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Editorial Note on Innovative Materials

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Editorial

The built environment currently consumes 51% of total energy in the United States, with 39% of it spent by building operations (mainly heating and cooling) and 12% utilised by construction material manufacturing and demolition. The built environment also accounts for 55 percent of total CO_2 emissions in the United States, with 43 percent coming from energy generation for construction operations and 12 percent from material manufacture and destruction. One of the ways we are working to reduce the negative impact of the built environment on our natural environment at Stanford is to do research on novel, sustainable building materials. We're working on novel cement-based, polymer-based and bio-based construction materials, as well as re-engineering existing ones. Civil, environmental, chemical, and material science engineers collaborate on our research, which is multidisciplinary.

The development and evaluation of fiber-reinforced polymeric materials generated from renewable resources such as bio based polymers and natural plant fibres are now underway in our department. The use of such materials reduces the reliance on non-renewable energy sources for material manufacturing, as well as the amount of recalcitrant, non-degradable building and demolition detritus in landfills.

These materials' ability to replace various non-structural and structural elements in buildings, to resist deterioration while in service and to biodegrade after their useful service life is currently being explored. To forecast the performance of these highly nonlinear materials, computational models and theoretical breakthroughs are being developed. We're looking into new green insulating materials in structural panels to boost building energy efficiency in building operations.

Additional research is looking into re-engineering existing materials for better performance and sustainability, such as using fiber-reinforced polymer composites and high-performance fiber-reinforced cement-based composites like Engineered Cementations Composites (ECC), which exhibit very fine, multiple cracking and tensile strain hardening up to strains of 3%. These materials, which are usually referred to as "bendable concrete" in the mainstream media, are extremely damage-tolerant in tension and compression and have the potential for better corrosion resistance as well as limited damage resistance to overloads such as earthquakes.

Physical experiments and computer modelling, as well as performance-based assessments, are being used to examine the applicability of these materials to new, sustainable building and infrastructure designs, as well as facilities in need of seismic retrofit. Many of the building materials are comparable to those that have been utilised by architects for hundreds of years. However, because the building industry consumes a lot of space and resources, it is working hard to develop new materials that have the potential to revolutionise the industry as a whole.

The ETH Zurich Department of Architecture has created concrete floor elements that are 70 percent lighter than standard concrete floors and do not require steel reinforcing. The curved and geometrically shaped plates, which are based on old vaulting techniques in cathedrals, are the key to weight reduction. The floor elements' supporting slab is only two centimetres thick and, due to its design, does not require any reinforcement steel. In order to cut expenses in the fabrication of the elements, the company used 3D printing instead of traditional moulds. The elements, on the other hand, were not formed of concrete, but of sand mixed with a specific binder. According to Philippe Block of ETH Zurich, the novel system works as follows: It's just sand with a binder to hold it together. Because the material is so flexible, this small portion might be easily broken off by hand. You can run on this soft material if you shape it in such a way that it absorbs the forces, which we discovered using a self-developed algorithm. You also have a safe structure that is 70% lighter than standard ceilings."

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