LIGHTNING PROTECTION SYSTEM

DAISY MAE R. BONGTIWON, BENJAMIN G. HABOC, DR. ELEONOR T. SALVADOR
Eulogio Amang Rodriguez Institute of Science & Technology
drbongtiwon@earist.ph.education

ABSTRACT

Lightning frequently damages people and properties. A lightning protection system protects the region, including homes and farms, against lightning. This research looked into the frequency of deadly lightning strikes in rural areas across the country. Farmers, cattle grazers, and workers have been the most common casualties, as they reside in disadvantaged locations where people are most vulnerable to the catalytic elements of lightning. The researchers designed a cheaper yet safe lightning protection system. Similar to the conventional type, it has exposed lightning masts or rods at construction sites' highest altitudes that are linked to a grounding system by descending conductors. It began with the lightning protection system prototype that was tested at Boso Boso, Antipolo City after it was constructed. The lightning rods and wires selected for the experiment were able to conduct electricity with low impedance or resistance, making them suitable for protection. The copper rod's tip is buried two feet in clay soil, which provides sufficient grounding. The multimeter measured current calculations in each circuit component and resistances in each. The researchers calculated and measured 33 1/3 A and 3.125 ohms for the lightning protection system at 220 volts. Results show that a basic, low-cost lightning rod can provide lightning protection. They also discovered that the output produces a safe power conduit that does not affect the environment, and may be utilized to minimize the number of deaths caused by lightning strikes in particular regions. Moreover, the design, safety, materials, and utility were all evaluated as excellent. Hence, this low-cost lightning protection system should be implemented in communities susceptible to lightning.

Keywords: Lightning, Lightning Protection system, Lightning rods, Lightning Struck

Introduction

Lightning frequently damages people and properties. A lightning protection system protects the region, including homes and farms, against lightning. This research looked into the frequency of deadly lightning strikes in rural areas across the country. Farmers, cattle grazers, and workers have been the most common casualties, as they reside in disadvantaged locations where people are most vulnerable to the catalytic elements of lightning.

Lightning rods protect structures from lightning. It can be hollow, pointed, rounded, flat strips, and bristle brushes. The most used materials in lightning protection are copper and its alloys. Thunderstorms create lightning, which kills more people than tornadoes.

Copyright © 2023 IEEE-SEM Publications

Lightning protection systems intercept lightning strikes with a low-impedance path to the ground to safeguard structures. Bonded to extra earthling or grounding connections, they exhibit low resistance and self-inductance. The split current can harm secondary side flashes, starting fires, breaking bricks and concrete or injuring people in structural structures.

Solar panels can affect the city's microclimate by generating heat or power from the sun. Lightning protection technologies like surge protection, utility bonding, and correct grounding avoid lightning-related fires. A complete lightning protection system includes lightning rods, conductor cables, arrestors, ground electrodes, utility bonding clamps, and surge protection. The researchers designed a lightning protection system different from the conventional type. Metal roofs may benefit from this design.

Literature

Lightning is a high-voltage discharge between clouds or the ground, according to Pangonilo, V. (2022). This high current discharge momentarily balances cloud-earth charges and protects buildings, transmission lines, and electrical equipment from lightning discharges and surges. Lightning creates transient overvoltage in electrical circuits and is one of the most researched natural occurrences. Understanding lightning is necessary to plan lightning protection to safeguard structures and electrical systems.

IEEESEM

Goetz (1915) said the invention of lightning rods provides an all-metal, detachable connection for lightning rod branch sections, consisting of a single flexible metal piece that is secured to a metal plug on one side and whose free end is designed to be bent over to engage the other side of the plug to encircle one rod. When the plug is inserted into the socket on the first rod, the tubular extension of the other rod detachably secures the ends of the metal piece. The invention provides a new and enhanced branch connection. He also noted that combining a flexible metal strip intended to ring the other section of a lightning rod with the branch parts, one of which has a tubular end, and a technique for attaching the ends of the strip within the tubular end of the first section,

A lightning arrester is usually placed at a building's highest point to safely transmit charges from a thundercloud to the ground. It has a lightning-protecting rod connected to the ground at one end and a discharge plate electrically linked to the rod under the rod cap and to which ground charges from the ground can be charged. A rod cap is electrically connected to the opposite end of the rod. (Chung, Y., 2007)

An Electric conduction compound-filled ground rod and connecting sleeve (Korea Electric Power Corporation, 2010) is a ground rod installation structure that drives the rod deeply into the ground includes an overhead earth wire installed to protect transformers, power transmission lines, etc. from lightning; a ground wire extended from a lightning arrester to the ground; a multi-stage ground rod extended by a thread

Copyright © 2023 IEEE-SEM Publications

type connection and connected with the end of the ground wire; and a connecting sleeve for attaching the ground rod to the ground wire.

Lightning Protection prevent fires and electrocution by protecting building electrical systems. Lightning conductors, usually metal rods, protect buildings from lightning strikes. If lightning strikes the structure, the lightning rod will be hit first, sending the strike safely through a wire to the ground. Lightning is an electrical charge that opposes electrical charges. The bottom of the cloud closest to earth has a negative charge, while the land below has a positive charge. The earth is non-conducting, dry air strip separates these opposed charges. Lightning falls in 150-foot increments when the two opposing charges pile up and the dry air belt moistens. The lightning protection mechanism draws the positive ground charge upward.

Methods

The construction of the Lightning Protection System includes copper-and-aluminum Lightning Arrester (LA) rods. Copper and other materials prevent lightning from scattering the charges during thunderstorms. Lightning strikes the building's highest poles. Once the bolt hits, the rod safely distributes millions of volts through copper or aluminum wires to ground the home and the earth. Lightning rods stop direct lightning strikes and flames. The researchers tested the device and the bulb's built-in output from an outlet. They checked the lamp's electrical flow, multi-tested output voltage counting at 250 volts on clay soil and checked the backyard voltage capacity. Since Philippine lightning testing is unavailable, the researchers undertook Do-It-Yourself experiments. The lLightning protection is optional, but the correct design method improves efficiency and utility. It requires theoretical and scientific inquiry, and air terminal improvements protect roof surfaces.

IEEESEM

The study utilized Copper wire, Solid Copper, Rubber Socket, Arduino Jumper Wires, LCD, and Clamp in the experiment, to wit:

- Cu-wire several types of electrical wiring use copper. Copper wire is utilized in power generation, transmission, and distribution for telecommunications, electronics circuits, and innumerable electrical devices;
- Copper, Solid metal core wire is heavier and thicker than stranded. Outdoor application requires durability and greater currents. This tough, affordable wire can withstand weather, harsh circumstances, and frequent transportation;
- Rubber Socket that fits to a ratchet or socket wrench to tighten or loosen a fastener by spinning it;
- Arduino Jumpers, Jumper wires have connection pins at either end. They join circuit locations without soldering. Jumper wires can change or diagnose circuits LCD;

Copyright © 2023 IEEE-SEM Publications

- The liquid crystal display (LCD) panel projects microcomputer on-screen information onto a bigger screen using a normal overhead projector so large crowds may observe it without crowding around the TV monitor; and
- Clamp, Clamps can temporarily fasten work. They are used in carpentry, woodworking, welding, building, and metalworking.

Findings

Components of lightning protection are made of corrosion-resistant materials, which need to be protected against rapid degradation. Copper and its alloys are utilized to make the highly conductive components of current-carrying systems. The strong corrosion resistance of copper, a noble metal that can endure attack rather well, is a result of its capacity to adapt to its environment and attain weathering equilibrium. When high electrical or thermal conductivity is required, copper alloys are preferable over copper alloys comprising more than a few percent total alloy content. It is prohibited to utilize material mixes that electrolytically couple in the presence of moisture. The outstanding combination of high strength and high ductility found in class 1 copper wire makes it the preferred material for lightning protection systems. Electrical wires may be made out of it because it is ductile, affordable, highly electrically conductive, and thermally resistant. Copper has a greater thermal conductivity rating than aluminum, which makes it more effective in reducing thermal hot spots. It is also thermally resistant, which makes it safer to use.

IEEE-SEM

Materials for stainless steel framing are exceptionally strong, ductile, and resistant to corrosion. They also have a natural covering that inhibits oxidation. Also, they offer a variety of standard and bespoke forms that may be utilized to create practically any element of a building and are resistant to damage from heat, water, and chemicals.

When planning and installing lightning protection systems, grounding is an important consideration because it offers a low-impedance route for fault and lightning-induced currents to reach the earth, assuring maximum safety. The performance of a grounding system can be impacted by changes in season or weather as well as temperature and moisture content in the soil. Current sources are sources of variable voltage that change their voltage until the amount of current they produced is what is required. The source can consume less power when a modest resistance is introduced, but when a high resistance is added, it has to work harder to provide the same amount of current. Higher touch or step potentials may result from this, as well as an inability to consistently run over-current or over-voltage devices strike.

The least resistance path to ground is provided by copper rod, which has a smooth, bright, and clean surface. To join copper wire to a copper ground rod, copper wire is connected using ground clamp, a high strength, highly conductive copper alloy. Materials used to construct stainless-frame nags can endure the impacts of heat, water, and chemical degradation. Due to its special blend of high strength and great ductility, copper wire is the preferred material for wiring systems.

Copyright © 2023 IEEE-SEM Publications

The height of a lightning arrester is what makes it stand out from other objects and impacts how well it can guard against lightning. The height of a lightning arrester when it is positioned on the ground is simply ascertainable, but this is not always the case with structures. The comparable collection area of a structure, which is three times as tall as the building, is calculated according to risk assessment criteria taking this into consideration. To discourage people from staying on the roof in the case of an approaching lightning strike, all roof components should be secured, and if the top half is open to the public, a local storm detector should be placed. With the addition of more technology to residential houses, the risk that electrical surges and strikes represent to homeowners is increasing.

Regardless of where it is situated in respect to the roof edge, the height of a single high-rise lightning arrester that is put on a roof and intended to shield structures below should be measured from the ground. The protective impact of the building itself should be evaluated when the facility's ground-level protection is insufficient, and the risk assessment parameters used to determine a residential property's lightning susceptibility include low risk, medium risk, and high risk.
Based on the experiment conducted by the researchers, the length of the cable for the lightning rod will depend on how high the house or building is, as long as the user has the same type of lightning rod/ground rod and wire. Copper and aluminum should not co-exist when constructing a lightning rod because of the galvanic reaction; the contact part of copper and aluminum will accelerate the oxidation of the aluminum wire. In addition, the copper and aluminum joints will lose contact over time. The prime example of this is the cable used that has a resistance of 3 ohms which is close to zero. This means that the circuit close to no resistance (0) would indicate a complete circuit or one that has no short.
With this, the experiment's length of the cable will not actually be an issue if the type of wires is correct and attached to the lightning and ground rods perfectly. The closer the cable to 0 resistance, the better the conduction of current.

The study investigated the time fatality rates from 2018 to 2020 in the Philippines. There are an annual total of 215 deaths: 70 in 2018, 49 in 2019, and 96 in 2020. This shows that there is a need to install lightning protection systems in barangay facilities to reduce the effect of lightning struck during thunderstorms.

IEEE-SEM

Copyright © 2023 IEEE-SEM Publications

Table 1. Numbers of deaths from lightning in year 2018

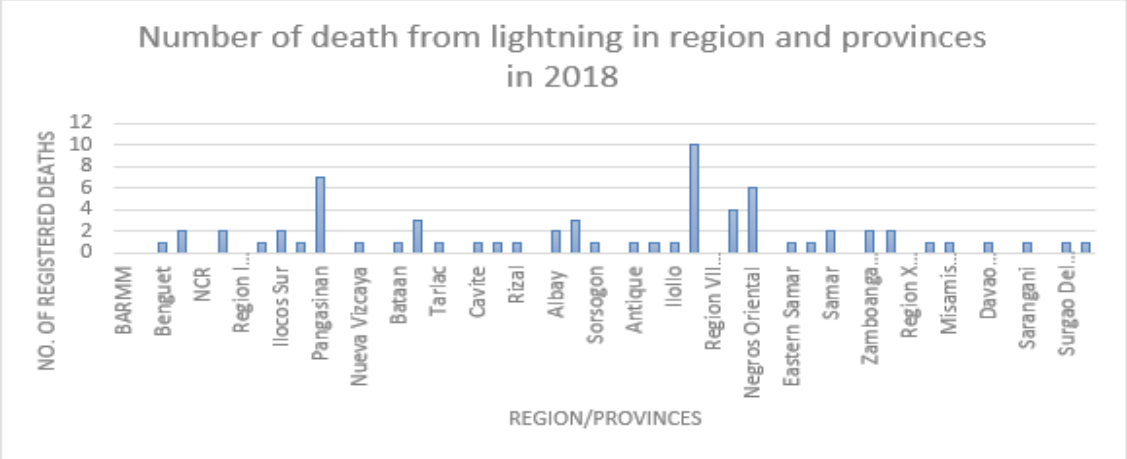
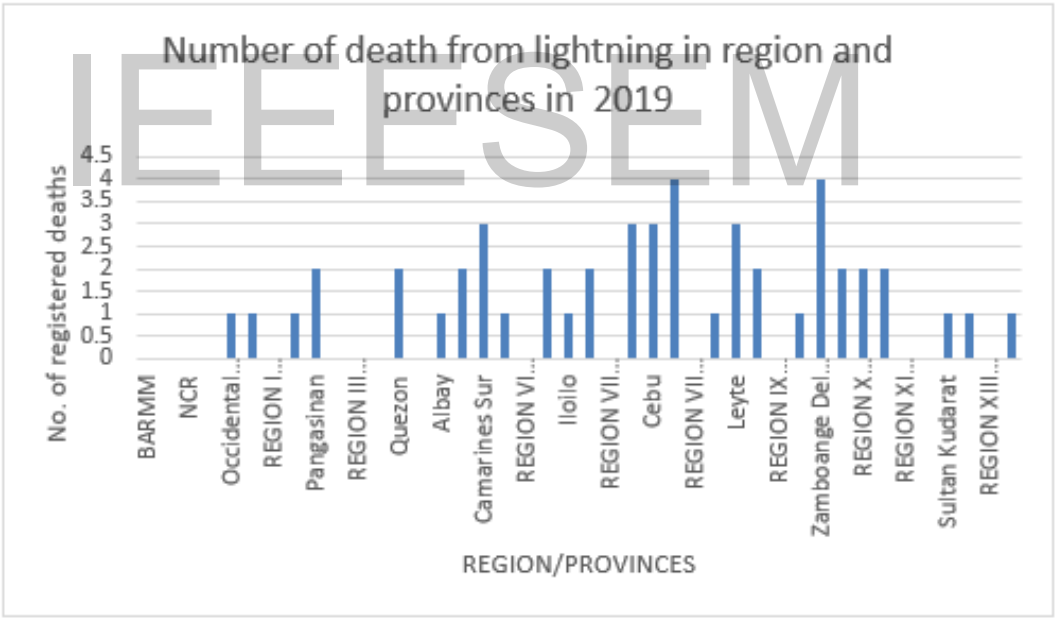


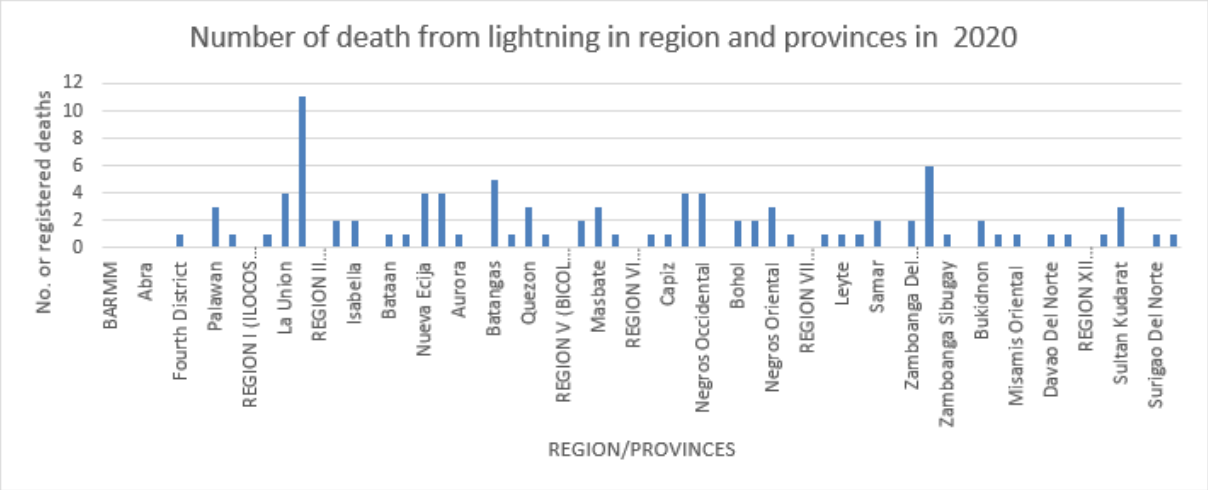
Table 2. Number of deaths from Lightning in the Year 2019



IEEESEM

Copyright © 2023 IEEE-SEM Publications

Table 3. Number of deaths from lightning in year 2020



All of the aforementioned incidents, as well as a large number of others over the past few years, demonstrate how lightning can strike people while they are engaged in a variety of daily activities like working, walking, resting, riding a habal-habal, or seeking shelter from the rain. Additionally, they demonstrate how common fatal lightning strikes are in rural areas across the nation. The victims have mainly been farmers, cattle grazers, and laborers, who live in marginalized communities where people are most susceptible to the catalytic elements of lightning.

IEEESEM

Conclusions

The device was built, improved, and given additional features before being tested to see how well it worked.

The respondents rated the design, safety, output materials, and usefulness as good and outstanding. The assessors found the manufactured output to be either satisfactory or exceptional at converting electricity. Researchers found that the output creates a safe power channel without harming the environment. The output shows that a cheap lightning rod can be protection against lightning.

Lightning often damages persons and property. Indirect impacts from inductive or capacitive coupling may damage electrical and electronic equipment inside the structure, while direct impacts may cause structural failure. The lightning protection evaluation study ensures that the facility, including buildings and tank farms, is lightning-proof. Traditional lightning protection uses exposed lightning

Copyright © 2023 IEEE-SEM Publications

masts or rods at the highest elevations of structures connected to a grounding system by downward conductors. A design approach determines the ideal lightning rod or mast positions based on their protective area. Lightning protection systems protect building occupants against fire, mechanical damage, and death.

Lightning protection is complex, and even the most advanced methods cannot silence thunder. Instead, use a complete management approach, the correct therapy, and prevent lightning strikes. The single signal ground prevents ground network stray current from disrupting communication equipment. The building's protective measures dampen the lightning electromagnetic field, reduce lightning overvoltage damage, and allow communication equipment to work correctly. It prevents lightning-related fatalities.

Reference

Portal, E.-. E. E. (2020, August 28). Lightning protection guide EEP. EEP- Electrical Engineering Portal. https://electrical-guides/electrical-engineering/lightning-protection

Karr, D. (2021, September 24). Does my home need a lightning rod to protect from lightning strikes? ValChoice. https://valchoice.com/consumer-insurance-information/lightning

Mesh width of ground grids in shelters with small base areas for low step voltages at lightning currents. (2018, September 1). IEEE Conference Publication | IEEE Xplore. https://ieeexplore.ieee.org/document/8503353

Current Impulses in the lightning Protection System of a Test House in Poland. (2015, June 1). IEEE Journals & Magazine | IEEE Xplore. https://ieeexplore.ieee.org/document/7042753

IEEESEM

Copyright © 2023 IEEE-SEM Publications