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The efficiency quest

NEW RESEARCH EXPLORES ENERGY SAVING OPPORTUNITIES IN METAL BUILDING SYSTEMS

By Dan Walker, P.E.

The skeletal framing for the low-rise FRP building.

The desire to provide high performance and energy efficient buildings continues to grow among architects, designers and building owners. Building codes and standards dictating minimum levels of insulation and mechanical system performance have also ratcheted up in recent years. Even with the push to increase energy efficiency, building owners often question whether or not the increases in insulation actually pay off in the long run. The Metal Building Manufacturers Association (MBMA) and Oak Ridge National Laboratory (ORNL) have embarked on a cooperative research project to prove the most energy efficient combinations for an actual building system.

What's being done?

The ORNL/MBMA joint project consists of the construction of a one story, 2,400-square-foot metal system "shell" building that will serve as a test bed for various energy efficiency experiments over several years. The research building, known as the Low-Rise Commercial Flexible Research Platform (FRP) will undergo multiple building envelope and mechanical system retrofits and upgrades throughout the course of the research to find the optimal insulation and mechanical system improvements that save the greatest amount of energy and dollars for building owners and operators. The construction of the low-rise FRP building shell is complete and currently consists of a typical building that would have been constructed in the 1980s with a mere R-13 in both the roof and the walls. This low-level of insulation for the first experiment is intended to give the ORNL researchers baseline performance data to which future experiments can be compared.

Wall panels and insulation being applied to the building.

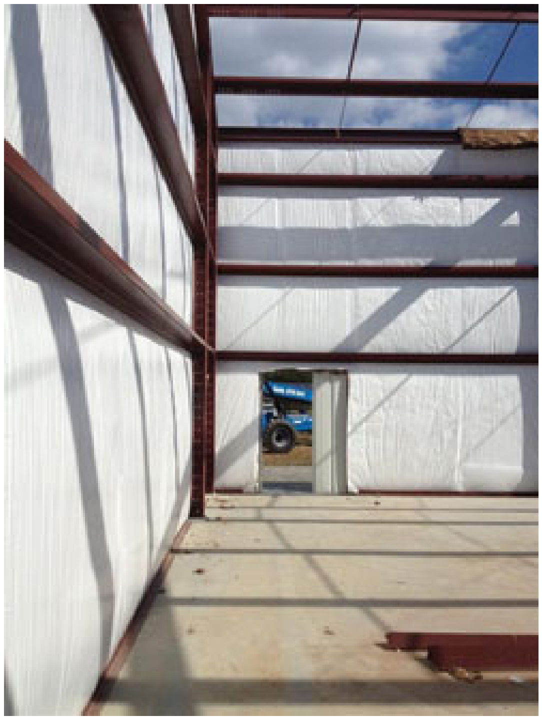
Overview photo of the completed low-rise FRP building. Although the roof appears to be white in color, it is actually bare Galvalume, which is an unpainted zinc-aluminum coating that is typically used in metal buildings. Bare Galvalume has an initial reflectance of approximately 65 percent and emittance of approximately 10 percent. Future experiments will use high-reflectance and emittance paint coatings to gauge the benefits of "cool" roofing.

What will happen in the future?

Planned future upgrades of the FRP building include incremental increases of roof and wall insulation, reduced air infiltration, and the incorporation of increasingly more efficient HVAC systems and lighting. At the onset of the first experiment, the building will undergo a whole-building air leakage test in accordance with ASTM E 779, "Standard Test Method for Determining Air Leakage Rate by Fan Pressurization." This will determine the level of air leakage in a typically constructed 1980s building. A computer will control equipment to mimic a pre-determined schedule of events within the building. After several months of normal operations, the researchers will swap out components and make incremental improvements to the building envelope and HVAC systems to measure the changes in energy use. Making incremental changes in a controlled environment makes it possible to single out the contribution of each energy saving measure implemented. By making these detailed measurements in subsequent experiments, the project team will be able to gauge the effectiveness of each envelope and HVAC change and see how these individual changes impact the overall energy performance of the structure. It allows researchers to separate the complex interactions of these components within the building system.

One of the first experiments planned is to reduce the air leakage of the building from the initial level to recently suggested potential code requirements. The U.S. Army Corps of Engineers has specified a total air leakage rate for the building shell of 0.40 CFM/ft2 (cubic feet per meter/square foot), which takes extra effort during building construction to achieve. Researchers expect to see significantly more air leakage in the baseline building because it will not have any special detailing to prevent air leakage. The partnership is currently planning the second experiment for the FRP building. Here, researchers will be air-sealing the building joints and penetrations to achieve the 0.40 CFM/ft2 performance level. This is an excellent opportunity to see just how much difference air sealing can make in an apples-to-apples comparison.

TOP/LEFT:
The low-rise FRP building interior is shown here prior to the roof installation. No interior finishes will be applied for the first few experiments to simulate a typical fully conditioned industrial or storage building. Various interior finishes will be considered for future experiments.



Subsequent experiments will make similar comparisons, but will involve increases to the building envelope insulation, lighting, HVAC systems and even the roof color. During each of the experiments, the ORNL researchers will be performing whole-building energy simulations using sophisticated computer modeling software to help fine-tune their understanding of the collected computer data from the physical building compared to the expected outcome from the computer models.

How will this research benefit the metal building industry?

MBMA statistics show that metal buildings are used in approximately 40 percent of all low-rise, non-residential construction, so this is an important construction type to study in order to analyze, document, and show improvements in energy performance. Where life-safety and structural codes such as the International Building Code (IBC) and others have focused on system performance, building energy codes and standards have traditionally focused on the minimum requirements for building components individually. A component approach does not take into account the complex interactions of the individual components when they are combined in a building system. By performing the research at ORNL, building owners will be able to see actual results and have a sense of how the available energy saving measures in the market place work together. Consequently, the industry may gain a better understanding of which improvements are the most cost-effective first solutions to implement when upgrading a building for energy efficiency.

The low-rise FRP building exterior is shown prior to the roof and trim installation. The beige pre-painted metal wall color was selected to provide a neutral baseline for the first few experiments. Other wall colors and materials will be considered for future experiments to see what impact these factors have on energy use.

Designers and building owners have a history of utilizing metal buildings for various types of occupancies, but may not view them as a highly efficient building type from an energy standpoint. The joint ORNL/MBMA research will not only help designers and building owners make decisions on future construction projects, but it will also demonstrate the various ways for building owners to retrofit their existing facilities to increase their bottom line by reducing their operating costs where it is most beneficial.

The ultimate intent of the research is to improve the energy efficiency of metal buildings by identifying and validating cost-effective new and retrofit construction techniques and learning how those systems interact in real buildings. Researchers expect the end result will provide real-world solutions that can cost-effectively reduce building energy use.

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