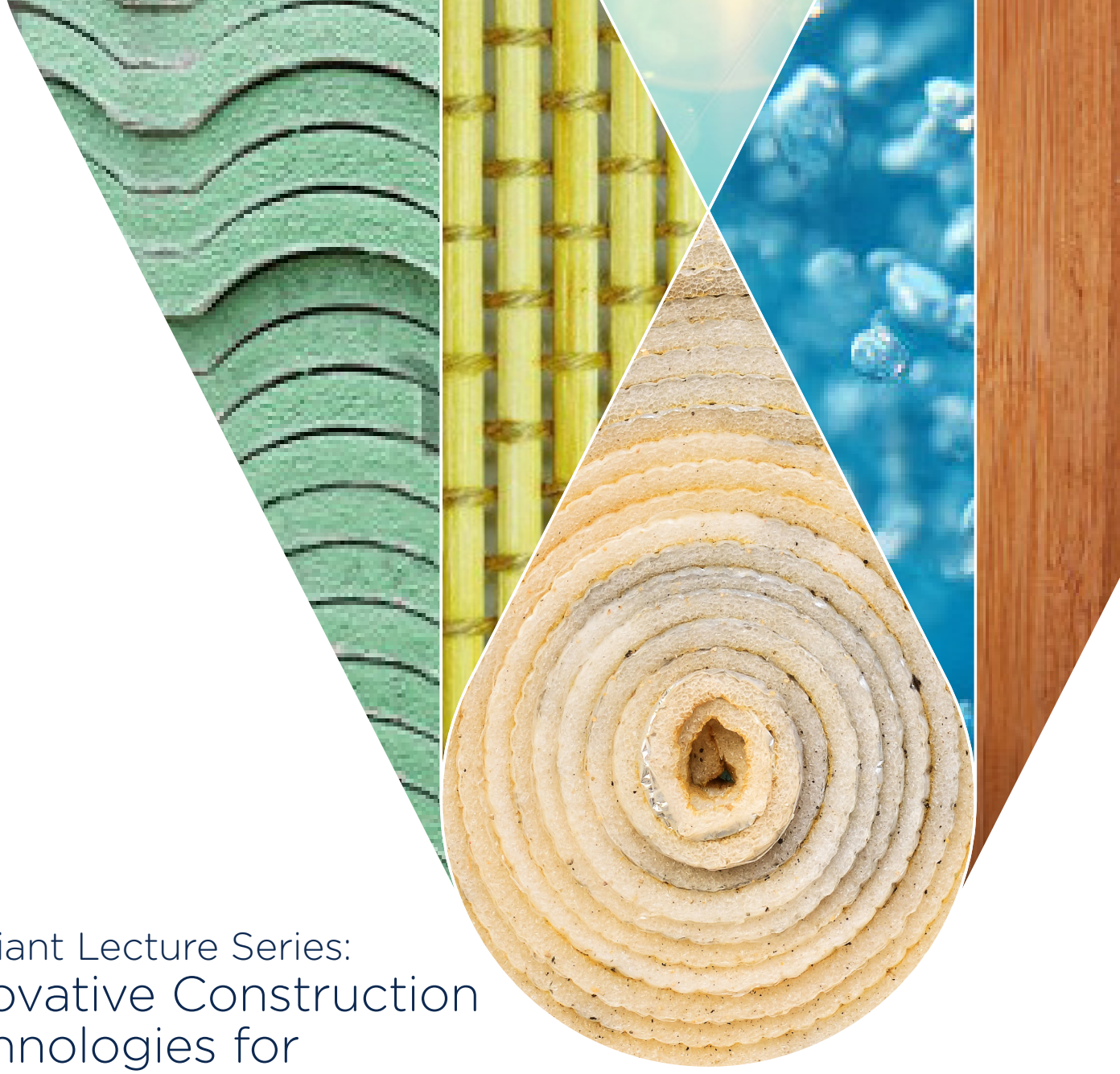

Viridiant Lecture Series: Innovative Construction Technologies for Healthy, High-Performance Homes

The holistic approach to house-as-a-system remains true as code, the industry and products continue to evolve. Critical components of high-performance building include: the building structure or envelope, heating, cooling, ventilation and dehumidification. This bulletin aims to show how EarthCraft program sponsors deliver to meet industry needs.

viridiant

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innovative construction technologies

building structure

The building envelope consists of an air barrier, moisture management layer, and insulation. It is critical to install each component correctly and to ensure that each layer is continuous and contiguous along the walls and roof. Regardless of what products are used, the envelope must provide:

- Structural integrity
- Moisture management
- Airflow control
- Thermal comfort

high-performance heating & cooling

High performance homes require high performance heating and cooling. Equipment should be sized based on actual loads and selected to optimize comfort, ease of installation, energy efficiency, and aesthetics. It's important to consider:

- Location of duct work
- Type and capacity of equipment
- Accessibility of the filter
- Efficiency level of the equipment

ventilation & dehumidification

As homes become increasingly fine-tuned, attention must be paid to the type and amount of ventilation provided, as well as the home's ability to handle interior moisture. Standard systems cannot always keep interior humidity at optimal levels, especially during the "shoulder seasons" and additional dehumidification should be considered. When evaluating indoor air quality as it relates to moisture, be sure to factor in:

- The type and amount of ventilation provided
- The capacity of the HVAC equipment
- Seasonal dehumidification

ZIPsystem®

MITSUBISHI ELECTRIC
COOLING & HEATING

Ultra·Aire™
WHOLE HOUSE VENTILATING DEHUMIDIFIERS

innovative construction technologies for healthy, high-performance homes

Recent revisions to both Residential and Commercial building codes are pushing energy use down, in some cases by up to 30% or more, compared to homes built only a few years ago. To reach these thresholds, the 2012 and 2015 versions of the International Energy Conservation Code (IECC) are calling for more stringent building envelope tightness, lower allowable duct leakage, and increased insulation values. Along with these increases to code comes the need to better control the indoor environment with regard to indoor air quality including the removal interior moisture. Full 2012 IECC and subsequent updates have also included envelope and duct diagnostic testing to ensure the higher standards are met. Hear from three EarthCraft program sponsors—Huber Engineered Woods, Mitsubishi Electric, and Ultra-Aire—on the latest strategies in building tightness, HVAC (heating, ventilation, and air conditioning), and dehumidification to acheive healthy, high-performance homes.

Building Structure

A strategic, systematic, and properly applied combination of air tightness and increased insulating value is essential to long-term energy efficiency. Gaps, joints, penetrations, rough openings, heating ducts, and other areas must be sealed against passive air and moisture transfer.

A “really good wall” is a key structural component of a building and an environmental separator. It helps keep the outside out and the inside in. We want this “really good wall” to perform four key functions.

key functions of a wall:

1. Structural Integrity
2. Moisture Management
3. Airflow Control
4. Thermal Comfort

First, walls need to be structurally sound and should shed bulk moisture. ZIP System® panels are Struc-1 panels with permanently integrated air and water barriers. They’re engineered to withstand the demands of the jobsite and provide long-term performance within the structure.

Taping the panel seams with ZIP System™ tape effectively seals the building envelope, forming a continuous, rigid barrier, with excellent tape adhesion. ZIP System® sheathing and tape reduces air leakage, decreasing unwanted air leakage into and out of the home.

Figure 1. Huber ZIP System®

Air leakage is one of the most significant causes of energy loss, because it works against heating and cooling equipment, affecting indoor temperature. Air leakage can also lessen the ability of insulation to resist heat flow, reducing its effective thermal resistance (R-Value). By eliminating gaps in the building envelope for a tighter seal, ZIP System® sheathing and tape products better protect structural and thermal elements of the wall assembly and prevent air leakage from degrading R-Value.

ZIP System® has undergone strenuous testing to ensure superior quality and durability. ZIP System® products help customers keep the elements out and seal comfort and savings in.

High-Performance HVAC

Tighter, better insulated houses result in lower loads and the need for smaller, more efficient mechanical systems. Traditional HVAC systems are often oversized, which causes "short cycling" resulting in comfort and indoor air quality issues. To properly size an HVAC system, a load calculation must be performed to determine the heat loss and heat gain of the structure. A load calculation analyzes the thermal characteristics of every wall, floor, ceiling, door, and window in the home. It takes into account not only the size of the space, but also the building materials that are used. Additionally, many other factors influence sizing of the HVAC system, including lighting, appliances, geographic location, orientation, envelope tightness, duct leakage, and the number of occupants.

With advances in the thermal performance of many building components, traditional "rule of thumb" sizing techniques and large oversized HVAC systems are becoming a thing of the past. When performed at the design stage using actual building components and code mandated performance metrics, many builders and home owners are finding substantial savings with overall specified tonnage needed to satisfy building loads.

Conventional forced air HVAC systems can have a variety of issues, including poor efficiency, pressure imbalances, duct leakage, particulate infiltration, and excessive noise. Alternatively, Mitsubishi Variable Refrigerant Flow (VRF) Systems minimize, and in some instances, eliminate the potential for these issues.

There are two types of residential VRF systems: split-ductless and ducted. Split-ductless VRF systems have no ductwork. Refrigerant moves from the outdoor unit to the indoor unit and a fan blows air over the coils (conditioning the air) in the room location of the unit. Ductless systems allow for additional savings over traditional ducted systems in that they eliminate material and labor costs associated with running and sealing duct work in addition to eliminating the monetary and indoor air quality impacts associated with duct leakage. Ducted VRF systems have the same indoor fan, except the air that is blown over the coils then travels in a short duct run to a vent location.

Indoor units come in a variety of designs for various applications: horizontal-ducted, ceiling-recessed, floor-mounted, wall-mounted, and ceiling-suspended *(see Figure 2)*. Unlike traditional HVAC equipment, they are easily located inside conditioned space. Due to their relatively small size, indoor units can be placed in many locations and oriented to deliver comfort directly where desired. Both ducted and ductless units can be flush mounted in the ceiling requiring minimal plenum space. Wall-mounted and floor-mounted units can be placed in a variety of locations out of the line of sight or even recessed into the building.

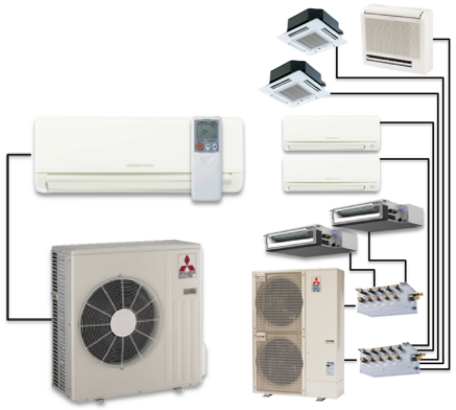

Figure 2. Various Mitsubishi VRF Units

Benefits of residential VRF systems include high-efficiency, variable speed operation, individual room control, quiet operation, constant circulation of conditioned air, and cold climate capability. Compressor speeds vary with demand, enabling VRF systems to maintain set points more accurately. Each room can have its own comfort control and filtration of the air occurs at each indoor unit head.

Residential VRF systems also allow for Zoned Comfort Solutions in every part of the home. Just as plumbing and electrical systems are zoned, VRF systems utilize zoning for home comfort and offer increased energy efficiency as rooms not in use can be set back or turned off completely.

Ventilation & Dehumidification

Reducing the amount of air that leaks in and out of the home through insulation, air sealing and penetrations in the envelope is the first step when it comes to cutting heating and cooling costs. Such energy saving strategies can result in unintended consequences. If effective mechanical ventilation and moisture control methods are not implemented, the result could lead to uncomfortable living conditions, homeowner health issues and in extreme cases - significant structural damage.

IECC) R403.5 states that "the building shall be provided with ventilation that meets the requirements of the International Residential Code or International Mechanical Code, as applicable, or with other approved means of ventilation. Air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating." (energycodes.gov)

Even where residential building code currently does not mandate a required amount of mechanical fresh air, there are recommended standards that help ensure a home's occupants are getting the fresh air needed. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has developed the standard 62.2: The Standards for Ventilation and Indoor Air Quality.

This standard is used to calculate the minimum ventilation air flow required for a given home or dwelling unit. For example, the current ASHRAE standard, 62.2 - 2013, provides a calculation for the minimum airflow allowed.

ASHRAE Airflow in cubic feet per minute (CFM) =
[House Area in Sq. Ft. x 0.03] +
[(Number of Bedrooms +1) x 7.5]

example:

2500 sq. ft. house
3 bedrooms, 4 occupants =
[2500 x 0.03] + [(3+1) x 7.5] = 105 CFM

The previous standard, 62.2-2010, required only 55 CFM of fresh air for the exact same home.

As homes are built more tightly, fresh air ventilation must be provided. Bringing in filtered fresh air to a tightly air sealed home from a known location to dilute indoor air contaminants is absolutely necessary. With the mid-Atlantic being a mixed humid climate, the removal of outside humidity will also have to be considered. Dedicated dehumidification will almost certainly be necessary to maintain <50% relative humidity (RH) in a house that meets these new building codes in green grass climates (areas where dew points reach above 60 degrees F).

Traditionally, dehumidification of interior air has been accomplished as a by-product of the HVAC system's cooling cycle. However, it is not uncommon for standard cooling systems to be oversized, particularly in homes with tighter envelopes. This limits the air conditioning (AC) run-time and results in poor dehumidification. It's also important to note that the system is only removing moisture when it is running. "Shoulder seasons," in the spring and fall, tend to be when the dew points are highest and temperatures are mild resulting in high interior humidity levels with little to no moisture removal. During certain parts of the year, the HVAC system will not satisfy dehumidification needs and supplementation dehumidification

Figure 3. Ultra-Aire Dehumidifier

should be considered.

An Ultra-Air whole house ventilating dehumidifer provides the ability to mechanically remove water from the air as well as maintain a slight positive pressure on the home to keep wet air out. It removes water from the air until a specific relative humidity set-point is reached throughout the home, plus meets mechanical fresh air ventilation codes and standards. This results in an indoor environment that is healthy, comfortable and provides the ideal conditions conducive to protecting and preserving the building and its contents.

A Whole-House Approach

The holistic approach to house-as-a-system remains true as code, the industry and products continue to evolve. Overviews provided in this bulletin seek to outline best practices and quality products that help builders, developers and homeowners make informed decisions in their high-performance buildings.