11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

NUMERICAL SIMULATION OF GROUNDING SYSTEMS FOR COMPACT UNDERGROUND ELECTRICAL SUBSTATIONS BY MEANS OF A BEM FORMULATION

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Key words: *Grounding systems, Compact underground substations, Ground Potential Rise, Numerical methods, BEM*

The design of grounding systems in electrical substations is a crucial aspect to obtain an adequate performance of the installation and safety conditions. Suitable designs of grounding systems allow to improve the power supply, to protect the equipment and to keep human safety on the surrounding areas when fault currents occur (GPR) [1]. These grounding systems are specially important when the electrical substations are located in urban areas or very close to urban areas, which is the usual practice since a few decades ago. Traditional designs of large electrical substations, usually stated on the earth surface and occupying large areas, are no longer installed in urban locations due to economical and environmental considerations among others. Thus, traditional designs are nowadays replaced by compact underground substations made of reinforced concrete and buried under streets, parks and other public spaces in urban areas.

The design of grounding systems for traditional substations is well known and has been widely studied [2, 3, 4]. The new compact underground designs also require grounding systems to avoid damage when fault currents occur. These new designs require more complex models to analyze the electrical dissipation problem due to the use of multiple materials with different electrical properties (concrete, steel of the reinforced concrete and natural soil) and much more complex geometries. Furthermore, it is important to consider that these substations are buried in urban areas (parks, streets). Thus, access to these spaces can not be restricted, while in traditional substations it is restricted. In addition, it is also quite frequent to find in the surroundings of these substations other different installations like metallic pipes or rails that may affect considerably the current dissipation phenomena and may produce hazards to people in unexpected places far from the installation. Consequently, the study of the electrical current dissipation problem in the grounding systems of compact underground substations is even more critical and more complex than in the traditional ones.

In this work the authors propose a numerical model based on the Boundary Element Method that allows to analyze the grounding systems of compact underground substations under different locations and considerations. The proposed formulation allows to consider most of the specific properties and conditions of this kind of substations: complex geometry, different material properties and different grounding grid configurations. Finally, grounding systems of real compact underground substations have been analyzed as application examples.

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