Ubiquitous and Perplexing Proliferation of Non-standard Lightning Protection System in Developing Countries

Shriram Sharma
Department of physics
Amrit Campus, Tribhuvan University Kathmandu Nepal
South Asian Lightning Network
ramhome2@hotmail.com,

Chandima Gomes
School of Electrical and Information Engineering, University of the Witwatersrand
Johanenesburg, South Africa
chandima.gomes@wits.ac.za

S. Gopa Kumar
Lightning Awareness and Research Center, Trivandrum, India
Cape electric Pvt Ltd India.
gopa0904@gmail.com,

Foster Chileshe Lubasi
Zambian Centre for Lightning Information and Research
Lusaka, Zambia
chile2015lubs@gmail.com

***Abstract*—Human safety and protection of properties from lightning hazards have been a challenge in many developing countries in lightning dense regions for the last many decades. Perennial and deep-rooted myths, superstitions and the proliferation of non-standard lightning protection systems aggravate the situation. In this study, we have attempted to underscore various challenges that protection practitioners and scientists have been encountering in developing countries at present. The non-existence of national standards and guidelines, weak imposition of codes, in those countries, can be attributed to the failures in mitigating the loss of lives and damage to properties. The proliferation of non-standard lightning arresters, that are being professed as magical solutions, has obscured not only the public but also the engineering professionals hindering them from adopting scientifically proven mitigation measures. Moreover, the design and installation practices adopted for such arresters fail to follow any national standards despite their claims. Such practices not only increase the risk but also lead to incur unnecessary financial burden. It is, therefore, an urgent need for the international scientific community to come forward and support the practicing scientists, engineers and the government authorities to ensure adoption of scientifically proven protective measures in the developing countries.**

Keywords—Non-standard, lightning, protection, lightning-myths, lightning deaths

I. INTRODUCTION

A significantly large number of people, around the world, succumbed to lightning-related injuries each year. The vast majority are from developing countries [1]. Documented numbers of lightning fatalities and injuries in developing countries are often not available. The paucity of the fatality data could be due to the fact that unlike other disasters such as earthquakes, landslides, tornadoes etc., lightning fatalities are rather sporadic and scattered, thus the chances of underestimation of fatalities by the governments and other concerned organizations/authorities are relatively high [2]. Holle and Lo'pez [1] estimated that 240,000 people are injured each year based on lightning stroke density and populations in the tropical and subtropical areas of the world. Fatality and injury rates in the developing countries are much higher than those in developed countries such as Australia, USA, UK, Japan etc. due to the following reasons [3]. These differences in fatality rates have been attributed to several factors common to developing countries [2].

a) Fewer lightning-safe homes, workplaces, schools, and other facilities than in more developed countries.

b) Higher rate of out door work such as manual agriculture, *street vending etc*

c) Lack of awareness or data/information about the lightning threat, how to avoid injury, and medical treatment.

d) Fewer easily available substantial buildings and fully enclosed metal-topped vehicles.

e) Inadequate emergency medical services and high-quality medical care.

f) Inadequate disaster risk reduction programs.

However, the above attributes do not take into account the perennial myths, superstitions that exist in those countries. Furthermore, in the developing world, national standards are usually non-existent and even when a code is specified by the nation's bureau of standards, it is usually not implemented at the construction level because of lack of familiarity with the codes, lack of experienced protection engineers and non-availability of code-compliant materials. The non-availability of code compliant materials for lightning protection systems can be attributed as another reason for the large number of fatalities and property damage in those countries [4]. In addition, other potential reasons may be attributed to lightning protection codes being perceived as too complicated as there is often a lack of qualified designers and installers [4]. Despite the several scientific reports that have denounced the claims of non-standard lightning arresters [5, 6, 7, 8, 9], such products continue being proliferated with greater pace in the less developed countries. While the non-standard and so-called active arresters are infiltrating the market in the less developed countries, another lightning protection system comprising of a bicycle rim fixed on the tall bamboo pole, has surfaced in some states of India. To the best of our knowledge, such products have neither been scientifically tested nor have any proven basis (or

record). The chaotic situation in the less developed countries have provided a conducive environment to the proponents and vendors of non-standard and claimed magical lightning protectors that lead to the proliferation of such products in the market. A methodical analysis of these drawbacks is a requirement at present to eradicate them from society. This work is an attempt to serve this need.

II. LIGHTNING MYTHS

Since time immemorial, every human civilization has incorporated lightning in its mythologies. Many such myths have been modified or distorted with time and region. A common perception in almost all those mythologies is that lightning was used by the deities of respective civilizations as a weapon to punish the people committing sin [5]. Protection from being struck by lightning was considered to be accomplished by appeasing the deities in various ways. Some of the techniques that were adopted in various cultures are as follows:

a) Erotic carvings that can be observed on the struss of many of the Hindu temples across Nepal and India are believed to be used to appease the Hindu deity Lord Indra, who is considered as the lord of fire and lightning.

b) In some communities in Nepal, such carvings were used in the temples to shy away the Goddess Kumari who is considered to be the goddess of lightning.

c) In some African tribes, the thunder god is charmed by winding some threads around trees.

In addition to appease the thunder god, there are some traditional methods and ways, still in existence in many societies, to protect the structures from lighting. A few of such concepts are as follows:

a) Cactus trees are planted on the roof of a house during the house warming ceremony that is believed to protect the house.

Figure 1: A photograph of cactus plant placed on the roof of common house in Nepal for averting lightning from striking the house.

b) Many hindus in Nepal and India keep the reed-grass or big cordgrass (*Desmostachya bipinnata*) in their house with the belief that this grass protects the house from lightning and fire.

Figure 2: A snapshot of reed-grass which is believed to (and advocated by the Hindu priests) avert lightning from striking the house.

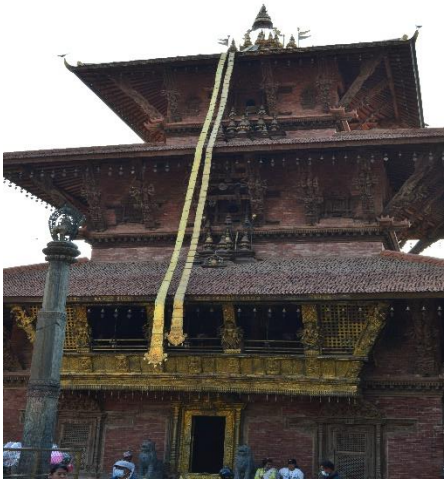
Figure 3: A photograph of Vazra (Dorje) placed on a pillar in front of a Swayambhunath Buddhist temple in Kathmandu Nepal. Note that the temple, partly seen next to the Vazra, was struck by lightning on 13th February, 2011.

c) Vajra (dorje) is placed on pillars in front of Buddhist temples with a belief that the thunderbolt is buried underneath and hence no lightning will strike the temple.

III. EVIDENCES OF SCIENTIFIC PRACTICES IN THE HISTORICAL TIMES

Although the present-day scientific practices such as IEC 62305 could not be verified, there is some evidence on the 400 AD monuments (such as Pashupatinath temple in Kathmandu) that protective measures against lightning could have been adopted. Most of the temples across Nepal built during the same era or middle ages, are seen to have metallic sheets on their roof on the highest point of which, a metallic sword is erected and is connected with a metallic strip seen hanging well below the lower part of the roof even today. Such an installation along with earthing system could have been practised during that time, but the lack of the transformation of knowledge led such installations to be a mere decoration of the structures.

(a)



(b)

Figure 4: Photographs of: (a) Manakamana temple, some 80 km west of Kathmandu. The roof of the temple is gold plated with a metallic spire on the top (apparently an air termination system) being connected with a metal strip (apparently a down conductor). (b) Two metallic strips hanging from the roof and connected to the spire on the top of Bhimsen temple (built in 1680 AD) located in the premise of Patan Durbar square, Lalitpur Nepal.

Similarly, the Buddhist temples/stupas built during the medieval period have large mettalic structrues towards the top of the structures.

Figure 5: A photograph of Buddhist temple (stupa) at Swayambhunath, built atop a small rocky hill (around 640 AD) in the western part of Kathmandu Valley.

IV. Present scenario

As many developing countries either do not have their national standards on lightning protection systems or have not been able to implement the standards even if they exist at all, protective measures against lightning complying with IEC in those countries is largely lacking. Exploiting the non-existence of national standards, several vendors unethically advocate their non-standard product to be much efficient than the methods proposed in IEC 62305 standards. Such non-standard protectors include Early Streamer Emission (ESE) devices, Dissipation Array System (DAS), Charge Transfer System (CTS) etc. These products are professed to be magical that either they avert lightning hazards, deviate the lightning attachment or totally eliminate lightning. Although, such claims have neither been scientifically proven nor have those products exhibited superiority over the conventional system as of today. Often the vendors are found to claim that these efficient arresters protect from lightning in a radial distance of a few hundred meters to a few kilometers. In extreme cases, they may even claim a few kilometer radius of protection. Furthermore, the installation of non-conventional protection systems are being practiced without complying with any of the national standards despite their claims. Such practices not only mislead the common people but often the engineers and managers. Interpreting these products as magical, they are installed on the structures breaching all the scientific values and standards. An example of such installation is shown in figure 6.

Figure 6: A photograph of ESE lightning air-termination erected right under the communication tower (marked in a circle) on a building in Kathmandu. Such practices are abundant in many urban areas of Nepal and this particular building is located very close to the Department of Urban Development and Building Construction, the regulatory body for building codes.

Such non-conventional lightning protection practices are often claimed to have been following the French standard (NFC 17-102) in order to get validation, though, the design and installation practices fail to comply with the claimed standard. Such installations have been observed at all the sites taken into account in this study in Nepal. An example of such installation can be seen in the photograph captured at the newly built building of Department of Hydrology and Meteorology (DHM) Nepal as is in figure 7. The new DHM building is about 40 m tall and ESE rod is placed towards a corner on the top floor of the building leaving the whole other section of the structure unprotected. Further, a copper strip

used as a single down conductor has been dragged through a PVC raceway within the structure as shown in figure 7 (b). Seen in the figure 7 (c) is the down conductor strip dragged out of the building through a window.

(a)

(b)

(c)

Figure 7: Photographs of (a) An ESE lightning air termination system positioned at a corner of the Department of Hydrology and Meteorology building, Babarmahal Kathmandu.
(b) A PVC raceway through which the down conductor has been dragged to the earth termination system through within the building.
(c) Down conductor dragged out of the building and fitted with lightning counter.

In addition to inappropriate usage of non-conventional lightning protection system, some practices on conventional system can also be seen. However, lack of knowledge on the scientific method as IEC 62305, they fail to comply with standards and often lead to increase the risk instead of mitigating. An example of such installation has been observed in some structures at Neelkantha municipality of Dhading district, Nepal. As seen in the photographs in figures 8 (a) and (b), lightning protection system installed on school building of Neelkantha, fails to protect the protrusions and the bare down conductors are seen within the easy reach of humans. One can clearly see that the installation was done without proper field assessment and fail to comply with the standards set by IEC 62305-3. A field assessment of the lightning protection system on the school building was conducted during which it was observed that the installation of down conductor system does not follow the measures set by the standards (IEC 62305) and were seen to have sharp bends as in the figure 8 (b).

(a)

(b)

Figure 8: Photographs of (a) Conventional lightning protection system installed on a school building of Neelkantha municipality of Dhading Nepal. As is seen in the photograph the protrusions of the building have not been covered.
(b) The down conductor left bare within the reach of school children. This installation neither addresses the measures against step potential nor has taken into account of the trees surrounding the school building.

In the recent past, a few people in India came up with a concept that a simple indigenous device that may give personal protection in a range that varies from a few hundred meters to a few kilometers. Such devices consist of a metal wheel (basically a bicycle rim) placed on the top of a few meters long bamboo pole as shown in figures 9 (a), & (b). Claiming the arrester to be magical, the proponent has been claiming that installing such arresters in some states has mitigated the loss of lives by about 60% compared with the previous years. It is not clear how such metal wheels provide protection scientifically. The proponents also fail to provide any evidence in which such system protecting humans while

intercepting lightning strikes. Such claims have not only misled the public but also have misled the media, humanitarian organizations, organizations working in the field of disaster risk reduction and even scientific community. This has become a big challenge to the scientific community practicing protective measures complying with IEC.

(a)

(b)

Figure 9: Photographs of (a) Bicycle wheel erected on a bamboo pole being advocated as magical lightning arrester that protects people in the area (b) Villagers preparing for the installation of bicycle rim on a bamboo post (photograph courtesy BBC news: https://www.bbc.com/news/world-asia-india-59006609). (Note: such practices have reportedly been awarded for the invention by one of the states in India).

V. SUMMARY

Lightning is one of the major disasters that kills around twenty-four thousand people globally, where a majority are from developing countries. The lack of awareness, paucity of safe shelters, (too many noble) outdoor activities, perennial myths, superstitions that exist in those countries are attributed as the main reasons for human fatalities in the developing countries. Furthermore, the lack of national standards and their implementation of lightning protection systems in these countries have provided a conducive environment to the proponents and vendors of non-standard and professed magical lightning protectors that lead to the proliferation of such products in the market. Unethical promotion of fraudulent products, lack of knowledge on the scientific methods of lightning protection systems are some other reasons for such fatalities. In order to curb the proliferation of non-scientific products and practices, urgent action is required for the purpose The scientific community should play a vital role to draw the attention of government authorities to help adopt the scientific methods. At this point it is worth applauding the enforcement of directives by energy commission of Malaysia stipulating the design, installation, supervision, testing, operation and maintenance of the lightning protection devices in a building be made in accordance with lightning protection system set by Malaysian standard MS IEC 62305 effective from January 01, 2021. Such an enforcement might be considered as good reference for other developing countries to adopt the international standards. Working in the developing countries, authors have felt that there is a dire need of getting support from the scientific community, particularly from the developed nations in an anticipation to encourage scientific practices and discourage fraudulent products from infiltrating developing countries.

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