International Journal of Applied Engineering Research
ISSN 0973-4562 Volume 10, Number 12 (2015) pp. 31629-31634

http://www.ripublication.com

Step Voltage: A Major Cause For Lightning Casualities

[1]S. Selvi and and [2]Dr. S. Rajapandian

1. Research Scholar, Sathyabama University, Chennai, India.
2. Senior Professor, Panimalar Engineering College, Chennai, India

Abstract

The technology of lightning protection have shown several improvements but even with all the known precautions, complete safety is still beyond our reach. In India, thousands of deaths occur every year from lightning strike. The reporting of lightning deaths and injuries are haphazard which leads to under reporting of lightning related incidents. In India such deaths are common in the rural areas compared to the cities and hence most of the victims are farmers, villagers and children. Despite the availability of several precautions and guidelines, there is no specific instruction to common man's safety in such places. The authors have visited various places of lightning incidents for the past few years. In this paper, three such similar cases of lightning incidents are analysed

Keywords: lightning, guidelines, precautions, safety, step voltage,

NEED FOR STUDY

Though several proactive measures and safety tips are available and distributed to common public, deaths due to lightning is very common in India.. Farmers are more prone to lightning accidents as compared to city dwellers, as they are from the low socio economic status group and they are forced to remain at work even during the high risk of thunderstorm and lightning. Due to obvious reasons, open fields are more vulnerable to lightning strikes and most of the deaths are reported from these places.

Economic damage due to lightning is another area to be studied further as lightning causes damages worth billions of rupees in the housing, agriculture, industrial sectors. Ever since the natural calamity compensation process was initiated by Goverment of India, lightning was not included as a natural calamity due to the underestimated death, injury, and damage figures. [2]. In India, the number of deaths due to lightning attack is very high in state like Kerala This year the Kerala state

government has placed a demand to the Union government to recognise lightning as a natural calamity, thereby making victims eligible for compensation from national relief funds. [3]. All these confirm that the people and Government of India is not fully aware and are yet to recognise the immense damage caused by lightning. Therefore, there is an urgent need to create the awareness on lightning protection and personal safety among different target groups such as educated and uneducated people, villagers, rural youths, school-going children etc.

In this paper the safety measures which are needed to be taken by the common man, when working in fields or in open areas are discussed.

The mechanism of step voltage

There are many ways a lightning current can cause casualities. The danger from lightning is not confined to direct strike. Most of the casualities come from indirect effects of nearby strike. In India the majority of the personnel injuries seems to happen due to ground conduction of lightning current. The prominent effect is damage due to step voltage.

Consider the point P where the lightning hits the ground at point 'P', and the lightning current flows radially outwards. The equipotential lines established in the ground are represented in figure. 1. The voltage difference between any two points on the Earth's surface at different radii a and b is called the ''step voltage'' because it will appear between the two feet of a standing humanbeing with one foot at 'a' and the other at' b'. The lightning current which is in the order of tens of thousands of amperes injected at the point P will create a potential difference of (Va-Vb) over the step length which can easily be tens of thousands of volts. Since there is a voltage difference between two points (feet) and the human body acting as shunt impedance causing a current to flow through the body. The magnitude of this current depends on the contact feet impedance and body impedance. The step voltage is given by

$$V_{ab} = -\int_{b}^{a} E_r \, \mathrm{d}r = \frac{\rho I}{2\pi}\left(\frac{1}{a} - \frac{1}{b}\right), \quad a > r_0, \quad b > a$$

The larger the distance between 'a 'and' b 'larger the step voltage. Therefore step voltage is highly dependent on distance between the feet. The lightning current is inversely proportional to square of the distance from the point 'P'. This means a person standing near the point where the lightning current enters the earth may have large potential from foot to foot. The potential difference for the same span will be less as the span is moved away from the point where the current enters. However if there is water body on the ground then the danger prone area is extended up to the end of the water body, as the resistance offered to the flow of current by water is less.

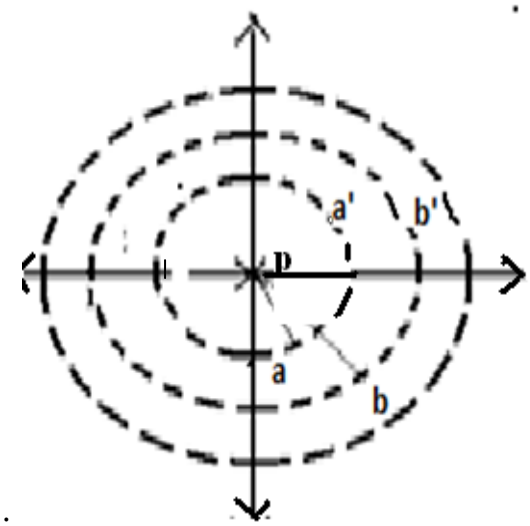

Figure. 1. The equipotential lines established by the lightning current flowing in the ground.

Analysis of Lightning Accidents

Case 1:

In November 2007 thirteen goats were dead due to lightning in kootadi village near ulundurpet Tamilnadu, India. at the time of incident, the goats were grazing in a open field and the lightning had struck a nearby tree. Though there were 100 goats but only 13 found dead.. The government officials were not even aware that the meat is edible so they did not give proper instruction to villagers. And finally it turned out to be big loss for the shepherds.

Case 2:

In july 2008 five farm labourers, including a woman were struck dead by lightning at Salavathi near Tindivanam, Tamilnadu, India. Seven of their co-workers were injured. The lightning had struck a tree in the paddy fields. At the time of the incident, the labourers were standing near the tree and were holding a plastic sheet over their heads for protection against rain. The leg position of the victims are depicted in the figure 2.

Cases 3:

In November 2014, two women agricultural workers were killed and five labourers injured when lightning struck at a paddy field in Mallivakkam near Ponneri in Tiruvallur district, Tamilnadu, India. The incident took place when nearly a dozen women were working in the slushy fields, braving the rain to transplant paddy saplings from the nursery. The lightning had struck nearby a tree. Two people died on the spot, and the four others were injured. The authors had visited this place. The victims who were dead were planting sampling with their legs apart as depiected in the figure 3

Impact of step voltage.

During lightning strike the leg position is very important, In India Generally the people while working in the fields will have leg posture as shown in figure 3 It is evident that in cases 2 and 3 the people who are dead were keeping their legs apart at the time of lightning strike. Considering the figure 1. at the time of lightning, if a human or animal with leg position at point a and a' are safe as they are on the equipotential surface, whereas at point a-b or a'-b' are unsafe and they will be subjected to step voltage. So protection from step potential hazard should be to stay on the equipotential surface as shown in figure. 4. But it is very difficult for anyone to realise the equipotential surface at the time of lightning strike. so the best thing would be to keep the feet together to make step voltage zero. In case 1, thirteen goats which are dead are victims of step voltage. The animals which are inside the potential gradient area i. e. between point a and b, a step voltage would have provided shock. The remaining goats would be either by chance with the leg position on the equipotential surface or they would have been faraway from the point of lightning strike. Afour legged animal like cow, will be exposed to a much higher voltage than human being, because of the larger distance between their hind legs and forelegs. In most, but not all, group strikes the people who were dead are probably victims of step voltages occurring between their feet, owing to a relatively uniform current flow in the Earth.

Step voltage is the reason for the death of animals or human beings. in India, most of the lightning causalities occurring in ruaral areas are of this type. The step potential hazard manifest in situations where people perceive that they are safe. Many step potential accidents occur when people find shelter from rain under a tree, Even though there is no direct strike to personnel, injuries and fatalities from the resultant electrical shock can occur. Protection from step potential is an important design consideration for personnel protection. Thus the common man should be instructed to keep their feets together at the time of lightning. This simple instruction could save many people from hazard.

Figure. 2. The leg position of people working in fields

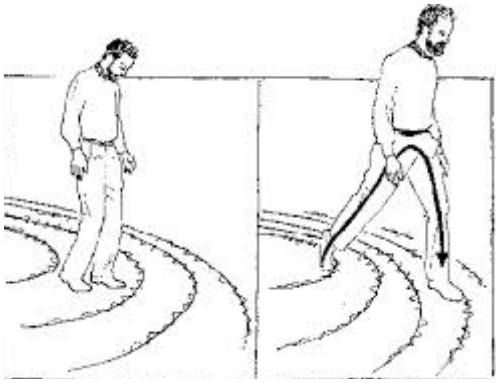

Figure. 4. The safe position of legs.

In India there is tradition practised right from olden days is, when there is a imminent danger of lightning people are adviced to pray and this belief would ensure them safety. While offering prayer to God, people tend to keep their feets together and this posture is nothing but a measure for protection against step voltage hazard.

Conclusion

It must always be remembered that no place outside is safe near a thunderstorm. Though lightning deaths are not predictable but preventable. Lightning safety can be mainly achieved mainly by creating public awareness. People who are working in outdoors and fields or in open aresa should be instructed to keep their feet together when there is a imminent danger of lightning, thereby escaping from step potential hazard.

Continuing their works in paddy fields, during lightning. It leads to lightning casualties and deaths leading the poor people to lose their family members. Though lightning deaths are not predictable but preventable. Casualties due to Lightning can be easily avoided and lightning safety can be achieved mainly by creating public awareness.

References

[1]. http://www. thehindu. com/todays-paper/tp-national/tp-tamilnadu/lightning-kills-two-workers-injures-five/article6559233. ece

[2]. http://www. thehindu. com/todays-paper/tp-national/tp-tamilnadu/lightning-claims-five-lives-in-tindivanam/article1312605. ece

[3] Different Presentations of Victims of Lightning During Thunderstorm, J Indian Acad Forensic Med. July-September 2013, Vol. 35, No. 3 ISSN 0971-0973

[4] Lightning Risk in IndiaChallenges in Disaster Compensation, Faisel T Illiyas, Keshav Mohan, Shibu K Mani, A P Pradeepkumar, Economic & Political Weekly june 7, 2014 vol xlIX no 23
[5] http://www. thehindu. com/news/national/kerala/drought-management-to-be-part-of-local-planning-process/article6516508. ece
[6] http://www. lightningsafety. com/nlsi_pls. html
[7] http://www. thehindu. com/todays-paper/lightning-kills-three-injures-nine-in-tirunelveli-district/article6455916. ece
[8] http://www. ndtv. com/topic/tamil-nadu-lightning
[9] Uman, Martin A. ' "All About Lightning"; p. 55, 81; Dover Publications N. Y. ; 1986; ISBN-2-486-2537