Categorizing Different Insulators With Respect to Withstand Voltage Under Same Environmental Conditions

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Abstract— **Dielectric properties of insulators changes with respect to the variation in voltage ap-plied Insulating material plays its very important role as its selection is considered ,important design parameter, in order to maximize its robustness, withstand maximum potential capacity during different environmental conditions. In this paper simulations are performed with a voltage of 11kV being applied on insulators in order to identify good insulating material with maximum withstands voltage capacity. It has been found that glass insulator has good dielectric strength in terms of high withstand voltage capacity during instantaneous light flashovers and certain overvoltage conditions. It is proposed that glass insulators can be used in trans-mission system as a robust insulator in worst weather conditions because of its reliability of withstand voltage for pro-long period.**

Keywords— Withstand Voltage, Insulating materials, ceramic insulators, glass insulators, dielectric property,

I. Introduction

Insulators are main part of the transmission and distribution lines and act as a vital elements in the power system to give protection against high voltage and high cur-rent[1]. It gives electrical insulation and mechanical support to tower in overhead transmission lines [2]. Insulators have ability to insulate the power as well as their function is to carry weight of conductors [3]. Conductors must not have less than 1 centimeter of diameter. Insula-tors are basically divided in two main types namely tension insulators and suspension. Usually suspension insulators are employed to support conductor in vertical direction and tension insulators are used to support conductors in horizontal direction[2].The conductors are suspended with the insulators at very low end where-as the other end of the conductor is secured with the cross-arm of the tower [5]. Requirements of good insulator consist of handiness and dependableness as well as economic aspects is also to be paid attention in order to optimize power system with the high magnitude of coefficients of [6]. The very reason of insulator is to employee an apparatus to provide isolation between zero potential and non-zero potential part[7]. The insulating materials are consists of glass, ceramic and rubber with some associated benefits and drawbacks. Suspension insulator usually consists of many discs, while each disc is used to for insulation of 11kV. A characteristic of polluted surface insulators varies with insulating material [5]. However, wind and rain clean the insulators occasionally. The polluted lower area of insulator depends on how the insulator profile is design [6].

High voltage and high current can affect the capacity of insulator regarding it with-stand performance for high voltage and high current [9].When firstly transmission lines is started the major problems for the insulators were at coastal and industrial areas[8] .The second problems is voltage and electric field distribution are not equally distributed on the insulators. Highly electric field and voltage distribution give easy way for the corona, limited discharge, early aging and flashover [10]. These problems give serious hurdles for proper distribution of the power. Therefore this is very important to calculate the electric field distribution and voltage in and around insulator for the improve quality and long lasting of the insulator time [9].

The change of voltage and electric field distribution give information about insulator condition. Various software that based on mathematical methods which calculate the e-field and voltage .There are some traditional methods of integral equations which are adopted to find effects on the upper thin layer with different conductivities on upper layer of insulation[8].

ISSN 2229-5518

II. MODELING

This paper is based on the software simulation based performance evaluation of the insulator under high voltage conditions. The tests are performed for 11k V insulators of fiber, glass and ceramic materials. These insulators are tested with A.C to analyze the performance for the withstand voltage [10]. In this paper insulator has been divided into three regions A_1 which is grounded, second is insulators which A_2 and last is region is high voltage A3 .The consideration is only for A_2 area .We did simulation of design of 3D in quick field software. Insulator is shown in Figure 1 below.

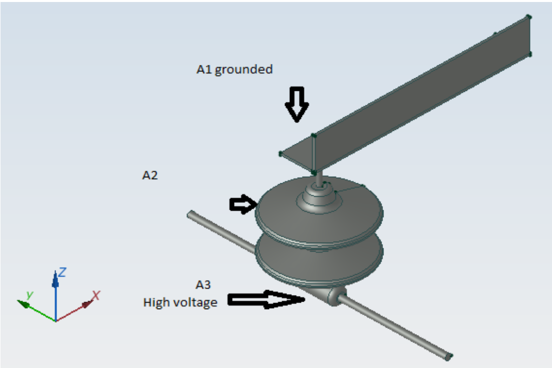


Figure 1: model of insulator

This insulator has been design from differ-ent material which are glass ,ceramic and fiber .The applied voltage is 11Kv , in which we are finding electric field and voltage distribution. The change of volt-age and electric field distribution give in-formation about insulator condition. Vari-ous software that based on mathematical methods which calculate the e-field and voltage[11].There are some traditional method of integral equations adopt to find effects on the upper thin layer with differ-ent conductivities on upper layer of insula-tion. In this paper we used suspension in-sulator for different material with respect its permittivity. The quick field profes-sional software is used for the simulation , which gives graphical values of e-field and voltages. This analysis is simplify e-field distribution caused by some voltage ap-plied which is time harmonic base. Combination of the gauss's equation(1),current continuity equation(2) and ohm's law(3) are applied in this analysis which are given below[12].

$$\nabla\cdot\varepsilon\, E=\rho \ldots\ldots\ldots\ldots(1)$$
$$\nabla\ .J=-\ (\delta\rho)/(\delta t) \ldots\ldots\ldots(2)$$
$$J=\sigma\, E \ldots\ldots\ldots(3)$$

Where

p Is Electric Charge Density (C/m3),
ε Is Dielectric Constant Of Material
σ Is Electric Conductivity Of Material
J Is Current Density (A/m2)
ε Is Electric Field Strength(V/m).

$$\varepsilon = \varepsilon r.\ \varepsilon o \ldots\ldots\ldots\ldots(4)$$

The simulation is modelled in free area .Where the potential is applied 11kv to the insulator pin and lower end is grounded .The other thing like structures, conductors etc. are neglected in this paper.

III. RESULT

The electric field and voltage distribution are gradually decreasing from area A_3 of insulator to area A_1 of insulator which illustrated in figure 2 and 3. But e-field and voltage distribution is high inside insulator of glass ceramic and fibre which followed by nearby material. Here in Fig. 2 voltage distribution very sharply decrease from 11kV to 7.7kV. Meanwhile the voltage distribution gradually decreases in the range 11kV to 5.5K.V graphs of different insulating material is studies for voltage and e-field distribution . In Fig. 3. voltage distribution of glass is increased at 3.690Kv so it is its breakdown voltage and it also shows that at this region insulator surface is more conductive.

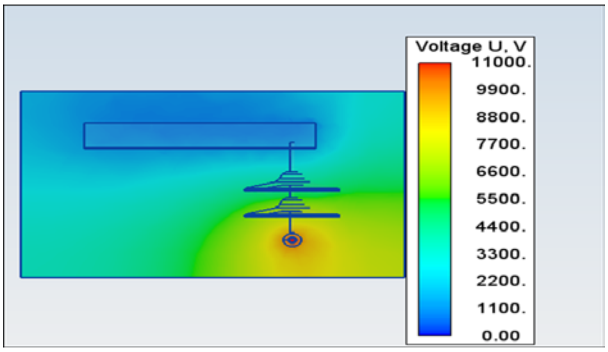


Figure 2: voltage distribution

This means that voltage distribution is converted into more resistive nature . Figure 3 also shows that its linearly increase from 3.480Kv to 3.690Kv and then gradually decrease mean breakdown start to 3.480Kv. The electric field distribution graph shown in Figure.4. which shows high electric field distribution of glass at upper region which is 46.900Kv/m. So at this point high electric field strength increase up to 46.900Kv/m. The voltage and electric field distribution of ceramic insulator which electric permittivity is 20 is shown in Figure 5 and6.

In Figure.5 voltage are linearly increase from 3.3kV to 3.425kV so the 3.425kV is its breakdown voltage. So the linearly distribution of voltage from 3.3kV to 3.42kV. The electric field distribution graph shown in Figure.6 which shows that high electric field strength obtained at 42.450Kv/m. It is due to manufacture imperfection. The e-field strength increasing in zigzag type at 42.450Kv/m and then decrease very sharply up to 40.Kv/m.

The voltage and electric field distribution of fiber insulator ,which its electric permittivity 10, is shown in Figure 7 and 8. Graphs shows voltage and e-field distribution .The voltage distribution seems linearly increase to 3.565Kv at this area insulator is more conductive than other area. Electric field is 44.700Kv/m at peak. And then suddenly drop at 40Kv/m. Then it increase and decrease in zig zag manner. . and decrease in zig zag manner.

IV. CONCLUSION

By applying voltage of 11Kv it is concluded that voltage and e-electric field distribution of glass ,ceramic and fiber insulator using quick field software is conducted. Suspensions insulator having middle area is main region of consideration. This paper compares different material of insulator showing effect the voltage and electric field distribution. Thickness of material shows breakdown voltage. Minimum voltage require to some area of insulator become conductive .The breakdown voltage of glass ,ceramic and fiber is respectively from the graphs 3.685kV, 3.42kV and 3.565kV among the three insulators minimum voltage is 3.425kV which is ceramic. So breakdown voltage of ceramic is 3.425kV. Electric field distribution are different for different insulators highest electric field distribution is of glass which is 44.700Kv/m .

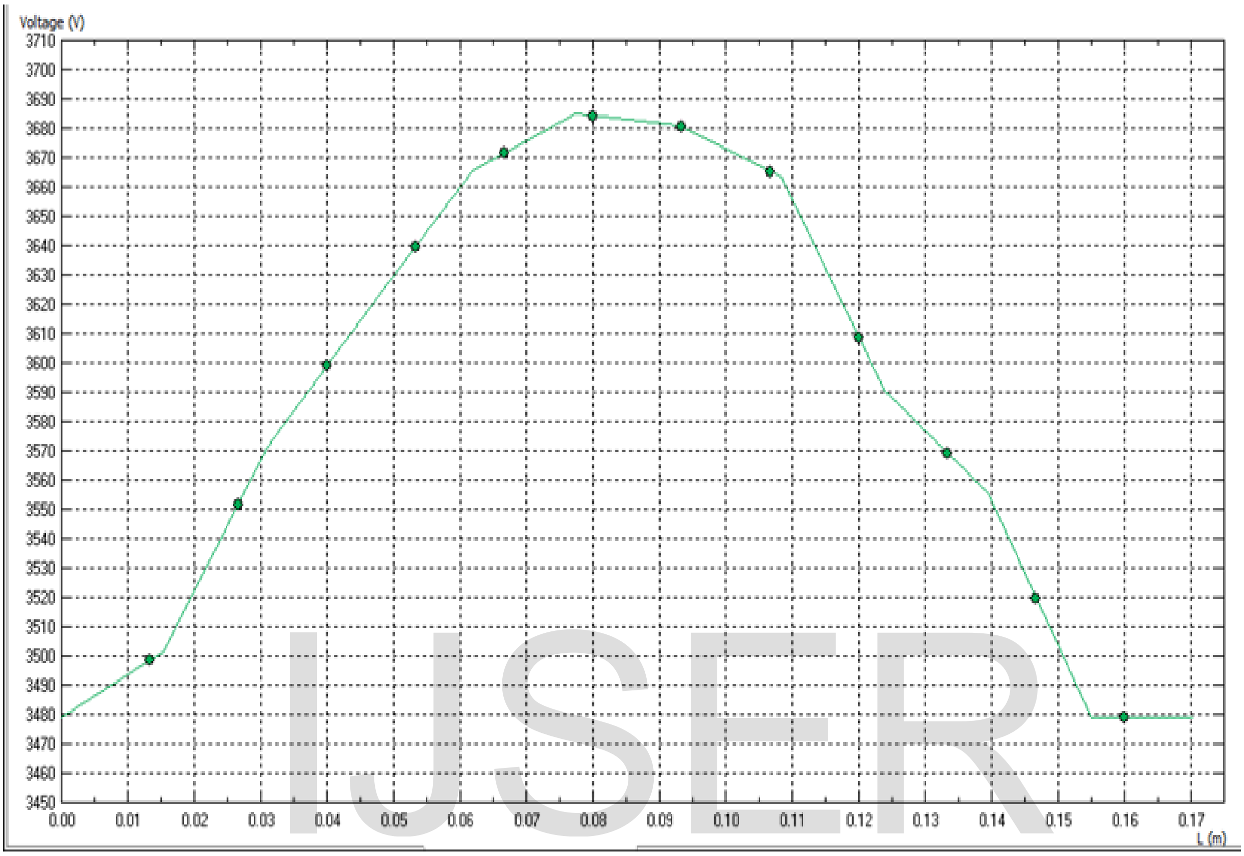
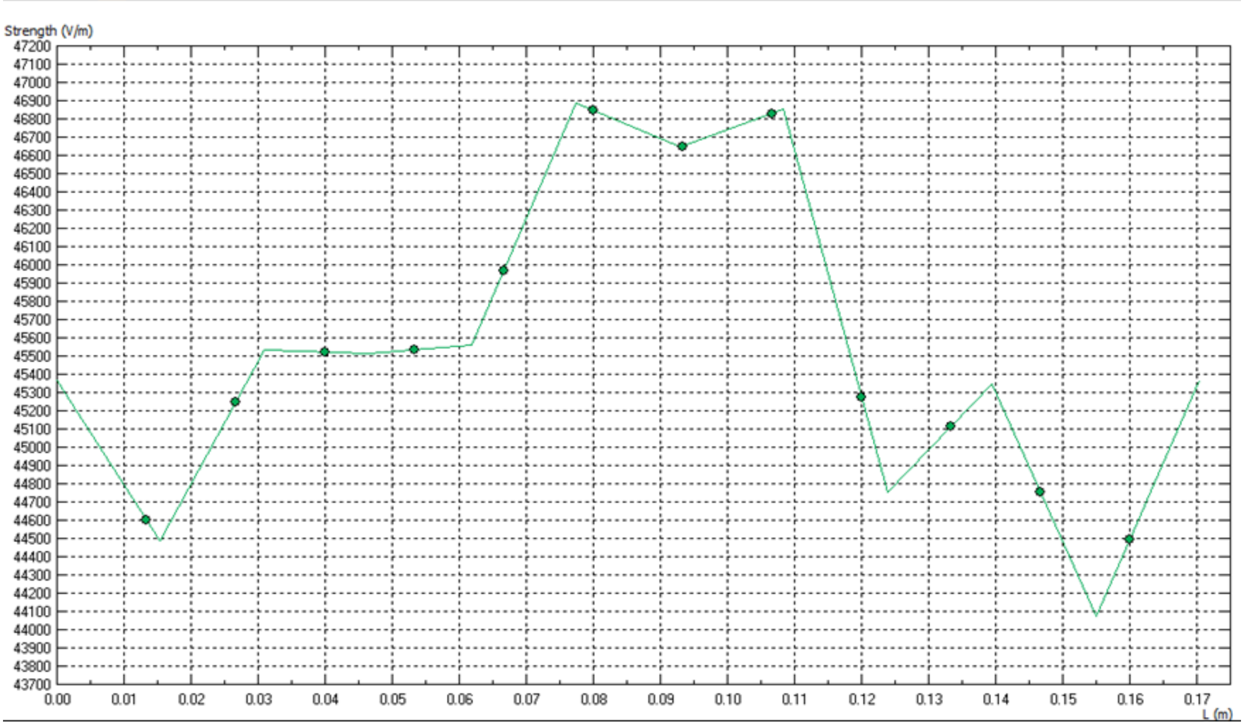


Figure 3. of voltage distribution glass insulator



ISSN 2229-5518

Figure 4. Electric field distribution glass insulator

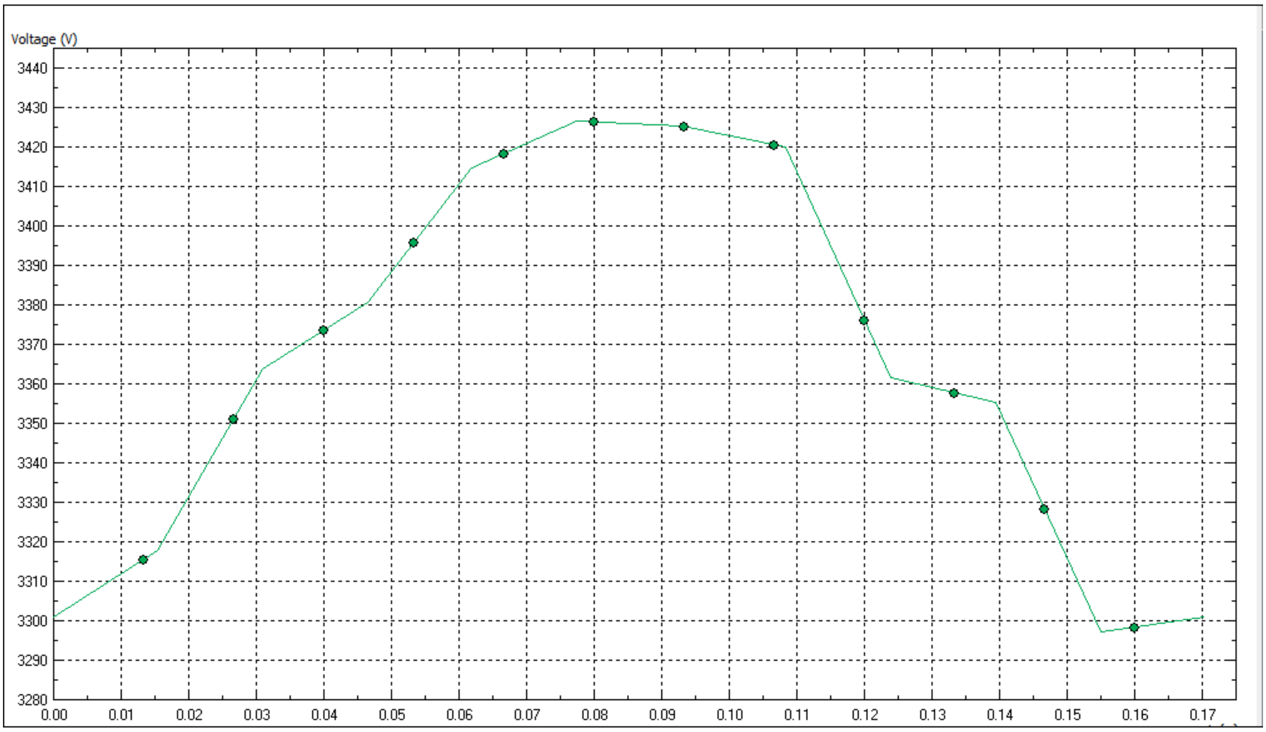


Figure 5. of voltage distribution ceramic insulator

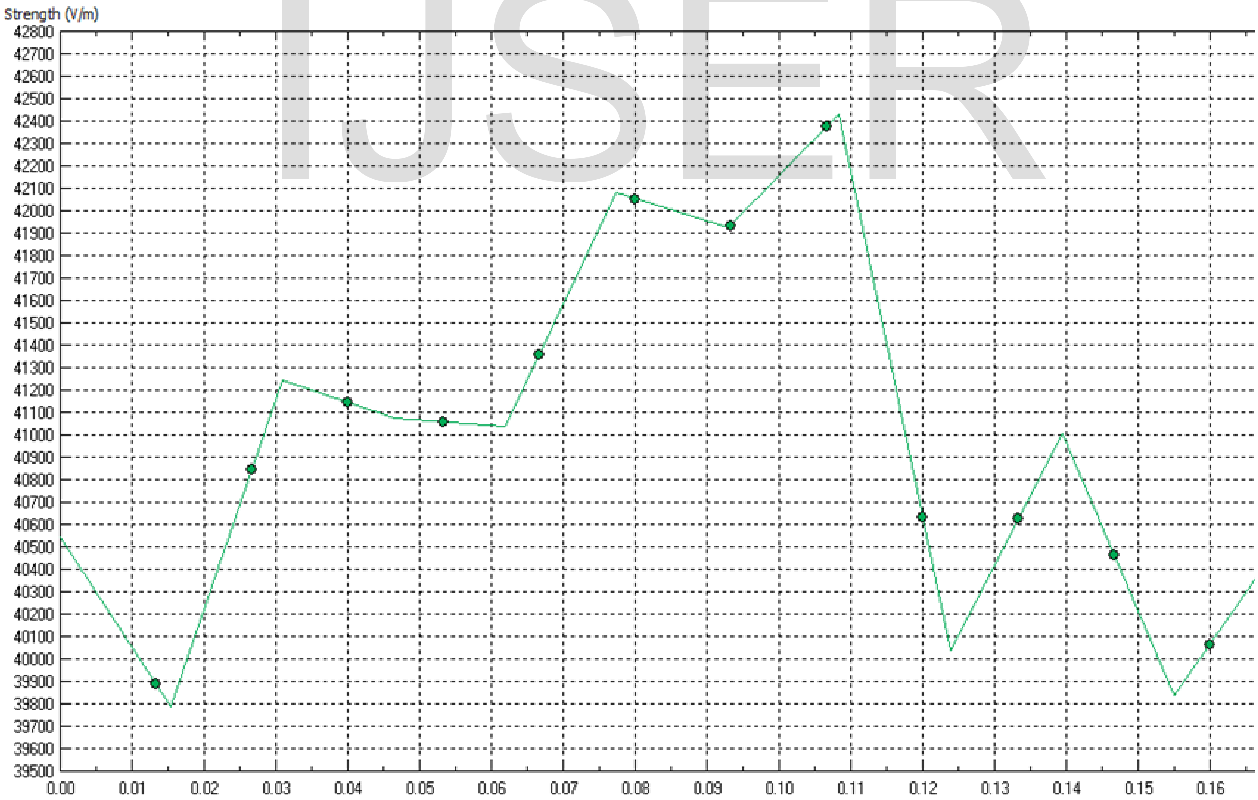


Figure 6. Electric field distribution ceramic insulator.

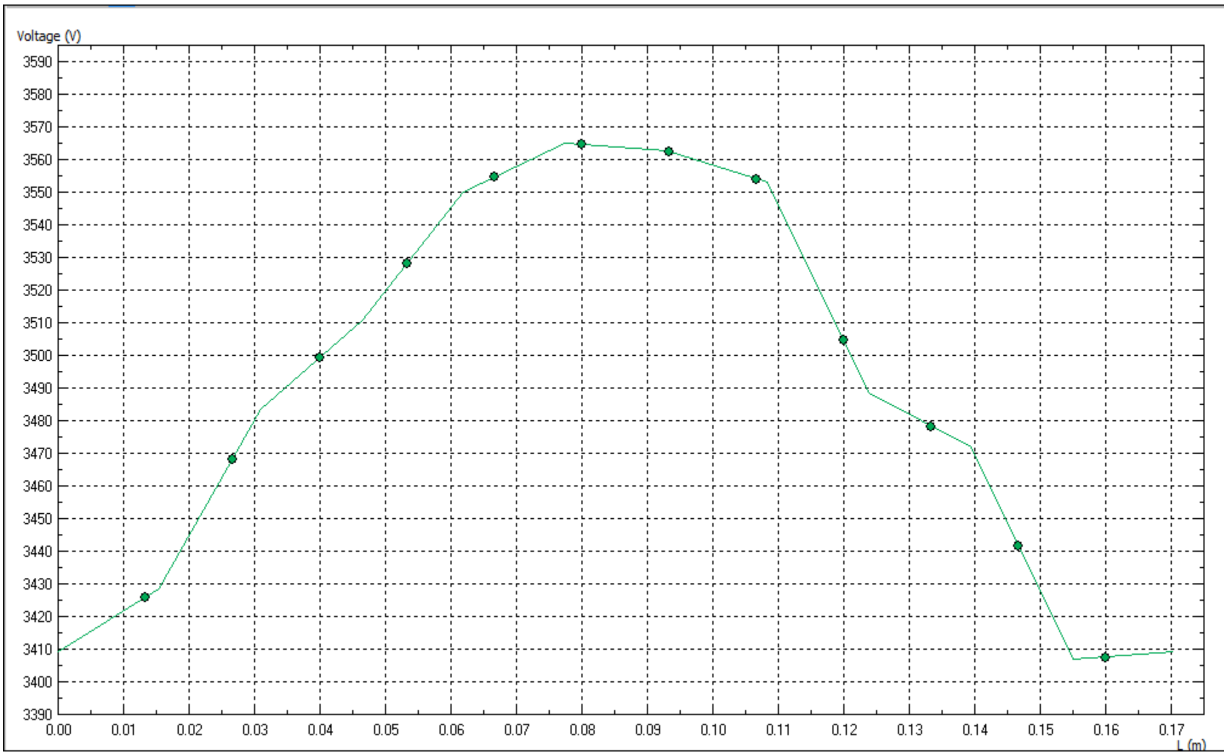


Figure 7 voltage distribution fiber insulator

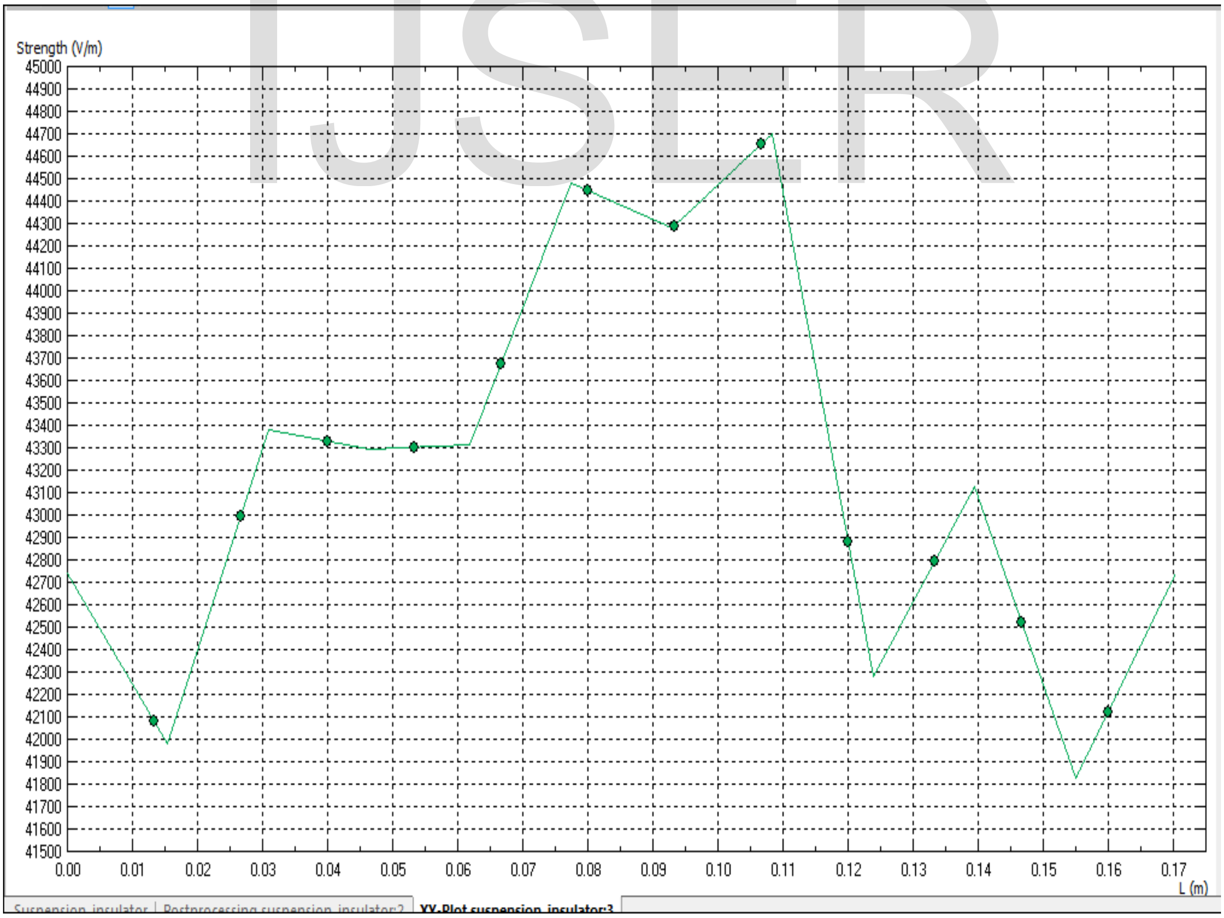


Figure.8: electric field distribution ceramic insulator

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