Singapore

NTU researchers develop 'safer, cheaper' bicycle helmets

(Left to right) Research associate Goram Gohel, Associate Professor Leong Kah Fai and research fellow Dr Bhudolia Somen Kumar, from NTU's School of Mechanical and Aerospace Engineering, with their composite bicycle helmet prototype. (Photo: Nanyang Technological University)

By Zhaki Abdullah

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SINGAPORE: Researchers from Nanyang Technological University (NTU) have developed a cycling helmet that they say will reduce the chances of critical injury to the wearer.

Not only is this helmet - made of a new plastic material - easier to produce, it will also offer the same level of protection as high-end helmet, but cost only as much as a mid-tier one, the NTU team said.

The prototype helmet - developed by a team led by Associate Professor Leong Kah Fai from NTU's School of Mechanical and Aerospace Engineering - is said to absorb more energy, thus reducing the amount of energy transferred to a cyclist's head in the event of an accident.

Conventional bike helmets typically comprise an outer shell made of polycarbonate, with a layer of expanded polystyrene foam underneath – similar to the material used in product packaging.

The outer shell is designed to crack on impact in order to dissipate energy across the entire surface of the helmet, with the foam layer absorbing the bulk of impact energy so that less energy is transferred to the head.

In a media release on Thursday (Jul 22), NTU said the helmet developed by its researchers replaces the polycarbonate shell with one made of Elium - a new thermoplastic resin developed by French materials manufacturer Arkema.

The university's researchers worked with engineers from Arkema to develop a moulding process for Elium to manufacture stronger bicycle helmets.

The Elium is reinforced with carbon fibre, making it tougher and less brittle than those of conventional helmets while also increasing the total amount of time where the helmet experiences the load of the impact.

These properties allow the shell to absorb more impact energy over a longer period, while also dissipating it evenly throughout the helmet.

This results in less overall force reaching the head, thus reducing the chances of critical injury.

"We want the major amount of energy to be absorbed by the outer shell rather than the foam, which is directly attached to the human head," said research fellow Dr Bhudolia Somen Kumar during a media briefing on Thursday.

About 75 per cent of the energy is absorbed by the foam in existing polycarbonate helmets.

In contrast, the shell absorbed over 50 per cent of impact energy in the prototype helmet, leaving the foam to absorb just about 35 per cent of the energy.

Figures from the Traffic Police showed an increase in cycling-related accidents amid a pandemic-inspired boom in the sport, with 572 traffic accidents involving bicycles last year, up about 25 per cent from 459 accidents in 2019.

A World Health Organisation report last year found that more than 60 per cent of reported bicycle-related deaths and long-term disabilities are a result of accidents with head injuries.

“Helmets have been proven time and time again to play a critical role in reducing the severity of injuries and number of fatalities,” said Assoc Prof Leong.

“Our prototype helmet has been subjected to a barrage of internationally benchmarked tests and has demonstrated the ability to provide greater protection for cyclists compared to conventional helmets,” he added.

REDUCED CRITICAL INJURY RATES

The helmets were tested by driving them down at high speeds on three different types of anvils – flat, rounded and pyramid-shaped – to simulate different road conditions, in line with the U.S. Consumer Product Safety Commission standard (CPSC 1203) certification, an internationally recognised safety standard for helmets.

While the prototype helmets performed on par with polycarbonate ones in flat anvil tests, tests on the rounded and pyramid-shaped anvils showed substantial improvements of the prototype helmet over conventional polycarbonate helmets.

The NTU team’s analysis of the flat anvil test results and the head injury criterion - a widely used injury metric that calculates the probability of serious injury and fatality - showed replacing a polycarbonate helmet with a composite helmet could potentially reduce critical injury rates from 28.7 per cent to 16.7 per cent.

Meanwhile, fatal injury rates could fall from 6 per cent to 3 per cent using the new helmet.

While other thermoplastic-based composite shells require higher temperature processing, Elium can be moulded at room temperature, allowing for more efficient manufacturing compared to conventional helmets.

Though the current prototype weighs about 20 per cent more than a polycarbonate helmet, the researchers are currently working on developing composite helmets made from Elium and polypropylene fabric, which could potentially make them just as light as polycarbonate ones but with better protection.

The NTU team - whose research is supported by the Agency for Science, Technology and Research under Singapore’s Research Innovation Enterprise 2020 Plan - is working with Arkema to commercialise the helmet’s manufacturing process. Assoc Prof Leong said the product could be on the market within the next two to three years.

He added that such helmets could offer the same protection as current top-tier helmets - which can cost upwards of S$400 - at the price of mid-tier alternatives, which usually cost between S$100 and S$150.

Assoc Prof Leong that Elium could be combined with thermoplastic fibres to make the helmets more recyclable. He added that the thermoplastic has a range of potential applications, from hockey sticks to bicycle frames as well as the protective casing for electric vehicle batteries.
Source: CNA/az(ac)