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Lightning ROD Design for Telecommunication Academy Campus and Bogor Technology

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ABSTRACT

Lightning rod is a lighting pole which has an external terminal installed in a building or structure that has the purpose of attracting lightning which has a controlled point of impact and preventing it from spreading to unwanted areas or striking someone. The aim of this research is to find out the design of lightning rods for the Akatelkom and Akatek Bogor campuses. The research method used is designing the building, testing the design results and implementing the design results. Results: Dry soil electrodes planted 6 meters range from 1.56 – 2.40 Ohm, wet soil ranges from 0.45 – 1.29 Ohm, and dry soil electrodes planted 12 meters range from 1.35 – 1.94 Ohm, for wet soil conditions range 0.42 – 0.86 Ohms. Parallel conditions are 6 meters and 12 meters for dry soil conditions, which range from 1 – 1.54 Ohm, for wet soil conditions, which range from 0.35 – 0.58 Ohm. Data obtained from plate electrodes with sizes 0.2 x 0.2 meters, 0.3 x 0.3 meters, and 0.4 x 0.4 meters obtained grounding resistance in dry conditions ranging from 3.45 – 7.51 Ohm, for wet soil conditions ranging from 2.78 – 5, 20 Ohms.
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Introduction

Indonesia is located on the equator, has areas that every year allow for the occurrence of thunderstorm days with an average (100 -200 days per year) where thunder is heard at least once assuming a distance of about 15 km from the observation station. Bogor specifically in Cibinong was recorded in the Guinness Book of Records in 1988 as having a total of 322 lightning strikes per year, with a lightning strike density in Indonesia of 12/km^2/year, this shows that every area width 1 km2 potential to receive a lightning strike as much as 12 times in every year with the energy generated by a single lightning strike can reach 55 kwhours.

With the magnitude of the risks and impacts caused by this lightning strike, it is imperative that a building is accompanied by a lightning protection system in the planning of a building. The Akatelkom and Akatek campus buildings located in Bogor City should have lightning protection in order to avoid damage caused by lightning strikes.

One of the technic lightning protection is pasif technic lightning protection, with the final function of lightning protection is to "catch lightning" or become "objects of lightning strikes" so that lightning does not strike or hit other places. The lightning rod finial is at the top of the lightning rod, made of metal and has an upright or horizontal shape. The lightning fins are placed in a certain arrangement in such a way that as much as possible all the lightning can be captured without hitting the other parts it protects.

Based on the background description above, then the formulation of the problem from this research is lightning rod design for the Akatel – Akatek Bogor campus. The purpose of this research is to design and realize a lightning rod on the Akatel - Akatek Bogor campus building.

Research Method

Technic lightning protection design wich will be design using pasif technic lightning protection, is just attach the lightning strike receiver and electrical current channeling cable equipment from lightning to the ground. The advantage of this method is that it is easy to install and economical, and can be intergraded seamlessly into the building structure. In this research, a lightning catcher (finial) will be designed that can quickly respond to lightning currents, in this case it is able to be faster than its surroundings. To install this finial, a tower will be made that is higher than the Energy Conversion Engineering laboratory building.

In testing the equipment system that is made, the following test methods will be applied:

a. Comparative Analytical Method: namely analyzing the test results with standard physics and electrical rules then comparing the measurement results with theoretical calculation results.
b. Descriptive Method: namely observing a change caused by the treatment of an object or system and describing it in a conclusion.

The parameters to be tested are divided into two parameters, namely the main parameters and additional parameters, for the main parameters, namely the amount of grounding voltage and grounding resistance, while the additional parameters are the amount of grounding soil resistivity. The test procedure is carried out in the following way :

1. Making Lightning Protection Finials

The lightning rod finial is at the top of the lightning rod, made of metal and has an upright or horizontal shape. The lightning fins are placed in a certain arrangement in such a way that as much as possible all the lightning can be captured without hitting the other parts it protects.

2. Procurement of Lightning Flow Distribution System

The lightning strike current that hits the finial must be quickly channeled to the ground by providing a lightning current distribution system through the shortest path. The dimensions or cross-sectional area, number and route of the conductors are determined by the square of the impulse current according to the level of protection specified and the height of the peak lightning current.

3. Making the Grounding System

The grounding system functions as a means of channeling lightning currents that spread in all directions into the ground. In addition, the grounding system greatly determines the design of the internal lightning protection system, the higher the value of the grounding resistance, the higher the voltage on the potential equalizing bonding so that the internal protection efforts will be heavier. In this study, rod electrode grounding will be made with 5 variations in depth and plate electrode grounding will also be made with 5 flat area variations with a depth of 2 meters.

From the results of testing the grounding system, the rod electrodes were planted with 6 meters and 12 meters respectively, and plate electrodes with sizes of 0.2 x 0.2 meters, 0.3 x 0.3 meters and 0.4 x 0.4 meters. The data obtained from the rod electrode with a depth of 6 meters obtained grounding resistance in dry conditions ranging from 1.56 – 2.40 Ohm, for wet soil conditions ranging from 0.45 – 1.29 Ohm. So that measurements can be obtained on dry soil, the resistance value is better than measurements on wet soil. For electrodes with a depth of 12 meters, grounding resistance in dry conditions ranges from 1.35 – 1.94 Ohm, for wet soil conditions ranges from 0.42 – 0.86 Ohm. For electrodes with parallel depths of 6 meters and 12 meters for dry soil conditions, which range from 1 – 1.54 Ohm, for wet soil conditions, which range from 0.35 – 0.58 Ohm.

Table of Comparison of Grounding Resistance Measurement Results Bar Electrodes (0.2 x 0.2 meter, 0.3 x 0.3 meter and 0.4 x 0.4 meter)

No.	Depth (m)	Yield (Ohms) for each soil condition	
		Dry	Wet
1.	6	1,56 – 2,40	0,45 – 1,29
2.	12	1,35 – 1,94	0,42 – 0,86
3.	Parallel	1 – 1,54	0,35 – 0,58

From the table above, it can be concluded that resistance measurements on dry soil are better than measurements on wet soil. On the other hand, soil depth also affects the results of grounding measurements. The deeper the measurement is carried out, the smaller the grounding value results. Meanwhile, when it is paralleled, the size of the ground is also getting smaller.

Data obtained from plate electrodes with sizes 0.2 x 0.2 meters, 0.3 x 0.3 meters, and 0.4 x 0.4 meters obtained grounding resistance in dry conditions ranging from 3.45 – 7.51 Ohm, for wet soil conditions ranging from 2.78 – 5, 20 Ohms. For electrodes with parallel areas, namely 0.2 x 0.2 meters, 0.3 x 0.3 meters, and 0.4 x 0.4 meters for dry soil conditions, the resistance values range from 0.2 - 0.5 Ohm, for wet soils, which range from 2.4 - 4, 5 Ohms.

Table of Comparison of Grounding Resistance Measurement Results Plate Electrodes (0.2 x 0.2 meter, 0.3 x 0.3 meter, and 0.4 x 0.4 meter)

No.	Electrode Condition	Yield (Ohms) for each soil condition	
		Dry	Wet
1.	Not Parallel	3,45 – 7,51	2,78 – 5,20
2.	Parallel	0,2 – 0,5	2,4 – 4,5

Depth calculation:
Stake depth (s) = 2.2 m, Stake area (w.l) = 0.2 x 0.2 m, Rp = 7.51.

To get the value of ρ, and R. Parallel ρ.

Depth x Rp = 2.2 x 7.51
= 16,52 Ωm

R. Parallel Calculation

$R_1 = 2{,}40\ \Omega$
$R_2 = 1{,}94\ \Omega$

$$\frac{1}{R.\,Paralel} = \frac{1}{2{,}40} + \frac{1}{1{,}94}$$
$$= 0{,}42 + 0{,}52$$
$$= 0{,}94\ \Omega$$
$$R.\,Paralel = \frac{1}{0{,}94} = 1{,}063\ \Omega$$

ρ Calculation

$$\rho = \frac{2\,\pi\,LR}{\ln\left(\frac{8L}{d}-\right)1}$$

Where :
ρ = resistivity (Ωm)
L = Electrode Depth (m)
R = Earthing Resistance
d = Electrode Diameter (m)
ln = Natural logarithm of Mathematics

For :

$$\rho = \frac{2\,\pi \times 2{,}2 \times 1{,}063}{\ln \frac{8 \times 2{,}2}{0{,}2} - 1}$$

$$= 1{,}49\ \Omega m$$

Conclusion

Based on the results of the discussion, it can be concluded that :

1. Dry soil The electrode is planted 6 meters in the range of 1.56 – 2.40 Ohm, wet soil ranges from 0.45 – 1.29 Ohm
2. Dry soil Electrodes planted 12 meters range from 1.35 – 1.94 Ohm, for wet soil conditions range from 0.42 – 0.86 Ohm
3. Parallel conditions, namely 6 meters and 12 meters for dry soil conditions, which range from 1 – 1.54 Ohm, for wet soil conditions, which range from 0.35 – 0.58 Ohm
4. Data obtained from plate electrodes with sizes 0.2 x 0.2 meters, 0.3 x 0.3 meters, and 0.4 x 0.4 meters obtained grounding resistance in dry conditions ranging from 3.45 – 7.51 Ohm, for wet soil conditions ranging from 2.78 – 5.20 Ohms
5. For electrodes with parallel areas, namely 0.2 x 0.2 meters, 0.3 x 0.3 meters, and 0.4 x 0.4 meters for dry soil conditions, the resistance values range from 0.2 - 0.5 Ohm, for wet soils, which are around 2.4 - 4.5 Ohms

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