Electric Field Analysis and Impact Study with Shrubbery on the 11 kV Distribution System fed by a 132 kV/220 kV Transmission Feeder

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Abstract - *In this paper impact of vegetation growth in rural distribution net networks is studied in FEM-2D software. The impact of vegetation growth, along with the Transmission & The model, utilizes parameters of an 11kV, three-phase distribution feeder, PCC poles, metallic cross-arms, and 160kN pin insulators. A pole span of 100 meters is considered for subject simulation. In this paper, a second case scenario regarding the Electric field analysis on 132kv transmission line tower and 220kv transmission line tower is studied in FEM-2D software. The FEM-based simulation and study indicate an increase in electrical field stresses for vegetation in the vicinity of the line.*

Key Words: Vegetation, Pin Insulator, Polymeric Insulator 132 kV Transmission Tower, 220kV Transmission Tower, FEM (Finite Element Method).

1. INTRODUCTION:

In the latest days, there has been a significant increase in the electricity demand. To fulfill this demand, switchgear, transmission, and distribution networks must be done more efficiently. The effectiveness of any system is primarily determined by the continuity of service while avoiding faults. The performance and properties of insulators must be good to ensure continuity. Ceramic insulators have long been utilized in power transmission and distribution systems. In nowadays ceramic insulator has been slowly replaced by composite insulator in power grid nowadays. However, flashover fault still occurs on this insulator type. Under certain conditions, partial discharges may occur on the insulator and lead to a complete flashover. The flashover can cause a breakdown and damage the whole power system. Compared to porcelain suspension insulators, composite insulators have many advantages, such as being lightweight, higher mechanical strength to weight ratio, higher resistance to vandalism, better performance in the presence of heavy pollution in wet conditions and better withstand voltage. Therefore, outdoor composite insulators are now preferable and widely used in maintaining the reliability of the power system. With the increase of demand and the use of composite insulators, factors of the occurrence of the fault have drawn wider attention.

Transmission and distribution of power are accomplished using overhead lines and UG Cables. In OH lines, metallic and non-metallic structures are used for supporting insulation (string or pin insulators) and the conductors. For capital costs involved, the use of strong metallic structures is restricted to high and ultra-high voltage transmission systems. Whereas, for most, medium voltage power distribution systems wooden, cement structures, or poles are recommended. It is worth noting that both wooden and cement poles not only provide requisite mechanical support, they also minimize charge leakage from the conductor, for their higher specific resistance. In the case of T&D systems, this neighborhood rendered by the metallic tower/ pole structure, the guard wire, and most importantly by the vegetation and creepers in the vicinity of T&D systems.

This project, model utilizes parameters of an 11kV, three-phase distribution feeder, PCC poles, metallic cross-arms, and, 160kN pin insulators. A pole span of 100 meters is considered for subject simulation. The simulation is carried out using the FEM model for an 11kV, 3-φ distribution feeder, PCC poles, metallic cross arms, and 160kN pin insulators. A pole span of 100 meters is considered for subject simulation for four different configurations. The power losses are aggregated for a line length of 10km [1]. In this paper, a second case scenario regarding the Electric field analysis on 132kv transmission line tower and 220kv transmission line tower is studied in FEM-2D software [2]-[3]. The FEM-based simulation and study indicate an increase in electrical field stresses for vegetation in the vicinity of the line.[1]

2. IMPACT OF VEGETATION GROWTH IN 11KV DISTRIBUTION NETWORK:

The analysis has been carried out using FEMM software. FEMM is a FEFEM-based simulation tool. The distribution system chosen is a rural section fed by a 33/11kV Shanthi Nagar substation in the Kakinada district of Andhra Pradesh State, India. The section consists of cement poles and cross-arms, the AutoCAD design is shown in Figure.1. Vegetation like trees, bushes, and creepers are found to grow during rainy seasons. The growth if abundant can reach alarming heights endangering short circuits. Such developments are modeled and resulting variations in electric field intensities, effective line capacity, once, and leakage current are studied. The results are compared with the standard line without such intrusion. The power and energy losses and additional line loading are determined and shown as the additional burden on distribution utility [1].

TABLE 1: Dimension of Electric pole

S.no	Particulars	Length(mm)
1.	Electric pole height	12500
2.	Width	300

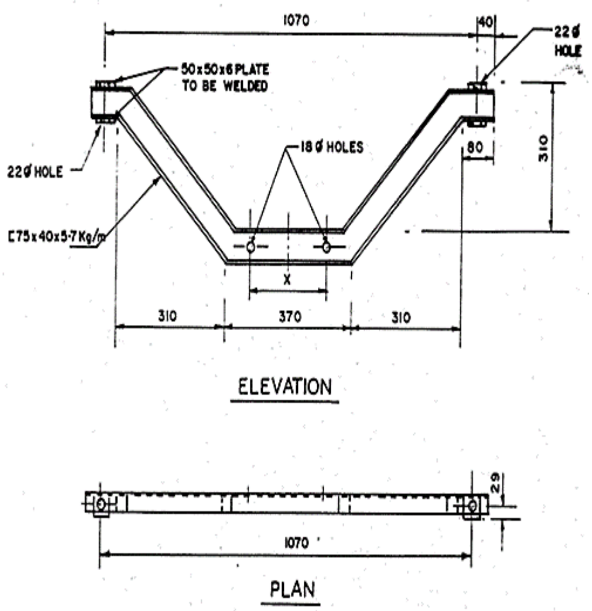

Fig-1:11kV distribution line cross arm design

Thus, the Simulation includes the following two cases:

Case1. A Clean distribution line

Case2. Unclean distribution line

2.1. FEM Simulation Analysis:

The analysis was carried out for all the two conditions and was discussed below.

2.2. Case1: A Clean distribution Line:

The 11kV, three-phase distribution feeder, metallic cross arms, and pin insulator were designed by using FEMM 2D software as per geometrical conFigurations shown in Fig 2.[9] The electric field distribution in and around the insulator is necessary for the optimal design of the insulator. The accurate computation of electric field distribution can be computed using the Finite element method (FEM). For this insulator, dimensions are very useful. 11kv Electric pole dimensions are shown in Fig 1 and Table1.

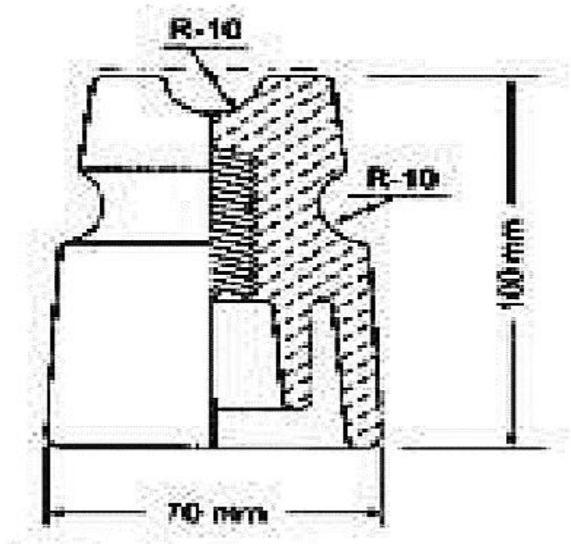

Fig-2:11kV pin insulator

Geometrical configurations 11kv pin insulator dimensions are shown in Fig 2. 11kv pin insulator design in FEM 2D software [9].

2.2.1. ASSIGNING MATERIALS:

As per the geometrical configurations, the insulator is designed by using FEMM 2D package. After designing, insulator materials like ceramic, steel, and air are assigned to the model with help of relative permittivity values. Insulator material properties are given in the table shown Table 2 and Fig2. After assigning materials to the model, the line to the ground voltage (i.e.,$12/\sqrt{3}$ =7kv) is applied to the energized high voltage end fitting and zero (0V) volts to the grounded end fitting of the insulator.

TABLE 2: Material properties

Particulars	Material	Relative permittivity value
Insulator housing	Ceramic	5.9
Electric pole	Steel	1
Boundary surface	Air	1

2.2.2. ASSIGNING 2D TRIANGULAR ELEMENTS:

Then 2D Triangular elements are assigned to the insulator. Triangular elements at the HV end and ground end are as shown in Fig 2. The boundaries in the model need to be split into individual sections, referred to as boundary elements. The distribution, number, and shape of these elements are the key factors that determine the accuracy of the solution. FEM generally uses 2D elements for analysis purposes. Names of Insulator 1 and Insulator 2 and Insulator 3 are shown in Fig 2.

2.2.3. ASSIGNING BOUNDARY CONDITIONS:

After assigning boundary elements 2D triangular elements are generated throughout the mode. A FEM model design for the clean distribution assuming that no tree/creeper is surrounding the pole. The results are showing that the stress is now varied between the top of the tree to the transmission line by treating the tree as the ground is as shown in Fig.3.By running the model electric field contours developed. In this electric field contours, the HV end is shown red color and the ground end is shown blue color.

The rated line-to-ground voltage is 12/√3=7kV to the high voltage end fittings. Zero volts to the grounded end fitting/Air is assigned as a surrounding medium. After assigning boundary elements 2D triangular elements are generated throughout the mode.

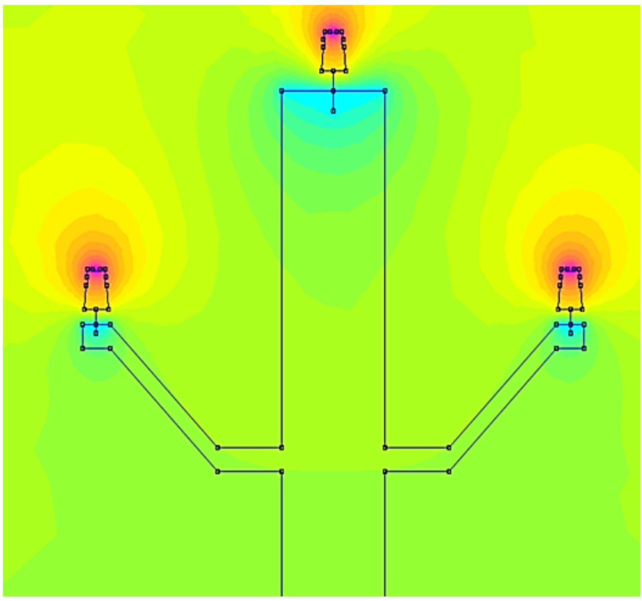

Fig-3: Electric field contours

Electric field contours are as shown in Fig 3. After assigning materials to the model, the line to the ground voltage (i.e 12/√3 =7kv) is applied to the energized high voltage end fitting and zero (0V) volts to the grounded end fitting of the insulator. Field analysis results of 11kv electric pole with cross-arm. Electric fields along the insulators are plotted. By running the model electric field contours developed. In this electric field contours, the HV end is shown red color and the ground end is shown blue color The insulator top is given as high voltage and the insulator ground is given ground voltage. The Fig. 3 shows different colors in which each color corresponds to a different voltage level.

In the Fig. 4, a graph is plotted between the voltage across insulator and the length of insulator(mm). This Fig. 4 is also known as Voltage Distribution along insulator length.

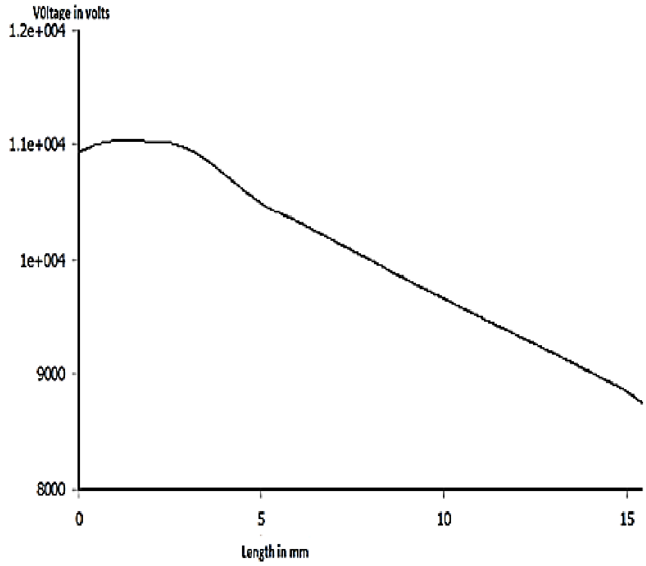

Fig-4: Voltage Distribution along the insulator

In Fig. 5, the Electric field Distribution along insulator1 has been presented. Maximum Electric field Distribution along insulator 1 is $8.53\times e^{4}$ V/mm.

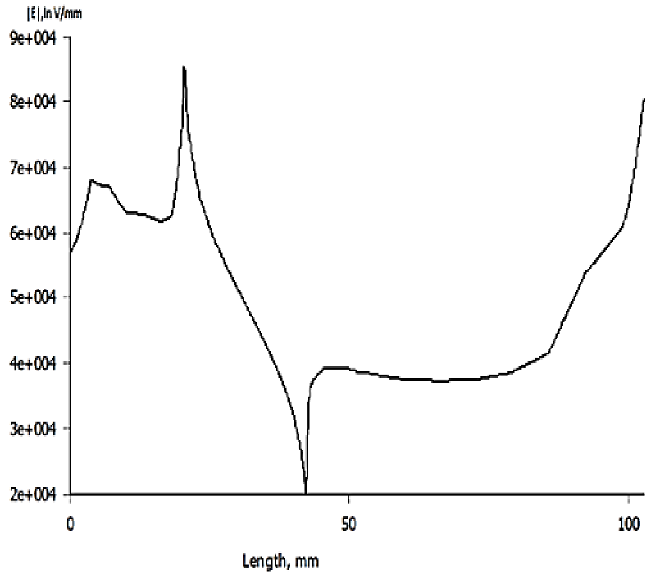

Fig-5: Electric field Distribution along insulator 1

In this Fig6 graph drawn between Electric field intensity vs length of insulator(mm). The maximum Electric field Distribution along insulator 2 is $7.67\times e^{4}$ (v/mm).

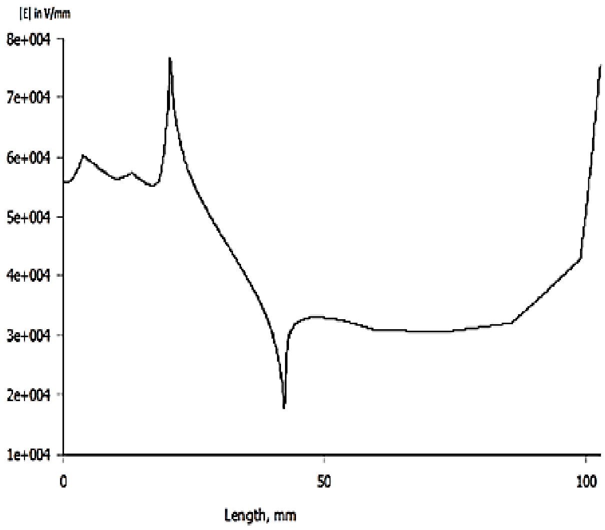

Fig-6: Electric field Distribution along insulator 2

In this Fig7 graph is drawn between Electric field intensity vs length of insulator(mm). Maximum Electric field Distribution along insulator3 is 2.47×e5 (v/mm).

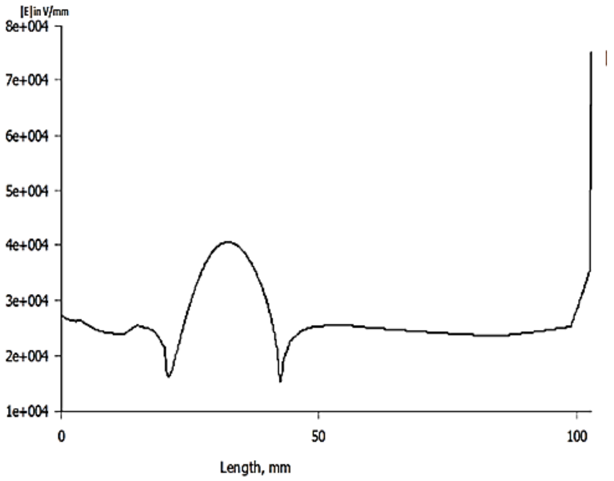

Fig-7: Electric field Distribution along insulator3

Table 3: Electric Field analysis Results

S.NO	FIELD REGION	ELECTRIC FIELD INTENSTY(V/mm)
1.	Insulator1	$8.53\times e^4$
2.	Insulator2	$7.67\times e^4$
3.	Insulator3	$2.47\times e^4$

The maximum Electric field intensity on the surface of insulator 1, insulator 2 and insulator 3 are presented in Table 3.

The comparison bar chart of EFA results for 11kv electric pole with clean distribution is shown in Fig 8.

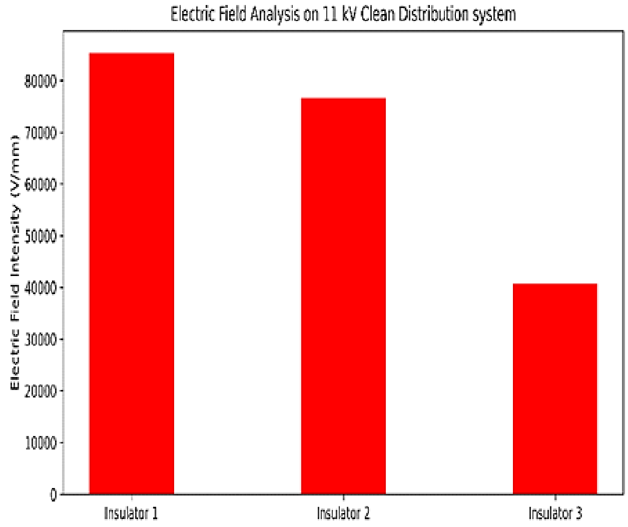

Fig-8: Electric field Results analysis

2.3. Case2. For Unclean Distribution Line:

The 11kV, three-phase distribution feeder, metallic cross arms and pin insulator was designed by using FEMM 2D software as per geometrical configurations shown in Fig 1. The geometrical configurations 11kv pin insulator dimensions are shown in Fig 2.

If the vegetation growth increased in steps of 10% from 40% to 100%, the electric field was found to be increasing.

- Tree height increased 40% of the total height of electric pole height = 4 m.
- Tree height increased 50% of the total height of electric pole height = 5 m.
- Tree height increased 60% of the total height of electric pole height = 6 m.
- Tree height increased 70% of the total height of electric pole height = 7 m.
- Tree height increased 80% of the total height of electric pole height = 8 m.
- Tree height increased 90% of the total height of electric pole height = 9 m.
- Tree height increased 100% of the total height of electric pole height = 10 m.

A FEM model design for the clean distribution assuming that no tree/creeper is surrounding the pole has been already presented in section 2.2. For a 50% grown tree/shrubbery, analysis has been primarily carried out in the FEM model. The results are showing that the stress is now varied between the top of the tree to the transmission line by treating the tree as the ground. is as shown in Fig. 9 i.e., the ground plane has increased increasing the electric field stress [1].

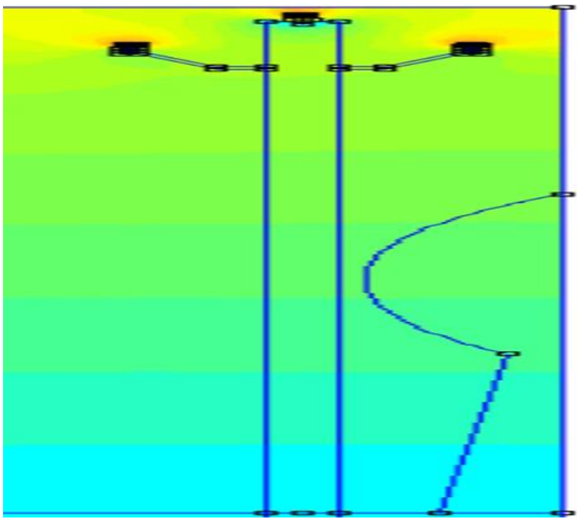

Fig-9: Electric field contours

Electric field contours are as shown in Fig 9. After assigning materials to the model, the line to the ground voltage (i.e 12/√3 =7kv) is applied to the energized high voltage end fitting and zero (0V) volts to the grounded end fitting of the insulator. Field analysis results of 11kv electric pole with cross arm. Electric fields along the insulators are plotted. By running the model electric field contours developed. In this electric field contours, the HV end is shown red color and the ground end is shown blue color. The insulator top is given as high voltage and the insulator ground is given ground voltage. In this Fig 9 shows different colors corresponds to its voltage intensity.

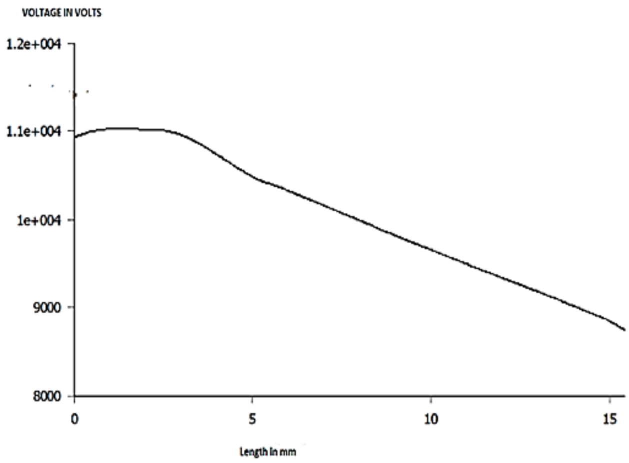

Fig-10: Voltage Distribution along insulator1

If the vegetation growth increased in steps of 10% from 40% to 100%, the electric field was found to be increasing.

a. *Electric field Distribution along insulator2 with 40% of tree height increase*

In the Fig10.1, the graph is drawn between Electric field intensity vs length of insulator(mm). Maximum Electric field Distribution along insulator 2 with 40% of tree height increase is 7.75×e4 (v/mm).

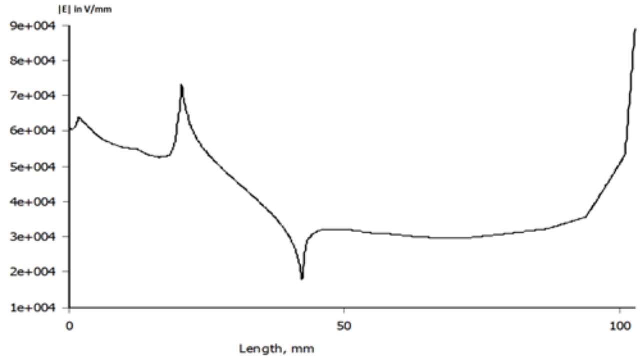

Fig-10.1: Electric field Distribution along insulator 2 with 40 % Tree height

b. *Electric field Distribution along insulator2 with 50% of tree height increase:*

In the Fig 10.2, the graph is drawn between Electric field intensity vs length of insulator(mm). Maximum Electric field Distribution along insulator2 with 50% of tree height increase is 7.80×e4 (v/mm).

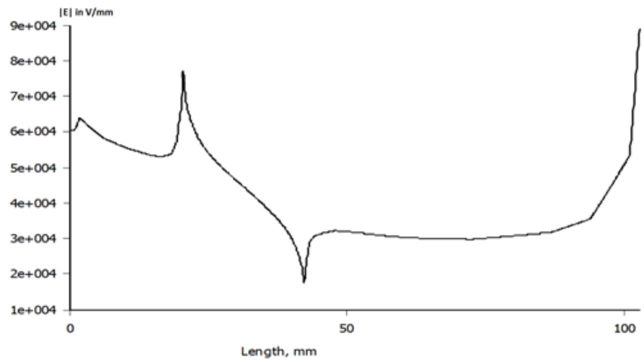

Fig-10.2: Electric field Distribution along insulator 2 with 50 % Tree Height

c. *Electric field Distribution along insulator2 with 60% of tree height increase:*

In this Fig10.3 graph drawn between Electric field intensity vs length of insulator(mm). Maximum Electric field Distribution along insulator2 with 60% of tree height increase is 7.90×e4 (v/mm).

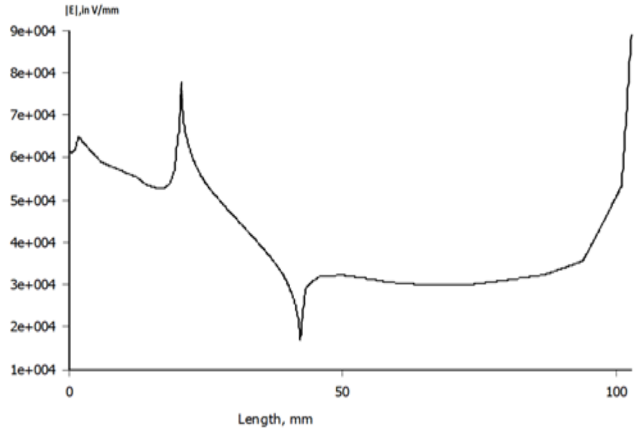

Fig-10.3. Electric field Distribution along insulator 2 with 60 % Tree Height

d. *Electric field Distribution along insulator2 with 70% of tree height increase:*

In the Fig10.4 graph drawn between Electric field intensity vs length of insulator(mm). Maximum Electric field Distribution along insulator2 with 70% of tree height increase is 8.00×e4 (v/mm).

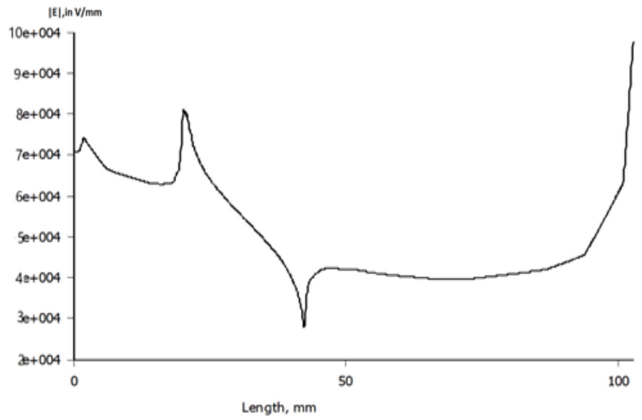

Fig-10.4: Electric field Distribution along insulator 2 with 70 % Tree Height

e. *Electric field Distribution along insulator2 with 80% of Tree height increase:*

In this Fig10.5 graph is drawn between Electric field intensity vs length of insulator(mm). Maximum Electric field Distribution along insulator 2 with 80% of tree height increase is 8.04×e4 (v/mm).

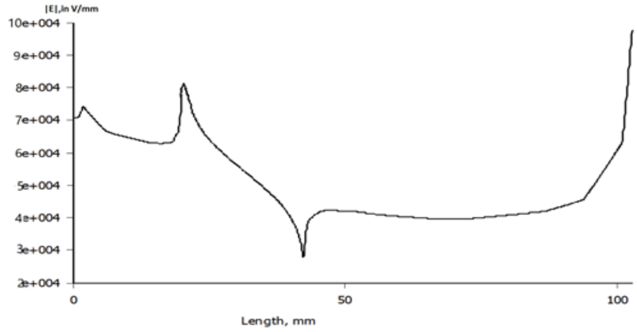

Fig-10.5: Electric field Distribution along insulator-2 with 80 % Tree Height

f. *Electric field Distribution along insulator2 with 90% of tree height increase:*

The Maximum Electric Field Distribution along insulator2 with 90% of tree height increase is 8.20×e4 (v/mm) as shown in Fig. 10.6.

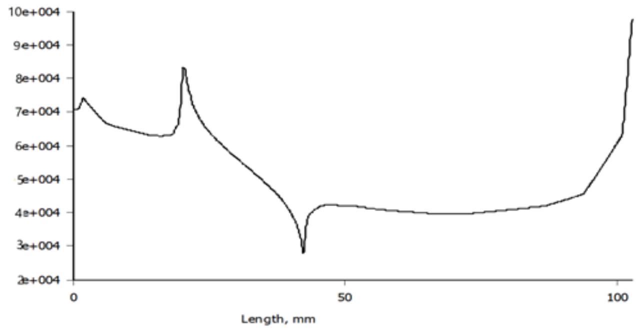

Fig-10.6: Electric field Distribution along insulator 2 with 90 % Tree Height

g. *Electric field Distribution along insulator2 with 100% of tree height increase:*

Maximum Electric field Distribution along insulator2 with 100% of tree height increase is 8.40×e4 (V/mm) as shown in Fig. 10.7.

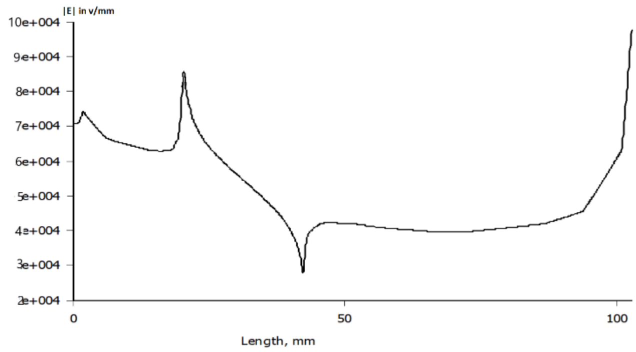

Fig-10.7: Electric field Distribution along insulator 2 with 100 % Tree Height.

Table 4: Electric Field Intensity (vs) Percentage Increasing tree height (%)

S.NO	Percentage Increasing tree height	ELECTRIC FIELD INTENSTY(V/mm)
1	40%	7.75×e4
2	50%	7.80×e4
3	60%	7.90×e4
4	70%	8.00×e4
5	80%	8.04×e4
6	90%	8.20×e4
7.	100%	8.40×e4

The comparison of EFA results for 11kv electric pole for various tree heights is presented in Fig 11.

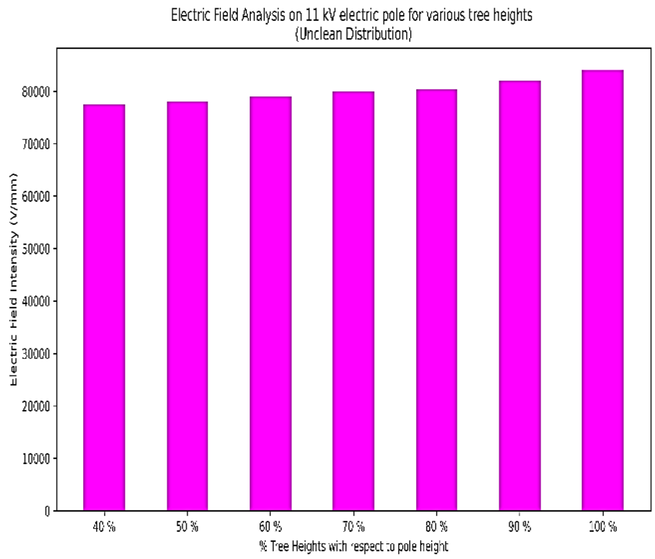

Fig-11: Electric Field Results Analysis

3. Electric field analysis of 132kv Overhead transmission line tower (Case-3):

In this case 3, the electric field distributions and voltage in 132kv overhead transmission line tower studied Fem 2D software. 132kv overhead transmission line tower with polymeric was designed by using Fem 2D software as per geometrical configuration shown in table 5 and Fig 12.

3.1. Geometrical Configurations:

The electric field distribution in and around the insulator is necessary for the optimal design of the insulator. The accurate computation of electric field distribution can be computed using the Finite element method (FEM). For this insulator, dimensions are very useful. Insulator dimensions are tabulated in table 5.

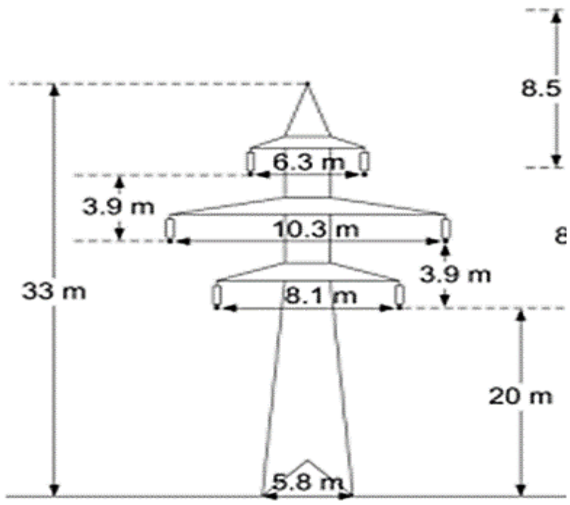

Fig- 12: Geometric Configuration of the Tower

Table 5: Geometrical ConFigurations-132kV polymeric insulator

S.no	Critical Regions	Dimensions in mm
1.	Insualtor length	1060
2.	Diameter of bigger shed	135
3.	Diameter of smaller shed	105
4.	FRP Rod length	960
5.	Core Diameter	28
6.	No Discs bigger shed	17
7.	No Discs smaller shed	16
8.	Pitch	52
9.	FRP diameter	20
10.	Thickness shed	3

3.2. Design of 132kV Overhead transmission line tower:

In this case3, the electric field distributions and voltage in 132kv overhead transmission line tower studied Fem 2d software.132kv overhead transmission line tower with polymeric was designed by using Fem 2d software as per geometrical configuration shown in Fig12.

3.3. ASSIGNING MATERIALS:

As per the geometrical configurations, the insulator is designed by using FEMM 2D package. After designing, insulator materials like SiR, FRP, and steel are assigned to the model with help of relative permittivity values. Insulator material properties are given in the table shown table 6.

Table 6: Material properties

Particulars	Material	Relative permittivity value
Insulator housing and weather sheds	Silicone	3
FRP Rod	Fibre glass	5
Tower	Steel	1
Boundary surface	Air	1

The rated line-to-ground voltage as 145/√3=83.71kV to the high voltage end fitting. Zero volts to the grounded end fitting. Air is assigned as a surrounding medium.

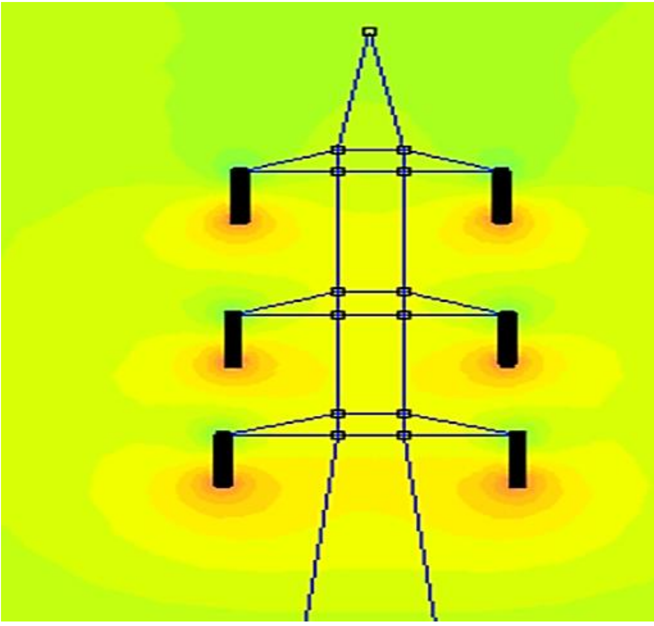

Fig-13: Electric field contours

Then 2D triangular elements are assigned to the insulator. Electric field contours are as shown in Fig 13. By running the model electric field contours developed. In this electric field contours HV, the end is shown red color, and the ground end is shown blur color. The insulator top is given as high voltage and the insulator ground is given ground voltage. In this Fig 13 shows different colors & each color shows different voltages.132Kv overhead transmission line bottom of the tower is grounded shown blue color in Fig13.

3.4. ELECTRIC FIELD DISTRIBUTION ALONG INSULATOR:

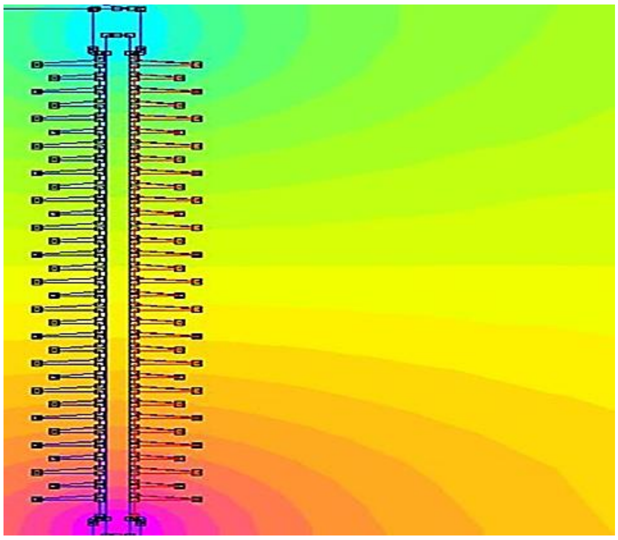

Fig-14: Electric field Distribution along Insulator1

Electric field distribution along the surface of insulator1 is shown in Fig 18. The rated line-to-ground voltage as 145/√3=83.71kV to the high voltage end fitting. Zero volts to the grounded end fitting/Air is assigned as a surrounding medium. Electric field distribution along the surface of insulator1 is shown in Fig 14. 132Kv overhead transmission tower is grounded shown blue color in Fig 14.

3.5. ELECTRIC FIELD LINES DIRECTION:

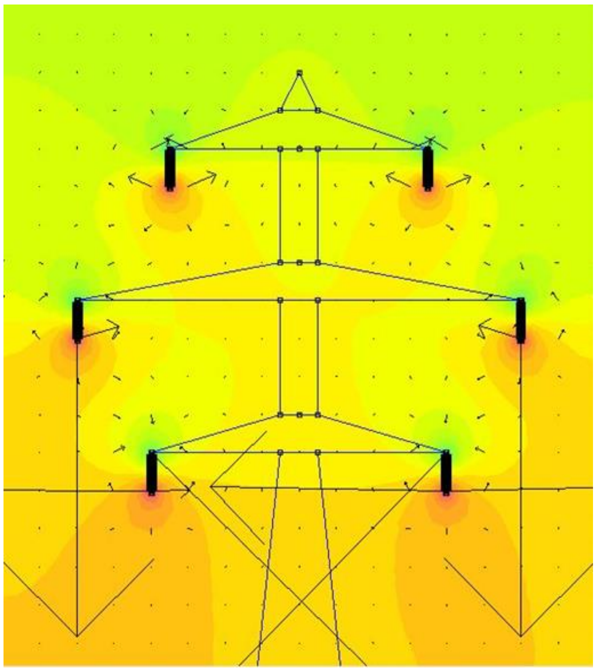

Fig-15: Electric field lines direction

Electric field lines direction shown in Fig 15. This Figure shows Electric field lines flow from hv end to ground end.

3.6. EQUIPOTENTIAL LINES:

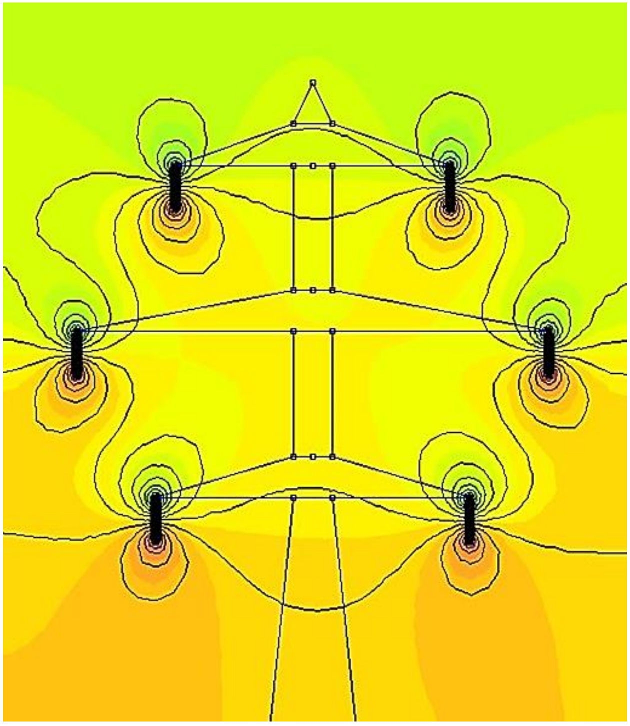

Fig-16: Equipotential lines direction

Equipotential lines direction shown in Fig 16. This, the Figure shows Equipotential lines flow from hv end to ground end

3.7. VOLTAGE DISTRIBUTION ALONG INSULATOR1:

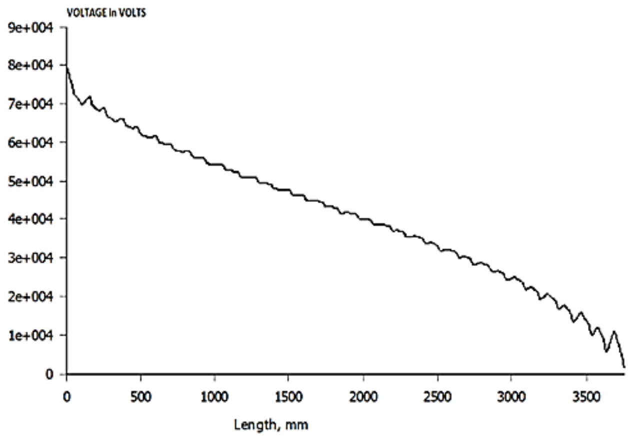

Fig-17.1: Voltage Distribution along insulator1

In this Fig17.1 graph drawn between voltage vs length of insulator(mm). Maximum Voltage Distribution along insulator3 is 8.00×e4 (v/mm).

3.8. VOLTAGE DISTRIBUTION ALONG INSULATOR2

In the Fig17.2 graph drawn between voltage vs length of insulator(mm). Maximum Voltage Distribution along insulator3 is 8.26×e4 (v/mm).

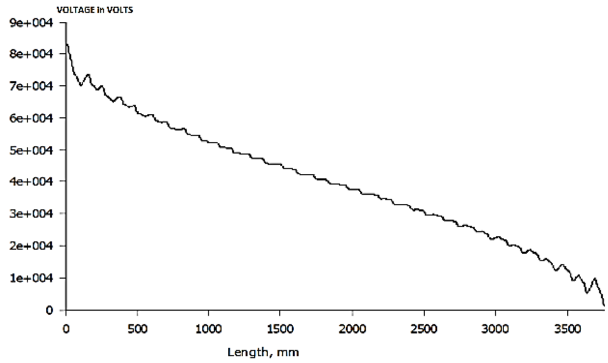

Fig-17.2: Voltage Distribution along insulator2

3.9. VOLTAGE DISTRIBUTION ALONG INSULATOR3:

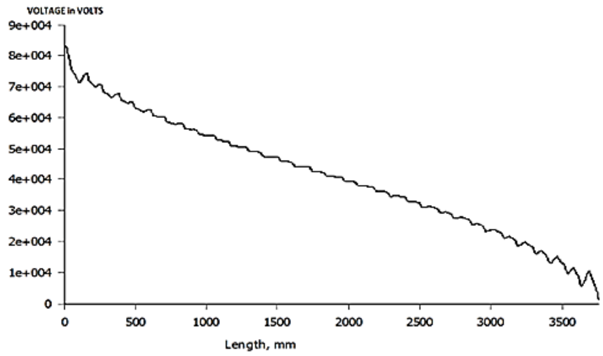

Fig-17.3: Voltage Distribution along insulator3

Maximum Voltage Distribution along insulator3 is 8.26×e4 (v/mm). In this Fig17.3 graph drawn between voltage vs length of insulator(mm).

3.10. ELECTRIC FIELD DISTRIBUTION ALONG INSULATOR1

Maximum Electric field Distribution along insulator1 is 1.74×e5 (v/mm). In this Fig18 graph drawn between Electric field intensity vs length of insulator(mm).

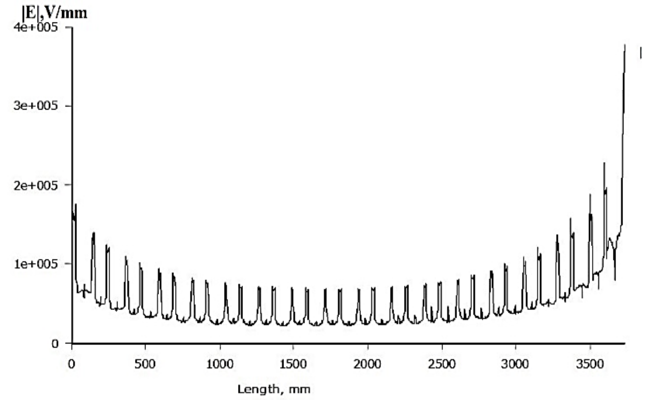

Fig-18: Electric field Distribution along insulator1

3.11. ELECTRIC FIELD DISTRIBUTION ALONG INSULATOR2:

Maximum Electric field Distribution along insulator2 is 2.28×e5 (v/mm). In this Fig. 19 graph drawn between Electric field intensity vs length of insulator(mm).

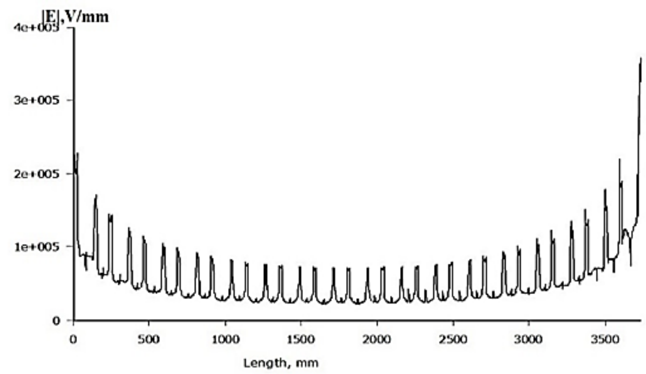

Fig-19: Electric field Distribution along insulator2

3.12. ELECTRIC FIELD DISTRIBUTION ALONG INSULATOR 3:

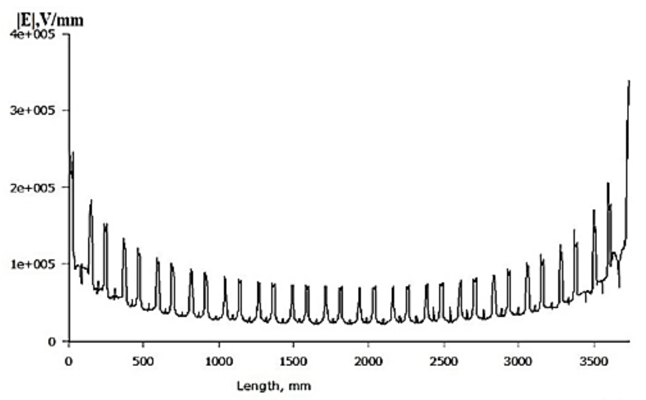

Fig-20: Electric field Distribution along insulator3

Maximum Electric field Distribution along insulator3 is 2.47×e5 (v/mm). In this Fig20 graph drawn between Electric field intensity vs length of insulator(mm).

EFA results for 132kV overhead transmission line tower insulator1, insulator2 & insualtor3 are shown in table 7.

Table 7: EFA results for 132kV overhead transmission line tower

S.NO	FIELD REGION	ELECTRIC FIELD INTENSTY (V/mm)
1.	Insulator1	1.74×e^5
2.	Insulator2	2.28×e^5
3.	Insulator3	2.47×e^5

Table 8: Voltage results for 132kV overhead transmission line tower

S.NO	FIELD REGION	VOLTAGE (Volt)
1.	Insulator1	8.00×e4
2.	Insulator2	8.26e4
3.	Insulator3	8.26×e4

3.13. EFA RESULTS COMPARISION:

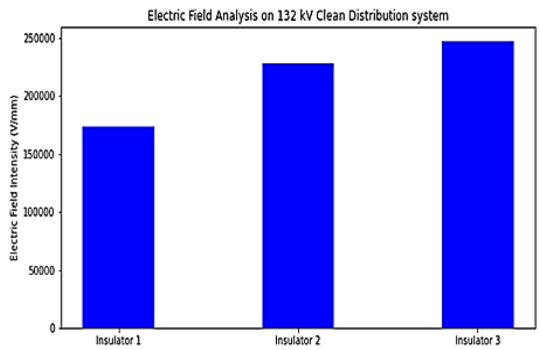

Fig-21: Electric Field Results Analysis

3.14. VOLTAGE RESULTS COMPARISION:

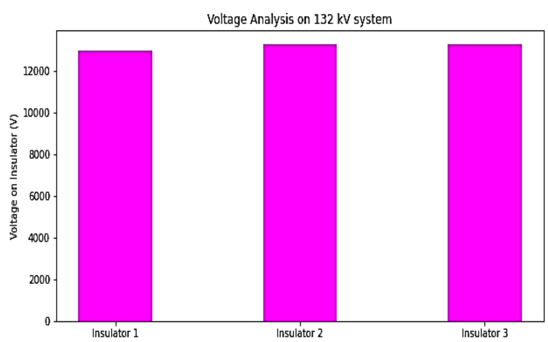

Fig-22: Voltage Results Analysis

4. Electric field analysis of 220kv Overhead transmission line tower (Case - 4):

In this case4, the electric field distributions and voltage in 220 kV overhead transmission line tower studied Fem 2d software.220kv overhead transmission line tower with polymeric was designed by using Fem 2d software as per geometrical configuration shown in Fig23.

4.1. Geometrical Configurations:

The electric field distribution in and around the insulator is necessary for the optimal design of the insulator. The accurate computation of electric field distribution can be computed using the Finite element method (FEM). For this insulator, dimensions are very useful. Insulator dimensions are tabulated in table 9 and Fig 23.

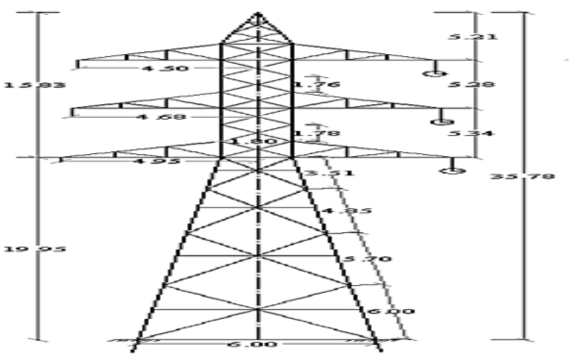

Fig-23: Geometric Configuration of the 220 kV Tower

Table 9: Geometrical ConFigurations-220kV polymeric insulator

S.no	Critical Regions	Dimensions in mm
1.	Insualtor length	2200
2.	Diameter of bigger shed	135
3.	Diameter of smaller shed	105
4.	FRP Rod length	2100
5.	Core Diameter	26
6.	No Discs bigger shed	46
7.	No Discs smaller shed	45
8.	Pitch	52
9.	FRP diameter	20
10.	Thickness shed	3

4.1.1. ASSIGNING MATERIALS

As per the geometrical configurations, the insulator is designed by using FEMM 2D package. After designing, insulator materials like SiR, FRP, and steel are assigned to the model with help of relative permittivity values. Insulator material properties are given in the table8.

4.2. ASSIGNING 2D TRIANGULAR ELEMENTS:

The boundaries in the model need to be split into individual sections, referred to as boundary elements.

The distribution, number, and shape of these elements are the key factors that determine the accuracy of the solution. FEM generally uses 2D elements for analysis purpose purposes.

4.3. ASSIGNING BOUNDARY CONDITIONS:

The rated line-to-ground voltage is $220/\sqrt{3}$=142kV to the high voltage end fittings. Zero volts to the grounded end fitting/Air is assigned as a surrounding medium. After assigning boundary elements 2D triangular elements are generated throughout the mode.

In this electric field contours HV, the end is shown red color, and the ground end is shown blue color. The insulator top is given as high voltage and the insulator ground is given ground voltage. In this Fig 9 shows different colors.

Each colors shows different voltages shown in Fig24. 220Kv overhead transmission line bottom of the tower is grounded shown blue color in Fig24.

4.4. Electric field contours:

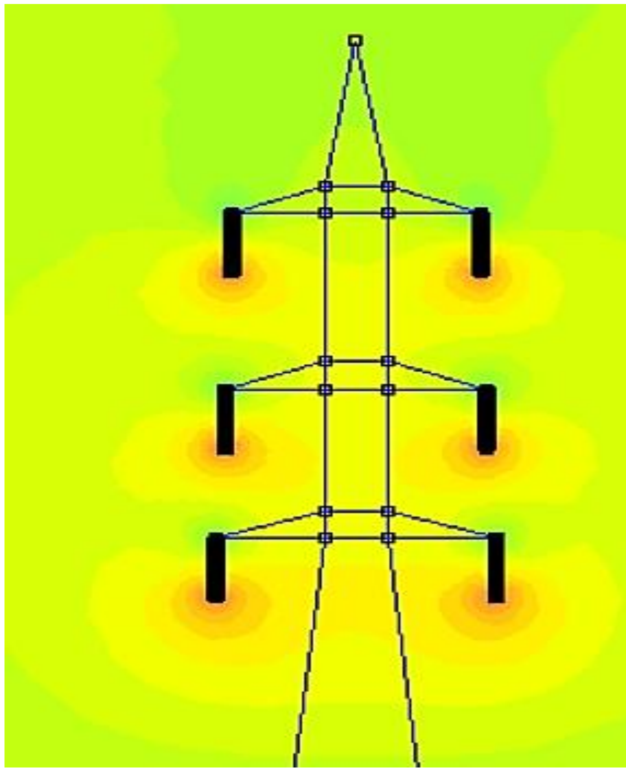

Fig-24: Electric field contours

4.5. ELECTRIC FIELD DISTRIBUTION ALONG INSULATOR1:

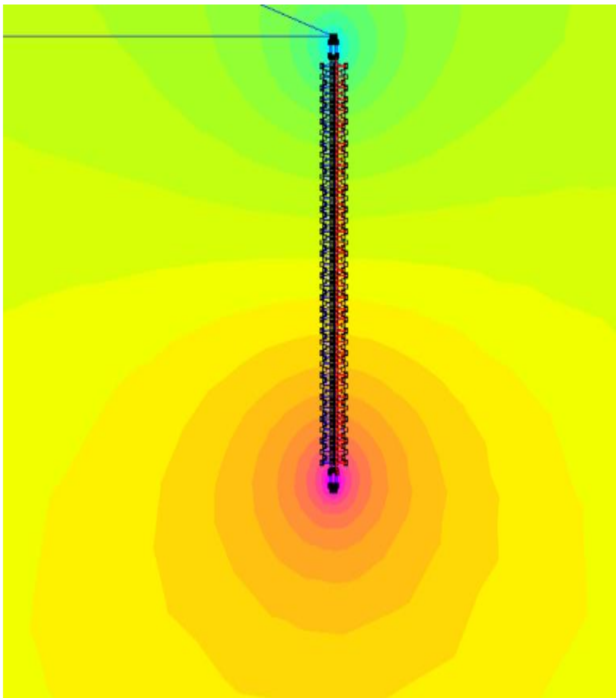

Fig-25: Electric field Distribution along insulator1

Electric field Distribution along the surface of insulator1 is shown in Fig 25. The rated line-to-ground voltage is 220/√3=142kV to the high voltage end fittin. Zero volts to the grounded end fittingAir is assigned as a surrounding medium.

4.6. VOLTAGE DISTRIBUTION ALONG INSULATOR1:

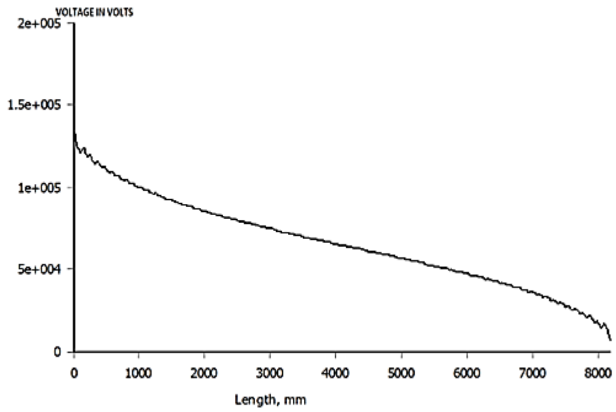

Fig-26.1: Voltage Distribution along insulator1

Maximum Voltage Distribution along insulator1 is 2.56×e5 (v/mm). In this Fig26.1 graph drawn between voltage vs length of insulator(mm).

4.7. VOLTAGE DISTRIBUTION ALONG INSULATOR2

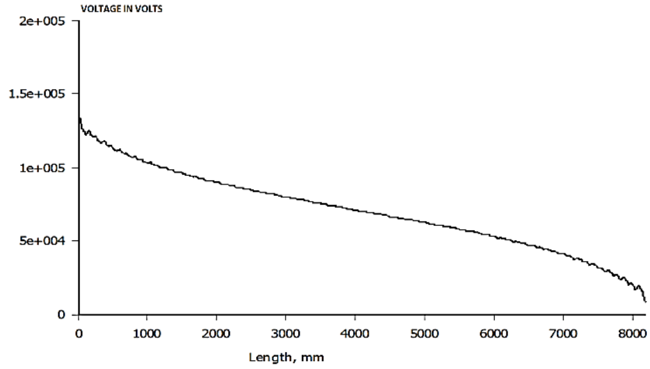

Fig-26.2: Voltage Distribution along insulator2

Maximum Voltage Distribution along insulator2 is 2.56×e5 (v/mm). In this Fig26.2 graph drawn between voltage vs length of insulator(mm).

4.8. VOLTAGE DISTRIBUTION ALONG INSULATOR3:

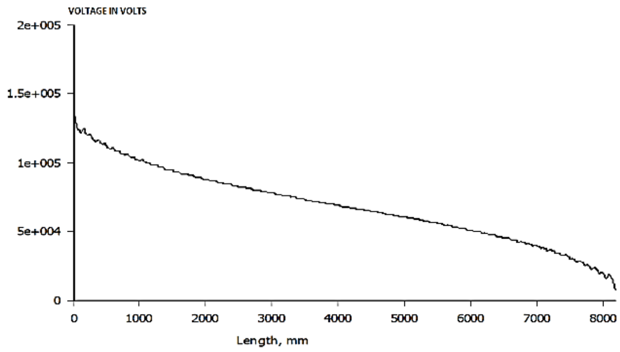

Fig-26.3: Voltage Distribution along insulator3

Maximum Voltage Distribution along insulator3 is 2.56×e5 (v/mm). In this Fig26.3 graph drawn between voltage vs length of insulator(mm).

4.9. ELECTRIC FIELD DISTRIBUTION ALONG INSULATOR1

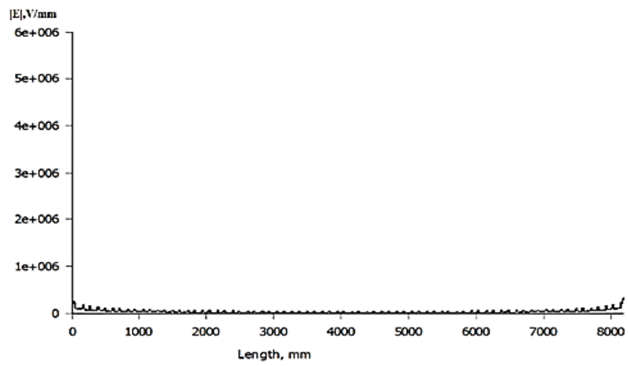

Fig-27.1: Electric field Distribution along insulator1

Maximum Electric field Distribution along insulator1 is 2.49×e5 (v/mm). In this Fig27.1 graph is drawn between Electric field intensity vs length of insulator(mm).

4.10. ELECTRIC FIELD DISTRIBUTION ALONG INSULATOR 2:

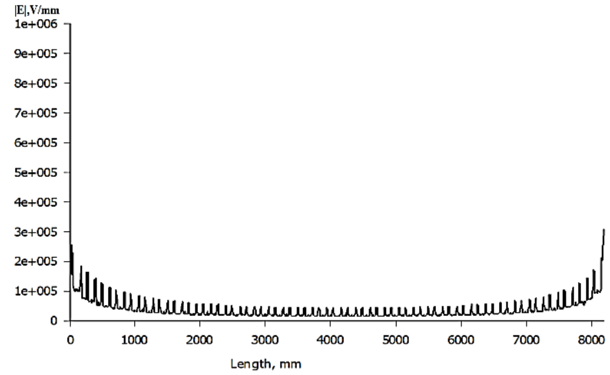

Fig-27.2: Electric field Distribution along insulator2

Maximum Electric field Distribution along insulator2 is 2.56×e5 (v/mm). In this Fig27.2 graph drawn between Electric field intensity vs length of insulator(mm).

4.11. ELECTRIC FIELD DISTRIBUTION ALONG INSULATOR3:

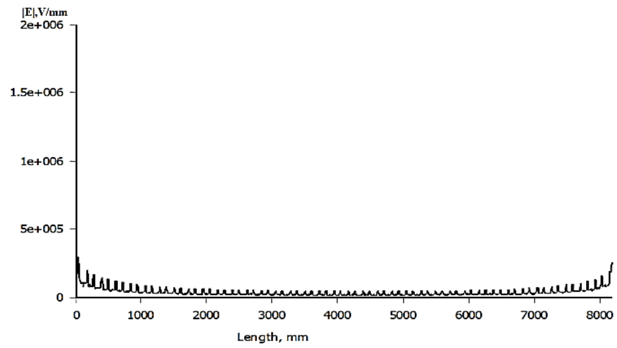

Fig-27.3: Electric field Distribution along insulator3

From Fig. 27.3, the Maximum Electric field Distribution along insulator3 is 2.90×e5 (v/mm).

Table 11: EFA results for 220 kV overhead transmission line tower

S.NO	FIELD REGION	ELECTRIC FIELD INTENSTY (V/mm)
1.	Insulator1	$2.49\times e^5$
2.	Insulator2	$2.56\times e^5$
3.	Insulator3	$2.90\times e^5$

Table 12: Voltage results for 220 kV overhead transmission line tower

S.NO	FIELD REGION	VOLTAGE (Volt)
1.	Insulator1	1.30×e5
2.	Insulator2	1.33×e5
3.	Insulator3	1.33×e5

4.12. EFA RESULTS COMPARISION:

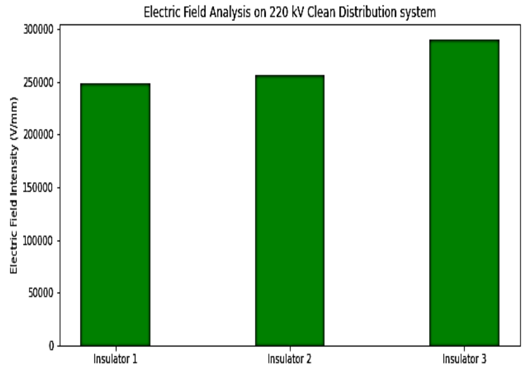

Fig-28: Electric Field Results Analysis

4.13. VOLTAGE RESULTS COMPARISON:

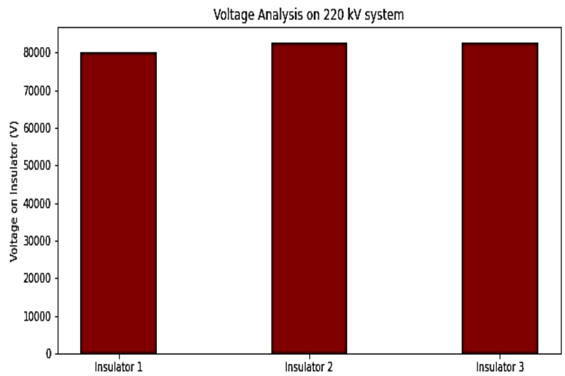

Fig-29: Voltage Results Analysis

5. CONCLUSION:

In this project, an electric field Analysis has been carried out and an 11 kV Distribution system. To enhance the study, three 11kv insulators are chosen and tests are conducted under clean and unclean environments. Later on, the study is extended to include the effects of shrubbery, we have chosen different levels of tree heights concerning the pole heights. The effectiveness of these analyses is proven by taking 132 kV and 220 kV feeders that are powering our 11 kV distribution system. By series of tests, it is confirmed that the shrubbery has the least effect on the Extra High voltage transmission systems due to their humungous tower heights. Thus the study is constricted to 11 kV system Electric field distribution under four cases. By comparison, case1 and case 2 results in electric field stress more in case2.

In the case2 of the electric field fields, stress increases with increasing vegetation growth. In case2 vegetation growth is 10% electric field stress is less. If the vegetation growth increased in steps of 10% from 40% to 100%, the electric field was found to be increasing. At vegetation growth of 100% pole height, the electric field stresses are very high. In case 3, three insulators of the same ratings are compared. The electric field stress is high in insulator3 compared to insulator 1 and insulator 2. In case 4 electric field stress is high in insulator3 compared to insualtor1 and insulator 2.

From this testing and simulation of electric field analysis, it is found that electric field stress is different even for insulators of the same rating and manufacturers. It is also affected by shrubbery and its height compared to pole height. From these tests, it is confirmed that shrubbery is a minor player in electric field stress of 132 kV and greater voltages due to high tower heights. Its effects are high for distribution systems of voltage 11 kV and under as their cross arms may be accessible near shrubbery.

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