Exclusives

Struck by the lightning bug

Hartono inspecting lightning damage from building tops

By Hooi You Ching

When lightning strikes, humans aren't the only casualties. Buildings too are subjected to the trauma that comes from Mother Nature's high-voltage electric whip.

The physical scars, says lightning scientist Hartono Zainal Abidin, are generally visible on sharp corners of buildings, pointed tips of spires, exposed edges of horizontal roofs and the ends of roof ridges.

Hartono's interest in lightning research began in earnest while working as an engineer for Telekom in 1980. During his field work, it struck him that he was constantly diagnosing equipment damage caused by lightning strikes. After he left the utility company to join Telekom vendors, he discovered that similar problems existed in those companies too.

The lack of information and scientific data on the subject of lightning strikes to buildings and equipment prompted his own research initiative. He began to study lightning behaviour by conducting case studies of buildings struck by lightning. Over a period of five years, he managed to compile data from 200 buildings within the Klang Valley. The findings proved invaluable as it helped identify the potential points of lightning strikes to a building.

"In Europe, it would have taken about 50 years to collect the equivalent amount of data. That is why no western scientists have attempted this kind of research since 60 years ago. It would have taken them more than a lifetime to collect the data."

For Hartono, the fact that Malaysia has between 200 to 300 thunderstorm days annually gave him

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an edge.

"There's plenty of them here. And free-of-charge too!," he quips.

International recognition

A decade after his research undertaking, he set up a consultancy together with his wife Robiah Ibrahim to provide expertise in diagnosing lightning problems in the electronic and IT environment.

Nowhere in the world is there a city like Kuala Lumpur with that much intense lightning activity. Incidentally, his work on the effects of natural lightning is the third of its kind done in the last 120 years.

According to research literature from the University of Queensland, his studies have been recognised by western scientists as having the most comprehensive report which is based on realistic settings.

"Other researchers use either the rocket-triggered lightning (which has a different characteristic to natural lightning) or the high voltage lab that launches big lightning-like electrical discharges. These are not lightning!

"The last experiment was done by a German who went by the name of B. Walter in 1937. But his data published in the "Zurnal fur Technikal Physik (Journal for Technical Physics) was so insignificant - there weren't many lightning-damaged buildings in Germany at that time - that it was soon forgotten.

"The only other known group that studied lightning using natural lightning is one led by Professor Moore of the New Mexico Tech. His 'lab' is in the mountains of New Mexico, USA," Hartono pauses to emphasise the next fact, "but barren without the buildings."

His field of expertise lies mainly in lightning interception. That means he investigates the damaging effects of lightning on buildings and finds solutions for installing proper lightning protection systems.

However, the recent proliferation of unconventional lightning protection technology called Early Streamer Emission (ESE) in the

market troubles Hartono.

"The ESE lightning rods are not approved by SIRIM and have been proven ineffective since 1995. I've been campaigning to the government that this standard of lightning rods not be allowed for public and private use.

"The ESE claims its ability to release early streamers helps form an umbrella shield across the building tops. But western scientists have refuted such claims, saying that theoretical evidence have shown otherwise. Countries like Australia, New Zealand Singapore have since banned their usage," explains Hartono.

Streamers are natural electrical discharges that are released from objects when subjected to a strong electric field. In reality, anything on the earth's surface has the ability to send a streamer.

On the other hand, Hartono explains, the conventional lightning rod or better known as the Franklin Rod does not claim to have any special properties. That is if you want to protect your building, you put the rods at the corners of the building. In the event of a lightning strike, it hits the rod that will conduct the energy through copper wires grounded to earth.

The chairman of the Singapore Code of Practice for Lightning Protection technical committee Prof Liew Ah Choy reiterates Hartono's concerns. In a letter to the Massachusetts-based National Fire Protection Association (NFPA), Liew highlighted discrepancies inherent in the ESE system.

"In 1982, the Public Works of Singapore banned the use of radioactive lightning protection terminals for installation. The technical committee of the Singapore Code cannot see scientific merits of the remarkable claims made by the ESE systems, particularly their much increased range of attraction to a lightning leader. Scientifically, I cannot reconcile the claims with the Law of Physics," wrote Liew, a professor with the Department of Electrical Engineering at the National University of Singapore.

According to Hartono, it takes a certain kind of discharge for the streamers to be released from the device to enable it to capture it from a distance of 50 – 100 metres. Apparently, the device claims to have a protective radius which Hartono alleges

was never there in the first place.

"Experiments in the West showed that the speed at which the streamers were discharged were too slow. ESE vendors claim that the speed is 100 times faster than what was observed in physics.

The odds of a lightning strike

When asked which was more prone to a lightning strike, buildings or people, Hartono cited scientific formulas.

"Buildings of course, simply because they are bigger and taller than humans. The probability of being struck by lightning is proportional to the "collection area" of the target. For example, the number of average annual lightning flashes per sq km in Malaysia is about 25, so we can expect on average about 1 flash in an area 200m by 200m.

"A building whose size is L=100m by W=100m by H=50m would have a collection area of 200m by 200m and can expect to be struck on average by one lightning flash per year.

"A human being who is, say 2m tall, will only have a collection area of about 4m by 4m. Hence, his probability of being struck is very much smaller than the building."

"Unfortunately, when lightning strikes a person, this is news. But when lightning strikes a building or something else, it goes unreported unless it's a major catastrophe like fire, failed traffic lights or a blackout."

He adds: "In reality, lightning strikes all exposed things on the ground, be it buildings, storage tanks, trees, hilltops, vehicles, telecom towers, electricity pylons, lamp posts, animals and people who are foolish enough to stay outdoors during a thunderstorm." Naming golfers, footballers, exercise freaks, ignorant pedestrians in the last category.

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Hartono pulls out a photo album. Expecting to see pictures of family photos and vacation shots, this writer was surprised to see 4R sized prints of damaged rooftops.

"Not many building owners believe it when I tell them I conduct research on lightning," says Hartono who is the president of Lightning Research Sdn Bhd.

Inside his black carrying case are research papers, a notepad, his trusty Nikon and a pair of binoculars.

From the photographs, one can only imagine the power behind the force of a lightning strike. As one photo showed, the impact was so great it blasted off a chunk of concrete from the upper section of a wall.

The shattering effect from a lightning strike

The US-based National Lightning Safety Institute (NLSI) defines lightning as "static electricity gone giant scale." Worldwide, it is estimated that some 2000 thunderstorms occur at any one time, creating some 100 lightning strikes to earth per second.

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The NLSI is an independent, non-profit consulting, education and research organization based in Louisville, Colorado, that advocates a pro-active risk management approach to lightning hazard mitigation with lightning safety and lightning information resources.

In today's technology-dependent era, electronic systems are more vulnerable to lightning strikes. Crucial building services like elevator systems, PABX, ventilation and fire protection systems are often at risk of disruptions from a lightning strike.

Hartono explains that lightning currents can measure anything between 2000 and 350,000 amperes. To give it some perspective, your electric kettle consumes about 10 amperes. Lightning is known to generate heat exceeding 28,000 degree celsius or three times hotter than the sun's surface. Therefore, without the proper lightning protection system, hardware is as good as toast from a lightning strike.

He goes on to explain that the striking distance of a lightning is proportionate to the strength of the current. Which means the more powerful the lightning, the further it hits. In most cases, lightning is attracted to the nearest point to the clouds such as tall buildings, people or trees in an open field, telephone poles and power lines.

For those working on the top floors of high-rise buildings, you might like to consider an office on a lower gravity level.

Hartono explains that compared to the person on the ground floor to one who is, say on the 50th floor, the latter is more prone to a lightning strike.

"This is because the person is closer to the point of lightning impact and likely to experience a greater amount of electrical effects, either from animate or inanimate objects."

However, he quickly points out that the individual is safe as long as he does not touch any electrical equipment, especially the phone, or any metallic parts of the building.

"On some of the buildings struck by lightning that I had inspected, the electrical system on the top floor was severely damaged. But those on the lower floors were spared from damage because

the lightning current had diffused into the building by then.

Bad wiring and improper grounding practices, says Hartono, can still cause damage to a building's electronic systems such as fire alarm and automation systems even if it had been installed with a lightning protection system.

As for the 1996 episode that plunged the whole of Peninsula Malaysia into darkness, he suggests that the power outage might have been caused by a lightning strike although he has reservations about it.

"The probability that it was caused by lightning is there. TNB operates a real-time lightning tracking system that actually can show when and where a lightning strike occur anywhere in Peninsular Malaysia, to within a few hundred metres of the exact location of the strike. Hence they can correlate the rogue lightning strike location with the initial tripping of the nationwide power distribution network to explain the massive power failure, if they had wanted to.

"However, I recalled that they did not disclose this information in the media, so I have my doubts as to whether lightning is the real cause of that nationwide power failure."

Besides structural damage, the cost of damages can be equally severe.

"A few years ago, the airport instrumental landing systems in Ipoh was struck by lightning and damages reportedly cost them about RM6 mil.

"In 1993, the Shah Alam City Council building had its corners eaten way. It was definitely a lightning trauma and not due to weather factors. If it were the latter, then all the corners should erode evenly. A lightning can be powerful enough to expose the enforcement bar within the concrete," says Hartono.

In Malaysia, there are two seasons for lightning which are associated with the inter-monsoon seasons of March – April and October – November. Lately, Hartono observes high lightning activity occurring during the months between June – August which are suppose to be dry season. He attributes such a phenomenon to the El Nino effect.

Incidentally, Hartono was almost struck by lightning once. It happened about 10 years ago, as he was crossing between two buildings. He was stopped in his tracks by lightning flash that appeared about 100 metres in front of him.

"I believe I was emitting streamers. I felt a tingling sensation, my hairs were standing on ends. If you feel your hair rising, it's a warning to seek shelter."

Today, modern architecture in commercial construction of buildings have made some of these structures immune to the terror of thunderbolts.

Says Hartono, 46, the skin of steel on some modern buildings acts like an armour that intercepts blows from lightning attacks. Still, the stainless steel structure that is the Petronas Twin Tower can't escape the furious slaps of lightning strikes.

"For buildings with the metallic outer cladding, (I'm not comfortable with the term 'curtain' which is used in the construction industry), they do not exhibit the lightning damages similar to concrete buildings. But that doesn't mean they're not struck by lightning. It's because metal conducts the current without the explosive impact that happens to of the concrete.

"Damage is determined through observation. The beauty is that the data is always there. You need to be able to recognise what a lightning damage on the building looks like. And to tell the difference from normal wear and tear effect," says Hartono who developed an eye for lightning marks through scientific journals and a calculated curiosity.
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