[打印本页]　[关闭]

高电压技术

任意块状结构土壤中接地的边界元法分析

张曾,文习山

武汉大学 电气工程学院，湖北省 武汉市 430072

摘要：

为计算分析任意块状结构土壤中的接地问题，根据边界元法基本原理，给出了一种通用算法,详细介绍了该算法的原理和计算公式。该算法以边界面元的电位和导体元的电位梯度为未知数，列写并解线性方程组，进而得到各接地参数。运用Matlab编程计算简单块状结构土壤接地模型，与CDEGS软件计算结果的比较表明了该方法的正确性。针对实际中经常出现的高台模型，给出了通用算法的计算结果，并对高台模型增加垂直接地极以减小接地电阻进行了计算分析。算例计算结果表明，该算法计算速度较快，可用于任意块状结构土壤中任意接地模型的计算分析。

关键词：

Boundary Element Analysis on Grounding Systems in Soil With Arbitrary Massive Texture

ZHANG Zeng ,WEN Xishan

School of Electrical Engineering, Wuhan University, Wuhan 430072, Hubei Province, China

Abstract:

To calculate and analyze the grounding system in the soil with arbitrary massive texture, according to the principle of boundary element analysis a general algorithm is proposed and the principle as well as calculation formulae of the proposed algorithm are presented in detail. In the proposed algorithm, the potentials of boundary surface elements and the potential gradients of conductor element are unknown numbers, the linear equations are listed and solved by the given algorithm to attain all parameters of grounding system. By use of Matlab, a simple grounding system in the soil with massive texture model is modeled and calculated, and the comparison of the calculated result with that by CDEGS software shows that the biggest relative error of the grounding resistance is 1.266% and the average error of the surface potential is 4.278%, thus the proposed method is correct. In allusion to the model of hathpace that often appears in practice, the calculation results by general algorithm are given and the occasion of adding vertical grounding electrodes to hathpace model to reduce grounding resistance is analyzed and calculated. Results of calculation examples show that the proposed method possesses higher calculation efficiency and can be applied in the calculation and analysis of arbitrary grounding models in the soil with arbitrary massive texture.

Keywords:

通讯作者: 张曾

作者简介:
作者Email: zhangzeng328@126.com

参考文献：

[1] 李俊峰，陶留海，陈方东．1000kV特高压线路接地模块的选型原则与施工关键研究[J]．电网技术，2008，32(23)：5-10． Li Junfeng，Tao Liuhai，Chen Fangdong．Principle of grounding module selection for 1000kV transmission line and key problems[J]．Power System Technology，2008，32(23)：5-10(in Chinese)． [2] 郭剑，朱艺颖．直流输电系统共用接地极的暂态接地性能分析[J]．电网技术，2008，32(24)：50-53． Guo Jian，Zhu Yiying．Analysis on transient grounding performance of common grounding

electrodes in HVDC system[J]. Power System Technology，2008，32(24)：50-53(in Chinese). [3] 景展，余华武. 变电站微机装置接地的电磁兼容性能设计[J]. 电网技术，2010，34(6)：54-58. Jing Zhan，Yu Huawu. Electromagnetic compatibility design of grounding for microcomputer-based devices in substations[J]. Power System Technology，2010，34(6)：54-58(in Chinese). [4] 钟建灵，王晶晶，张波，等. 基于夹角法的城市变电站接地电阻测量[J]. 电网技术，2010，34(6)：40-43. Zhong Jianling，Wang Jingjing，Zhang Bo，et al. Grounding resistance measurement by angle-offset method for urban substations[J]. Power System Technology，2010，34(6)：40-43(in Chinese). [5] 谢广润. 电力系统接地技术[M]. 北京：中国电力出版社，1991：3-21. [6] 何金良，曾嵘. 电力系统接地技术[M]. 北京：科学出版社，2007：130-134. [7] 杨德全，赵忠生. 边界元理论及应用[M]. 北京：北京理工大学出版社，2002：1-109. [8] 陈慈萱. 边界元法在接地计算中的应用：发变电站地网接地电阻的计算[J]. 高电压技术，1984，10(2)：25-29. Chen Cixuan. Application of the BEM for calculation of the grounding：calculation of the grounding resistance of the grounding grid of the substations[J]. High Voltage Engineering，1984，10(2)：25-29(in Chinese). [9] 戴传友，文习山，方瑜. 垂直多层土壤接地电阻的计算[J]. 高电压技术，1996，22(3)：47-49. Dai Chuanyou，Wen Xishan，Fang Yu. Computation of grounding resistance of grounding grids in a vertical-layer earth structure [J]. High Voltage Engineering，1996，22(3)：47-49(in Chinese). [10] 蒋俊，文习山. 块状结构土壤中的接地系统分析[J]. 湖北电力，2006，30(3)：50-52. Jiang Jun，Wen Xishan. Analysis for grounding systems buried in soils with massive texture[J]. Hubei Electric Power，2006，30(3)：50-52(in Chinese). [11] Ma Jinxi，Dawalibi F P. Analysis of grounding systems in soils with finite volunes of different resistivities[J]. EEE Trans on Power Delivery，2002，17(4)：594-602. [12] 赵志斌，崔翔，张波，等. 多层土壤中含有不同电阻率块状媒质时的接地网分析[J]. 中国电机工程学报，2004，24(9)：218-223. Zhao Zhibin，Cui Xiang，Zhang Bo，et al. Analysis of grounding systems in multi-layer soil with finite volumes of different resistivities [J]. Proceedings of the CSEE，2004，24(9)：218-223(in Chinese). [13] 彭向阳，文习山，陈慈萱. 大型水电站接地网接地电阻的初步计算[J]. 中国电力，1997，30(7)：10-13. Peng Xiangyang，Wen Xishan，Chen Cixuan. Calculation of resistance of grounding grids in large-scale hydropower station[J]. Electric Power，1997，30(7)：10-13(in Chinese). [14] 王坚强，彭岳林，杨文宾. 垂直层状介质中接地网接地参数的计算[J]. 电网技术，1995，19(12)：27-33. Wang Jianqiang，Peng Yuelin，Yang Wenbin. The parameter calculation of grounding nets in vertical medium demarcation [J]. Power System Technology，1995，19(12)：27-33(in Chinese). [15] 彭岳林，王坚强. 边界元法在基础接地中的应用[J]. 高电压技术，1995，21(3)：79-82. Peng Yuelin，Wang Jianqiang. Application of BEM in foundation earth field[J]. High Voltage Engineering，1995，21(3)：79-82(in Chinese). [16] 王坚强，杨文宾. 边界元法在均匀介质复合接地网接地参数计算中的应用[J]. 湖南电力技术，1994(4)：40-44. Wang Jianqiang，Yang Wenbin. Application of the BEM for calculation of the grounding parameters of the complex grounding grid in uniform medium[J]. Hunan Electric Power，1994(4)：40-44(in Chinese). [17] 李俊. 关于变电站接地降阻措施的应用分析[J]. 湖北电力，2006，30(增刊)：20-22. Li Jun. Application analysis about the messures for reducing the grounding resistance of substation[J]. Hubei Electric Power，2006，30(Supplement)：20-22(in Chinese). [18] 李佳林. 变电站接地网的降阻方法分析[J]. 电气安全，2008，27(13)：49-50. Li Jialin. Analysis of the methods for reducing the grounding resistance of substation[J]. Electircal Safety，2008，27(13)：49-50(in Chinese). [19] 郑志煜，杜忠东，何平. 垂直接地体对大中型接地网降阻的计算[J]. 高电压技术，2003，29(7)：19-21. Zheng Zhiyu，Du Zhongdong，He Ping. Study on resistance reducing of large ground grid using vertical grounding electrodes[J]. High Voltage Engineering，2003，29(7)：19-21(in Chinese). [20] 王洪泽，杨丹，王梦云. 电力系统接地技术手册[M]. 北京：中国电力出版社，2007：201-203.

本刊中的类似文章