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With more than 1.6 billion people lacking access to adequate shelter, there is a global need for low-cost housing and more sustainable building materials and production methods. Population growth, urbanization, and increases in household income in emerging markets have led to higher demand for housing and building materials. However, a serious obstacle to affordable housing is the lack of a low-cost roofing material that will perform long-term in hot and humid climates.

In emerging markets such as South Asia, common roofing materials that are affordable for lower-income families include corrugated metal sheets and asbestos or fiber cement sheets. These building materials contain a large amount of embodied carbon from manufacturing, can include hazardous materials, and absorb heat, which can be fatal in already hot climates.

In addition, rapid urbanization has led to an increase in urban heat islands, and the energy demand for space cooling will more than triple by 2050. In lower-income urban communities, up to 20% of a building's heat gain occurs through the roof; addressing this can significantly affect internal building temperatures and provide thermal comfort indoors without energy-intensive air conditioning.

▲ Dharavi settlement rooftops in Mumbai, India, often use corrugated metal sheets that absorb heat.

Recent advances in natural fiber composite (NFC) materials offer a sustainable opportunity to address the global roofing challenge. Advantages of NFCs include their light weight, insulative properties, low operational energy requirements, and ability to store captured carbon into long-lifecycle products, thus reducing the release of greenhouse gases.

With funding from the U.S. National Science Foundation (NSF), Eco-Shelter Inc. and Washington State Univ.'s (WSU) Composite Materials & Engineering Center (CMEC) are developing a commercially scalable, non-woven bamboo composite roof panel. The product under development utilizes bamboo strands rather than woven bamboo mats to allow for more efficient production. A preliminary third-party lifecycle assessment of the bamboo composite roof panel showed that the product has much lower embodied carbon than commonly used corrugated metal.

Preliminary pilot data collected in India by Eco-Shelter found that bamboo roofing reduced indoor temperatures by ~4°C on average with reductions up to 6.5°C, which could significantly reduce mortality rates among lower-income communities. Peer-reviewed studies have shown that New Delhi's mortality rate increases ~4–6% per every degree Celsius increase over a temperature threshold of ~29°C.

A key technical challenge of NFCs is that natural fibers exposed to rain, sunlight, or other natural elements can deteriorate over time due to moisture intrusion and prolonged exposure to ultraviolet light. The funding from the NSF is enabling Eco-Shelter and WSU's CMEC to develop an effective product composition that is weather-, su Ò Ø Ł ' sandwich panels. The corrugations in such panels have cavities, that when filled with insulation materials, make them energy efficient for not just roofs, but also floors and walls.

The team at Eco-Shelter and WSU are developing the manufacturing process to go into production by 2024. A leading North American residential building material distributor has shown interest in the technology. "We are especially interested in simple and sustainable products with a transparency on all materials used… Bringing additional innovative products to our current customers is a preferred way of growing business," says Chris Andrews, Technical Director at Shaw Industries.

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