANSYS Maxwell to achieve earth resistance values. Numerical model will used to represent the resistance value in a single figure. Earthing network profile has been discussed and elaborated in relation calculate the resistance values from the simulation. Validation of the results has been performed through the comparison between simulation results and measurement values.

Analysis has done for various soil types in different geographies in different areas of the Mobitel network and possible limitations for study have been discussed. Thesis concludes with a model to represent the accurate earth resistance for the site. Further includes the general assumptions and the possibilities for the further studies of the model proposed in the thesis.

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# ABBREVIATIONS

| | |
|---|---|
| 3D | - Three Dimensional |
| AC | - Alternative Current |
| ART | - Attached Rod Technique |
| DC | - Direct Current |
| GPR | - Ground Potential Rise |
| TRCSL | - Telecommunication Regularity Commission Sri Lanka |
| EPR | - Earth Potential Rise |
| LPL | - Lightning Protection Level |
| LPS | - Lightning Protection System |
| LV | - Low Voltage |
| MV | - Medium Voltage |
| RBS | - Radio Base Station |
| SPD | - Surge Protective Device |