Potential Characteristics of Single and Group Earthing Devices

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***Abstract* – The paper proposes a model for obtaining the alteration of the potential in the area around a single and a group earthing device in homogeneous and heterogeneous soil, and verification of the adequacy of the model. The aim is to study the possibility of obtaining the potential characteristics of the earthing devices by modelling and their use in the process of earthing equipment design.**

***Keywords* – Earthing Electrode, Potential characterization**

I. Introduction

Main technical protection measure against indirect contact, which can be used separately or in common with other measures is the protective earthing. Requirements for earthing and protection against direct and indirect contact are subject to many legal documents that are constantly evolving and updated. There is a trend for development and improvement of methodologies for the design of earthing systems, including more accurate models of soil, taking into account the natural earthing, underground and above ground infrastructure, use of modern software, increasing the accuracy in determining the values of foot or contact voltages depending on the configuration of the earthing installation. The paper proposes a model for obtaining the alteration of the potential in the area around a single and a group earthing device in homogeneous and heterogeneous soil, and verification of the adequacy of the model. The aim is to study the possibility of obtaining the potential characteristics of the earthing devices by modelling and their use in the process of earthing equipment design

II. Research Model

To find the potential alteration around individual and group earthing devices (potential characteristics) electrostatic task is solved [1, 2].

A model of a single vertical earthing electrode in a homogeneous environment is shown in Fig.1. The following assumptions are made:

• The soil layer around the electrode is homogeneous, with constant specific electrical resistance and dielectric conductivity;

• The electrode has dimensions: length - 1m and diameter of 0, 08 m;

• The electrode is on the ground surface;

• Current flows through the electrode is 10 A.

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The boundary conditions are as follows:

• The potential's alteration around the earthing electrode on the ground surface is given;

• At the other boundary surfaces at a distance of 20 m from the electrode potential is taken as zero, which corresponds to the data practices [3].

Fig. 1 shows equipotential lines around the electrode and Fig. 2. – potential's alteration with distance from the electrode according Fig.1.

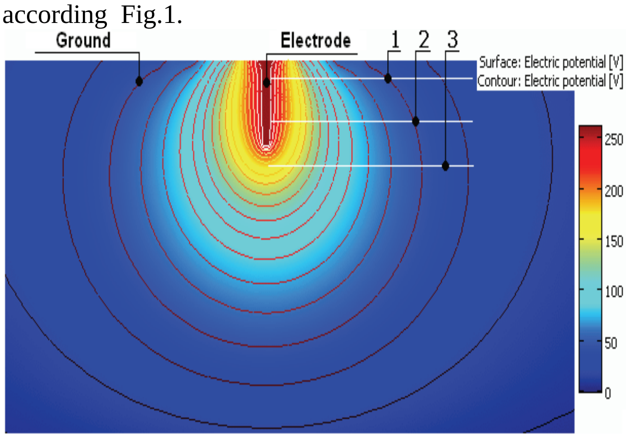

Fig. 1. Model of earthing electrode. Lines 1,2 and 3 – lines of observing potential's alteration

A model of a single vertical earthing electrode, laid on the ground in heterogeneous layer of soil around it is shown in Fig.3, and Fig.4 shows the results obtained in this case. The following assumptions are made:

• The soil layer around the electrode is divided into three layers with different specific electrical resistance and dielectric conductivity, taking into account the real case of moisture in different depth of soil;

• The electrode has dimensions: length - 1m and a diameter of 0,08 m;

• The electrode is on the ground surface;

• Current flows through the electrode is 10 A.

The boundary conditions are the same as in the first case.

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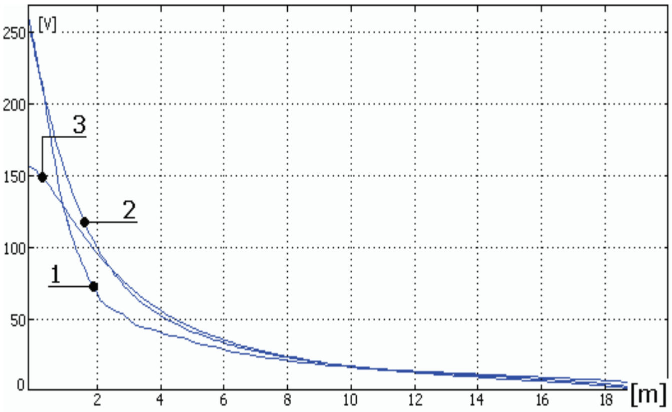

Fig. 2. Potential’s alteration. 1,2 and 3 are according to Fig.1.

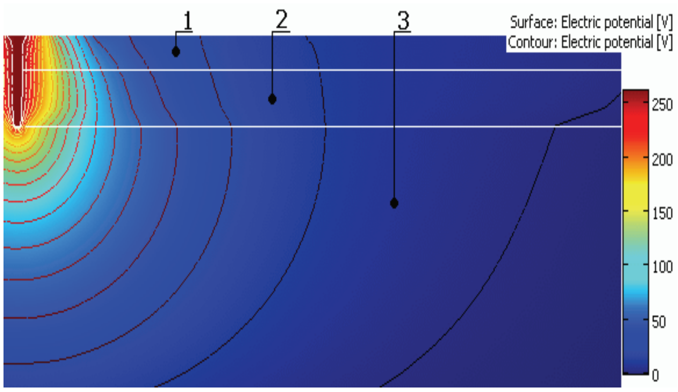

Fig. 3. The field in the heterogeneous soil
1 – wet soil ε=25; 2 – moist soil ε = 14; 3 – dry soil ε = 5

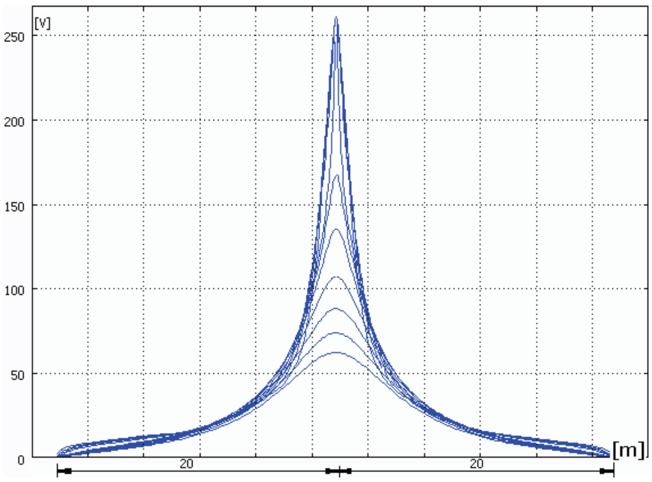

Fig. 4: Alteration of the potential around vertical earthing electrode

Fig.5. shows a model of earthing group of two single vertical electrodes placed on the land surface in the homogeneous soil layer around and Fig.6- the results obtained in this case. Assumptions, dimensions and boundary conditions are as in the first model.

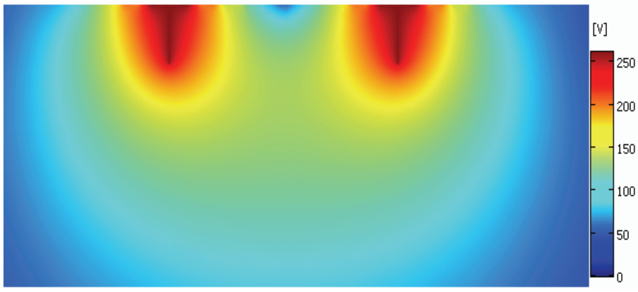

Fig. 5. The field around two electrodes

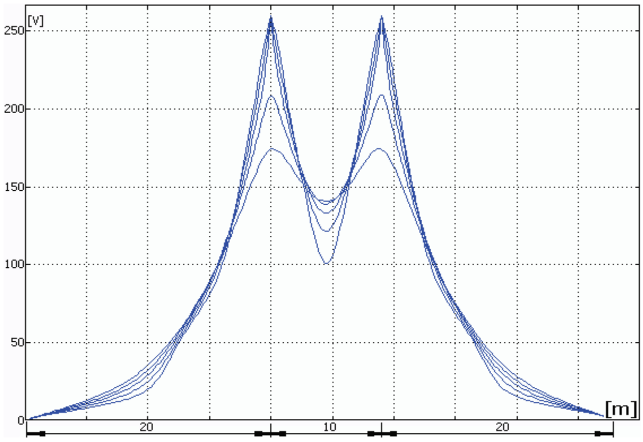

Fig. 6. Alteration of the potential between and out of two electrodes

III. CONCLUSIONS

The received results from modeling were compared with calculation results obtained using known in the bibliography and well known formulas for potential characteristics. They are mainly applicable for single earthing rods. The potential characteristics for group earthing device can be obtained graphically using the individual electrode’s potential characteristic. The advantage of using modeling to obtain potential characteristic is primarily related to the ability to obtain the characteristics of grounding group comfortably, quickly, in graphic form and accuracy, corresponding to the theoretical calculations.

Other direction, which can be claimed advantage of models, is related to heterogeneity of a soil. Offer complex theoretical dependencies it mostly for double-layer model of soil. Considerably more complex studies of heterogeneous soils with different distribution of layers around the earthing rods can be made using models.

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