

Multifunctional construction elements lower buildings' energy needs

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Alexandre Mudry, Dolaana Khovaly and Thomas Keller won the Best Paper Award for their research. Credit: A.Herzog/EPFL

Engineers at EPFL have studied the use of construction slabs that serve both as structural building elements and floor heating systems. Made of composite materials, these slabs could deliver heating performance on par with conventional radiant heating but consume less energy.

Buildings have a big appetite for [energy](#). They account for almost half of Switzerland's energy consumption during both their [construction](#) and use, according to the Swiss Federal Office of Energy. A great deal of research is being done on strategies for reducing buildings' environmental footprints; one such approach involves the use of multifunctional construction elements.

"With current construction methods, each [building](#) element performs a single function," says Dolaana Khovalyg, a tenure-track assistant professor at ENAC and head of the Thermal Engineering for the Built Environment Laboratory (TEBEL) in the Smart Living Lab. "The traditional sequential design of building elements, where every element performs only one dedicated function, is obsolete and labor- and time-consuming. As a result, the traditional design carries significant embodied energy." Alternative solutions are modular pre-fabricated multifunctional building elements that can overcome the major disadvantages of the current practice and go beyond; overall, that aim to reduce the embodied energy of buildings.

Multifunctional slabs supply both structure and heating

Engineers at TEBEL, working in association with colleagues at EPFL's Composite Construction Laboratory (CCLab) headed by Prof. Thomas Keller, have demonstrated that slabs made of glass fiber-polymer composites can be used as [structural elements](#) in a building. Composites are lightweight yet strong, durable materials which can be used in hollow cellular structures. The research team designed a system whereby water is circulated through the hollow structures, thereby turning the slabs into floor heating elements.

"We studied the addition of only one functionality to the composite slab,

but it would be possible to use the hollow cells to further elevate the functionality of the slab. For example, cells could be used for hiding electric wiring and ventilation ducts, thus further enhancing the use of the building space," says Prof. Khovalyg. Such composites could become a primary construction material, alongside concrete, steel and wood. This research was presented at the in 8th International Building Physics Conference (IBPC 2021), held on 25–27 August 2021, and won the Best Paper Award.

Improving efficiency in case of fire

One drawback to composites is that they are less fire-resistant than other building materials. However, because the engineers' design involves partially filling the slabs' hollow structure with water, this problem can be avoided. Should a fire break out, the water flow velocity will be significantly increased in critical areas—maintaining the structural integrity by keeping the temperatures within acceptable limits, and also allowing these areas to be used as secure spaces for occupants to gather and subsequently be evacuated.

The engineers performed computer simulations to test the feasibility of their system at a building in EPFL's Innovation Park. They isolated a floor of the building and simulated using their slabs as floor structure elements. Their results demonstrated that the slabs can be used effectively as both structural and construction elements and provide sufficient thermal efficiency and structural fire resistance. The engineers also found that their design can provide the same indoor comfort as standard radiant floor heating systems but with much less energy due to the reduced water temperature, and it also makes better use of space.

More information: D Khovalyg et al, Towards multifunctional building elements: thermal activation of a composite interior GFRP slab, *Journal of Physics: Conference Series* (2021). [DOI:](#)

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