CHAPTER 3

GROUNDING RESISTANCE OPTIMIZATION FOR BUILDING LIGHTNING PROTECTION

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3.1 INTRODUCTION

A lightning protection system (LPS) is a protection system that protects a building structure from lightning strikes, either mitigating the strike safely to the ground or intercepting the lightning strike before it strikes the structure. An effective LPS consists of three components, namely air terminals, down conductors, and grounding termination. All these components must be well connected and provide a shallow impedance path for the lightning current to dissipate safely through the ground. Conventional and non-conventional methods are the two types of LPS that is used worldwide.

The general arrangement of a conventional lightning protection system is illustrated in Figure 3.1, which shows a standard LPS that complies with the relevant technical standards and codes of practice. For this system, Franklin rod acts as a passive device and a sacrificial device to protect the structure from lightning strikes (Shindo, 2020). Several Franklin rods will be installed at a different location on the roof with the highest possibility of being struck by lightning.

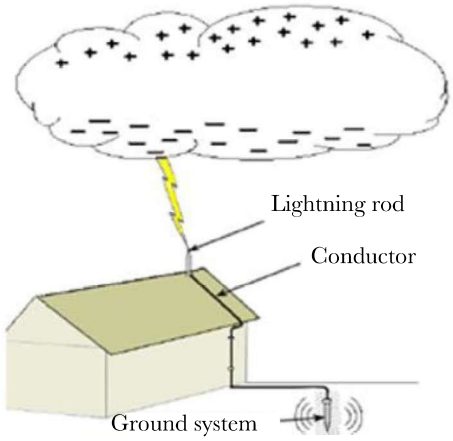

Figure 3.1 Franklin rod as air

The lightning stepped leader begins in the cloud charge region and carries negative charge towards the ground at a typical average speed of 5 kV/m to 20 kV/m (Shindo, 2020). The charge on the leader channel produces an electric field near the earth's surface that becomes strong enough to create a positive charge that is enhanced by the Franklin rod on the roof. When the leader reaches the ground, this electric field becomes large enough to produce an electrical breakdown between the Franklin rod and the ground (National Lightning Safety Council, 2020).

Early streamer emission (ESE) air terminals' primary objective is to produce ionization around the lightning rod and attract strikes before hitting the earth or the structures (Shindo, 2020). However, from the ESE study, evidence has been discovered that strongly suggests these types of LPS are vulnerable to protection against lightning. The data collected shows that it does not provide a better protection zone than conventional LPS. A performance test study between Franklin rod and ESE found that there are no superior results of ESE compared to Franklin rod.

Table 3.1 shows the effect of ten consecutive discharge tests on both the terminal in 1m height and found that the discharge hit the Franklin rod and hit the ground. The result also refutes the claim that ESE had a more extensive protection scope than Franklin rod.

Table 3.1 Result of ten discharge test from 1.0 meter

Normal Polarity of Voltage Waveform D						
Discharge distance	**2.0m**	**2.5m**	**3.0m**	**3.0m (exchange)**	**3.5m**	**3.5m (exchange)**
ESE stuck time	3	2	7	5	6	7
Lightning rod struck time	4	3	1	2	2	3
Ground struck time	3	5	2	3	2	0
Negative Polarity of Voltage Waveform D						
Discharge distance	**2.0m**	**2.5m**	**3.0m**	**3.0m (exchange)**	**3.5m**	**3.5m (exchange)**
ESE struck time	4	4	5	4	6	5
Lightning rod struck time	1	3	5	6	4	5
Ground struck time	5	3	0	0	0	0

3.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

Effective LPS consists of three components, namely air terminals, down conductors, and grounding termination.

3.2.1 Air Terminal

A system of interconnected metal rods or tapes, etc. at the right position on the structure for optimum protection and interception with lightning stepped leaders who would have attached to the building if there were no such system. Air terminal positioning must follow the guidelines of International Electrotechnical Commission (IEC) 62305-3 standard, namely rolling sphere, protective angle, and mesh methods. Minimum cross-sectional area for vertical copper rods is 100 mm^2, while 50 mm^2 for copper tapes makes a horizontal mesh.