NATURAL HAZARDS CENTER

University of Colorado Boulder

RESEARCH BRIEF SERIES

MITIGATION MATTERS

AWARD RECIPIENTS

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AWARD AMOUNT:
$10,000

FEMA defines mitigation as the effort to reduce loss of life and property by lessening the impact of disasters. Effective mitigation requires that we all understand local risks and invest in long-term planning to reduce risks and enhance community well-being.

FIRE-RESISTANT AND ENERGY-EFFICIENT FUNGI-BASED BUILDING MATERIALS: TOWARDS HAZARD-MITIGATING HOUSING

SUMMARY

Today homes are often built with petroleum-based synthetic building materials, including insulation foams and resin-based engineered woods, which are more combustible than solid wood. When ignited, these synthetic materials burn rapidly, generate intense heat and dark smoke, and emit toxic gases. Concerns about their combustibility are now rising as extreme heat and fire hazards increase with climate change.

This project builds on previous research showing that fungi-based engineered woods and insulation could be viable alternatives. Evidence suggests that fungi-based materials have properties associated with fire resistance and energy efficiency, which means they could mitigate risk from fire and extreme weather hazards and reduce household energy consumption. This study aimed to test these propositions.

We started by cultivating Fusarium oxysporum, a filamentous fungus, using sodium silicate solution and agricultural waste. Next, we prepared fungal films and fungi-based insulation in a laboratory and measured their fire-resistant and thermal properties in various experiments. Then, using computer simulations, we compared energy consumption and electricity costs in homes with fungi-based insulation to homes with synthetic insulation.

Fully engulfed structure fire

Laboratory testing revealed that adding silicon source to fungi significantly increased their fire-resistant properties; specifically, ignition temperatures were higher and flame heights were shorter. The computer simulations, which modeled energy use in seven U.S. cities, showed homes with fungi-based insulation used less energy for heating and cooling and had electricity bills $17.84 lower per month than homes with conventional insulation. Overall, these findings provide more evidence that fungi-based building materials could make future homes safer and more efficient.

KEY FINDINGS

- Fungal fibers grown with silicon source achieved enhanced fire resistance by decreasing the likelihood of ignition and reducing flame intensity. Higher concentrations of silicon source in the fungal fibers increased their fire resistance.
- Fungi-based insulation exhibited smaller fluctuations in indoor temperatures during hot and cold weather than conventional insulation.
- Computer modeling showed homes with fungi-based insulation used less energy for heating and cooling and had lower electricity bills than homes with conventional insulation.

POLICY IMPLICATIONS

- Fungi-based engineered woods and insulation have many desirable qualities—including, fire resistance, temperature control, affordability, and non-toxicity.
- More investment is needed in research that examines the health, safety, environmental, and economic benefits of fungi-based building materials.
- Policy frameworks that promote research, development, and deployment of fungi-based products can accelerate market acceptance and scale-up production of.

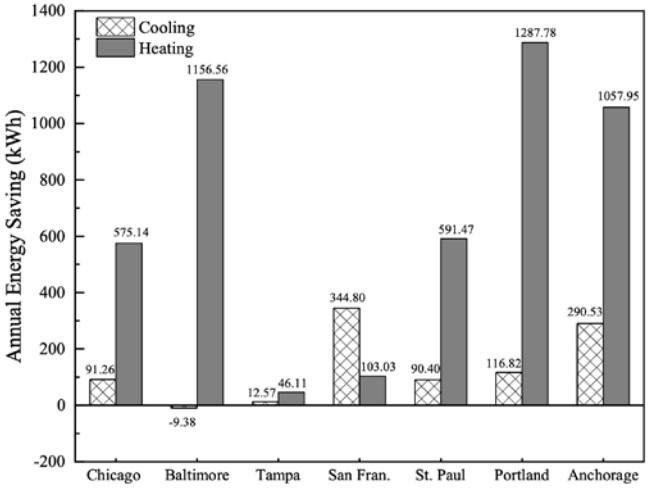
AUDIENCE

This study will be of interest to civil and environmental engineers, hazard mitigation professionals and researchers, and those interested in nature-based solutions to challenges in infrastructure and the environment.

Fire Resistant Behavior of Fungal Films

Panel a shows the fungal film with no silicon source (SSO). Panel b shows the fungal film with 1% silicon source (SS1). Panel c shows the fungal film with 2% silicon source (SS2).

Annual Reduction in Energy Consumption in Buildings With Fungi-Based Insultation in Select U.S. Cities



Among the evaluated cities, the fungi-based insulation resulted in an annual reduction in energy used for heating and cooling, except for a slight increase in cooling energy in Baltimore.

Full report: Zhang, X. (2024). Fire-Resistant and Energy-Efficient Fungi-Based Building Materials: Towards Hazard-Mitigating Housing. (Natural Hazards Center Mitigation Matters Research Report Series, Report 19). Natural Hazards Center, University of Colorado Boulder. Available at: https://hazards.colorado.edu/mitigation-matters-report/fire-resistant-and-energy-efficient-fungi-based-building-materials

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