Executive Summary: Innovative Recycling and Upcycling of Mattress Foam for Construction Applications

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In work sponsored by the MRC, researchers at West Virginia University evaluated the feasibility of using recycled polyurethane mattress foam as an eco-friendly insulation core for prefab concrete housing panels (developed in partnership with Omnis Building Technologies).

Key Findings

- **Superior Insulation:** The recycled mattress foam provides better thermal insulation than the company's current materials, both on its own and when sandwiched inside concrete panels.
- **Effect of Foam Compression on Insulation Performance:** When compressed to a specific degree, the thermal conductivity of the mattress foam and resulting composite panels is reduced
- **Qualitative and Semi-Quantitative Analytical Models for the Effect of Foam Compression on Thermal Conductivity were Developed:** Both models predict the trends observed relating foam compression to thermal conductivity. Initially compression leads to reduction in foam thermal conductivity, but with further compression the conductivity rises.
- **Structural Performance:** The panels show good overall strength and crack safely under heavy loads. However, the concrete currently bends slightly more than building code limits allow because its structural stiffness (modulus) is lower than targeted.
- **Ongoing Improvements:** Researchers successfully tested a new concrete mixture that significantly improves stiffness, bringing it much closer to design goals.

Risks & Next Steps

- **Stiffness Scaling:** The high stiffness achieved in small lab samples needs to be fully replicated at full scale. This will be addressed by modifying the concrete mix (using

stiffer granite aggregate, less fly ash, a small amount of cement, and an improved steel frame).

- **Long-Term Durability:** Creep (long-term gradual deformation under load) needs to be measured, which will be evaluated through upcoming tests on full-size panels.