

# Passive House Design

## Model Home Technology Showcase

*Providing a Paradigm Shift in  
Energy Efficiency, Quality & Affordability*

Compliance with IECC 2012

State-of-the-Art Insulated Concrete Forms (ICF) Technology

Geothermal Heat Pump System including Radiant Heating, Cooling & Hot Water

Energy Recovery Ventilation Systems integrated with Heat Pumps

Solar (Photovoltaic) Power System for Net-Zero Homes

High Efficiency Windows, Doors & Appliances

Smart Home System Controls and Energy Management

Superior Technology & Construction at Affordable Pricing

Energy Tax Credits & Energy Efficient Mortgages

# Passive House Technology

- Passive technology refers to a house or building that heats and cools itself.
- The house or building actually doesn't consume energy in the form of oil, gas, electricity, or other conventional means, but rather produces all the energy needed to be self-sufficient using geothermal and solar energy.
- Inefficient crawl spaces are replaced with full basements and attics are replaced with insulated lofts/2<sup>nd</sup> stories, providing more home for less cost.

# Model Home Objective

- Provide an energy efficient model home for homeowners and businesses to see and experience the advantages of reducing energy loads by up to 90% less than conventional homes.
- Utilize superior building materials, architecture, engineering, and construction techniques.
- Function as a distributor and training program for contractors to incorporate state-of-the-art products and services provided by industry partners for construction of energy efficient homes and commercial buildings.
- Use solar photovoltaics to achieve net-zero or passive home design.

# Model Home Marketing

- Once the model home is completed an informative website will be developed and an Internet Marketing campaign will be launched for new home construction (targeting homeowners, businesses, architects, engineers, and contractors).
- The Passive House Model Home (PHMH) will be open 10 hr/day six days a week and will serve as the home office of the distributor (RM Enterprises, LLC).
- The PHMH will not be sold unless a new model home is built in order to showcase newer more efficient technologies developed by industry partners.

# Model Home Concept

- Passive House Model Homes are popular in Brooklyn, NY where demand for energy efficiency is overwhelming ([http://www.zehnderamerica.com/how-the-system-works/video\\_list.aspx](http://www.zehnderamerica.com/how-the-system-works/video_list.aspx)).
- Seeing is believing and energy efficient homes cannot be produced fast enough for informed homeowners.
- One of the keys to mainstream acceptance is integration of passive house technology with conventional architecture.

# Energy Efficiency & Savings

- ICF, geothermal heat pump systems, high energy efficiency windows and doors, energy efficient appliances (including venting), bathroom venting, light bulbs (Cree LED) and electronics (LED TVs), natural gas stove/oven and dryer, can reduce energy costs by over 90% for new homes.

# Energy Tax Credits & EEM

- Federal & state tax credits (30% for geothermal heat pump and solar power systems including radiant heating, cooling and hot water; and energy recovery ventilators); and Energy Efficiency Mortgages (EEM) will provide further economic advantages that in most cases will more than offset increases in construction costs for Passive House design.

# International Energy Codes Commission (IECC)

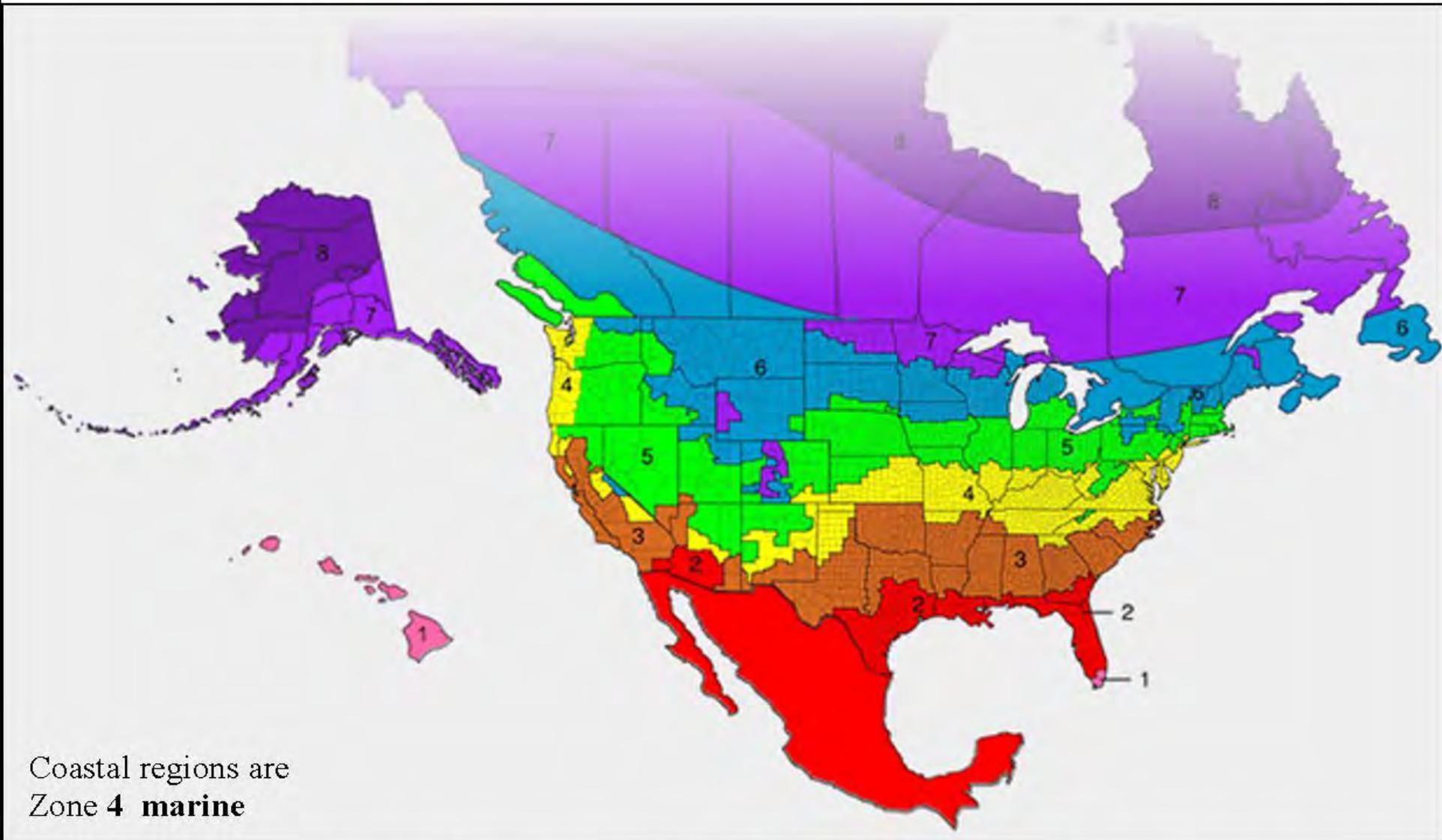
## *Summary of Changes to IECC 2012*

*(~30% better than IECC 2006)*

- Major changes
  - Consolidated with IRC energy chapter (actually a change to the IRC, not the IECC)
  - Mandatory whole-house pressure test
  - More stringent duct leakage test
  - DHW distribution system requirements
- Minor changes
- Key non-changes
  - Retains prohibition on envelope-equip. trade-offs
  - Makes lighting requirements “mandatory”

([http://www.resnet.us/uploads/documents/conference/2012/pdfs/Barcik-Energy\\_Code-IECC2012\\_vs\\_2009IECC.pdf](http://www.resnet.us/uploads/documents/conference/2012/pdfs/Barcik-Energy_Code-IECC2012_vs_2009IECC.pdf))

# ASHRAE/IECC Zone Map



IECC 2012 Insulation Requirements

# Cold-climate Builders

- **Mandatory Foam Sheathing or ICF**
- The 2012 International codes will require new homes in cold climates to have exterior foam sheathing, or some similar layer of continuous insulation that interrupts thermal bridging through studs.
- An alternative to stick-frame construction is Insulated Concrete Forms (ICF) which meets all 2012 IECC Insulation and Tighter Envelope Requirements.

# Summary of IECC 2012

- The 2012 International Energy Conservation Code will require more insulation, a tighter envelope, tighter ducts, better windows, and more efficient lighting than the 2009 code.
- The PHMH project is designed to meet or exceed all of these building requirements through industry partnerships with leading technology providers.

# Energy Savings

- New 2,400 square foot single family homes in Idaho that meet the 2012 IECC will cost an additional \$1,350-1,892 in construction costs per new home.
- Energy cost savings are estimated at between \$209 and \$267 per year. Stated differently, a homeowner's monthly utility bill savings are at least triple the additional mortgage payment needed to cover the cost of energy saving features required by the 2012 code.

# Net-Zero Homes

- Idaho residents buying new single family homes meeting the 2012 IECC will pocket between \$4,139 to \$5,038 in net savings over the life of their 30 year mortgage according to an analysis of energy savings and incremental construction costs by the Building Codes Assistance Project and ICF International.
- The PHMH project is designed to provide an immediate cash flow from day 1, substantially increasing savings by reducing energy loads by 90% and allowing homeowners to build Net-Zero Homes with minimal investments in grid-connected solar photovoltaic power systems.

# Industry Partners

- Professional Services
- Manufacturers
  - Core manufacturers, e.g., ICF; Heat pumps, radiant heating, cooling, and hot water; windows and doors; concrete providers; timber providers
  - Other manufacturers, e.g., supporting products such as
- Contractors

# Professional Services

- Bruce Poe, Modus Architecture
- Kara McKernan, Sage Consulting Engineering

# Core Product Manufacturers

- Quad-Lock Insulating Concrete Forms & Building Systems, LTD
- WaterFurnace Variable Geothermal Heat Pump or Hydro-Temp Earth Coupled Heat Pump integrated with radiant heating, cooling and hot water
- Waterfurnace NSW hydronic heat pump and Viega Climate Mat & Climate Control Technology
- UltimateAir<sup>®</sup> RecoupAerator<sup>®</sup> or Zhender ComfoSystems Energy Recovery Ventilators (ERV)
- Teckmar Heat Pump and Radiant Heating and Cooling Control Systems via Lundquist Sales, Inc. (Salt Lake City, UT)
- InsulStone - Concrete Cultured Stone

# **Pending Core Product Manufacturers**

- Marvin or Rehau Passive Windows, Awnings/Shades & Glass Doors
- Hammer & Hand Passive Entry Doors
- Concrete companies (to be determined)
- Lodge Logs (Boise, ID)
- Western Timber Products, Inc.
- High Efficiency Appliances (to be determined)
- Grape Solar (photovoltaic) Power Systems

# Other Pending Product Manufacturers & Dealers

- [Düraamen](#) decorative concrete and resinous flooring systems
- Eragy Connected Home and Energy Management Solutions
- Control4 Home Automation Solutions & Home Security
- Sight & Sound by Design - Whole-house Music and Home Theatre

# Contractors

- Scott Flynn - Flynnner Homes – Energy Efficient Construction
- Matt Fletcher - EcoBuild Design & Construction – Certified Passive House Consultant
- Pending
  - Craig Hammet – Hammet Homes - Luxury Home Builder

# Insulated Concrete Forms (ICF)

- ICF technology integrates concrete with foam insulation, providing up to R-59 thermal heat efficiency at a cost similar to conventional 2x6 wood frame and fiberglass insulation construction, but with the following advantages:
  - Energy savings of up to 70%
  - Relatively short time of installation
  - Ease of maintenance and longevity (mold proof foam and concrete)
  - Soundproofing
  - Earthquake and hurricane/tornado proof construction

# ICF Construction Benefits

## Short Term Benefits

- Reduce required cooling tonnage by up to 30% or more
- Shorten construction time
- Fit any design with ease
- Reduce worker injuries with lightweight materials
- Lower labor costs with smaller crews

## Long-Term Benefits

- Lower maintenance and lifetime operating costs with higher energy efficiency
- Profit from cleaner, quieter and more comfortable interiors
- Increase longevity and structural integrity
  - Enhance security with greater fire resistance and storm safety

# Energy Performance & R-Values of Insulated Concrete Forms

- Fact or Fiction: "The R-value tells me how much energy my house will use, right?"
- R-value measures the resistance a material has to heat transfer, this much is true. R-value alone, however, does not fully describe the energy performance of a building.
- Everyone in the ICF community knows that ICF buildings far outperform framed buildings with comparable stated R-values in terms of energy efficiency and comfort level, but why is that?

# Energy Performance Factors

- The main factors affecting actual energy performance of a building are:
  - Thermal Conduction
  - Convection
  - Radiation
  - Mass
- Each of these factors must be considered when planning and building an energy efficient structure.

# Thermal Conduction

- Thermal Conduction is the heat transfer through a material by contact of one molecule to the next. This is the only factor an R-value measures.
- Thermal conduction is not the only mode of energy loss in a building. In fact, conduction contributes less to energy losses in wood frame buildings than convection, which is not even measured by R-values.

# Wood Framing & Thermal Conduction

- We have all heard builders claim to build "R-13" or "R-21" walls with wood frame construction.
- The problem is that only the highest rated component in the wall - the insulation itself - performs at these stated R-values.
- A wood frame wall is made up of several components, not all of which have the same R-value. For instance, a 2x4 or 2x6 stud has an R-value of about R-5 or R-7.

# Wood Framing & Thermal Conduction Cont.

- Every 16 inches or so, one of these components breaks the insulation layer and forms a 'thermal bridge', conducting heat through the walls at high rates. Adding up the area of studs, plates, and headers, 12% to 16% of the total wall area is an R-5 or R-7 thermal bridge, all detracting from the stated R-value.
- In addition, batt insulation tends to sag over time and leave spaces without any insulation! How can those builders claim only the highest component R-value? From a 'whole-wall' perspective, framed walls operate at far lower R-values.

# ICF & Thermal Conduction

- Most ICF walls consist of two layers of EPS, with a center cavity to contain concrete.
- The EPS remains in place to provide two largely uninterrupted layers of insulation rated at roughly R-20 and higher.
- From a 'whole-wall' perspective, an ICF wall actually lives up to the stated R-values because thermal bridging is minimal.

# ICF Technology Advantages

- Ultra Energy-Efficient because of continuous EPS insulation (higher & uniform R-value), greatly reduced air infiltration, and the thermal mass effect of concrete.
- Much more Comfortable and Healthy because of very even inside temperatures (no cold spots or nasty drafts), far better sound attenuation, and low risk of mold growth and allergen infiltration.
- Longer-lasting and more resistant to natural disasters, rot, mold, and pests because the solid reinforced concrete is up to 8 times stronger and nearly impenetrable (even for car crashes) - it's what gives bunkers their strength!

# Thermal Convection

- Thermal Convection is heat transfer by movement of currents within fluids (or gases).
- When considering energy performance of buildings, it's the air moving between the inside and outside or 'air infiltration'.
- A common measurement is 'Air Changes per Hour' at a blower-door induced pressure differential of 50 Pascal (ACH50).
- US Energy Star standards for new homes require less than 4-7 ACH50.
- By comparison, British standards are 3-5 ACH50, Canadian R-2000 standards are 1.5 ACH50, and Swedish standards are 0.5 ACH50 or less.

# Wood Framing Thermal Convection

- In wood frame buildings convection can be felt as 'drafts' and is usually the biggest source of energy loss.
- Air infiltration accounts for up to 40% of the energy losses of a wood framed structure.
- Heat is carried by air leaking through thousands of cracks, openings, and joints between all the pieces of the building shell.
- Major culprits include framing connections, wall, floor & roof intersections, shrinkage of wood and caulking, and poor installation of components and sealants.
- A typical new wood frame home has between 1.75 and 3 air changes per hour (ACH50) and after some years it's often between 5 and 10 ACH50 as the wood shrinks and sealants deteriorate. Old wood frame homes commonly have 10 to 20 ACH50.

# ICF Thermal Convection

- ICF walls & roofs are an effective air barrier because the concrete is poured in semi-liquid form, forcing air out of the cavity and filling every void after consolidation.
- A chemical reaction turns the concrete into a solid without passages for air to leak, thus eliminating a major percentage of air infiltration.
- ICF homes consistently show results of 0.5 to 2.5 ACH50 and less, largely depending on the installed roof type and sealing.
- Most air infiltration in an ICF home is through a conventional roof and around windows & doors, so pay attention to these areas, e.g. use [Quad-Deck](#) for the top of the building.
- Building consultants recommend energy or heat-recovery ventilators (ERV or HRV) for further energy savings and adequate air exchange in very airtight buildings.

# Thermal Radiation

- Thermal Radiation transfers heat via electromagnetic waves, which for buildings are mostly the sun's rays.
- Depending on factors like site & location of the building and the prevailing climate, [Passive Solar Building Design](#) helps optimize a building's absorption and reflection of solar radiation through solar orientation, placement of windows and shading elements, choice of finishes, and incorporation of thermal mass.

# Thermal Mass

- Thermal Mass refers to a material's capacity to store heat. Concrete and (Adobe) bricks have high thermal mass, which can act like a battery for heat.
- The classical use of thermal mass is in desert climates, where outside temperatures swing above inside temperatures during the day and below at night.
- High mass building shells can store the heat from the outside during the day and release that heat to the inside at night - keeping the inside comfortable using almost no additional energy.
- In temperate climates, thermal mass is best used in combination with the principles of [passive solar design](#), e.g., strategically allowing the sun to heat high mass (concrete) floors through windows.

# Wood Frame Thermal Mass

- Wood frame buildings have almost *no thermal mass* - unless finished with brick or other masonry product.

# ICF Thermal Mass

- High mass construction built into ICF walls & floors can significantly reduce the requirements for active heating and cooling systems in many climates - which translate into ongoing energy savings and savings from smaller sized HVAC equipment.
- Most current residential HVAC sizing software does not factor in the effects of thermal mass.
- In response, the Portland Cement Association (PCA) developed [HVAC Sizing software](#) that uses Dept. of Energy 2.1E calculations to estimate the required heating and cooling system capacity for single-family concrete homes based on a user-defined thermostat set point, house dimensions, construction materials, and location.

# Summary of ICF vs. Wood Frame

- The R-value of one component alone does not reveal how a building will perform. The Building Code is only a MINIMUM standard, and there are many factors that influence energy performance.
- ICF buildings far outperform framed buildings despite similar stated R-values.
- The secret lies in the combination of reduced conduction & convection, and high thermal mass.
- The result is a building with a lower appetite for energy and more consistent and comfortable temperatures inside the building.

# Passive Building Design

- Every building must be considered from a 'whole system' perspective.
- Besides walls, roof and slab, windows also have a significant impact on performance since they usually make up 10% to 20% of the total wall area and range widely in energy performance.
- Building envelope consultants now offer modeling services that will provide a much more accurate picture of how a building will actually perform.
- A small investment in computer analysis helps in formulating the most energy efficient design to save tens of thousands - even hundreds of thousands - in energy costs over a building's lifetime.

# Green Building/Passive House Design

- Sustainable or green building practices promote the construction of buildings that are healthier for the occupants and healthier for the environment.
- They reduce the tremendous impact that building construction, operation, maintenance, and disposal have on both people and nature.
- According to the U.S. Department of Energy's Center for Sustainable Development, buildings consume 40-50% of the world's total energy, 25% of its wood harvest and 16% of its water.
- The building industry is the nation's largest manufacturing activity, representing more than 50% of the nation's wealth.

# Green Building & ICF Technology

- A recent report by the Commission for Environmental Cooperation (CEC) promotes [Green Building for the Biggest, Easiest Cuts in CO<sub>2</sub> Emissions.](#)
- Energy-saving technologies applied in buildings can result in enormous reductions in demand for fossil fuels and emissions of greenhouse gases.
- Insulated Concrete Forms are one key technology because they provide an ultra-efficient, high mass, high strength, and very durable building shell that keeps occupants healthy and comfortable.

# Quad-Lock ICF Technology

- Quad-Lock is [ISO 9001 and 14001 certified](#) to ensure and continually improve product and service quality, and have minimal impact on our environment.
- Quad-Lock ICFs are constructed of dense Expanded Polystyrene (EPS) foam insulation that is fire retardant and mold-free and injection molded high-density polyethylene cross ties spaced at 12” (305 mm) on center horizontally.
- Quad-Lock will be contributing ICF materials for building and demonstrating a passive house design via a model home.
- RM Enterprises, LLC and General Contractor will become joint distributors and train other contractors for installation of ICF and other technologies utilized in the passive home/building design.

# Quad-Lock ICF vs Wood Frame Construction

- Ultra Energy-Efficient because of continuous EPS insulation (higher & uniform R-value), greatly reduced air infiltration, and the thermal mass effect of concrete. [Learn more...](#)
- Much more Comfortable and Healthy because of very even inside temperatures (no cold spots or nasty drafts), far better sound attenuation, and low risk of mold growth and allergen infiltration.
- Longer-lasting and more resistant to natural disasters, rot, mold, and pests because the solid reinforced concrete is up to 8 times stronger and nearly impenetrable (even for [car crashes](#)) - it's what gives bunkers their strength!

# Quad-Lock ICF vs other Insulating Concrete Forms

- Quad-Lock has the highest range of insulation values.
- Different combinations of Quad-Lock [Panels](#) provide true R-Values of 22, 28, 30, 38, 43, 45, 53, and 59.
- Don't trust claims about "effective R-Values" (often cited as R-50 for R-22 ICFs) which are unscientific and prohibited by advertising laws.

# Quad-Lock ICF vs other Insulating Concrete Forms Cont.

- Quad-Lock creates much less waste compared to ICF block systems because most parts that need to be cut can be reused in the same project (see [Reduce, Reuse & Recycle Tips](#)).
- Quad-Lock typically adds a **2-4%** waste factor in [estimates](#) (some installers can achieve 1% or less!), while many projects using ICF blocks need a **5-8%** waste factor - often not included in estimates.
- A price per square foot of forms is NOT suitable for comparisons because you need to add the waste factor, structural bracing for corners and angles, plywood wrap-arounds on openings, zip-ties or clips to hold ICF blocks together, method to align walls along top and bottom, etc. along with all the associated labor costs!

# Quad-Lock ICF vs other Insulating Concrete Forms Cont.

- Most Quad-Lock items are in stock ready for shipping whereas many competitors require long lead times to first produce what you order; in addition it means their forms are often still moist and not shrunk down to final size.
- Quad-Lock offers less thermal bridging because internal buck-outs are made easy. "External bucks" - the only option for most ICF blocks - create a significant thermal bridge around every window and door opening.
- Quad-Lock is highly versatile using a few standard parts. Quad-Lock can easily be shaped to form all the design elements of modern buildings - wide openings, arches, corners, any angles, and real curves with almost any radius.

# Quad-Lock ICF vs other Insulating Concrete Forms Cont.

- Quad-Lock produces a flat, solid concrete wall providing a constant thickness of concrete throughout the wall (no thin/thick sections like grid or post-and-beam systems).
- Quad-Lock is Code Approved. See [approvals & tests](#).
- Quad-Lock provides a better surface for stucco application. Quad-Lock creates an all-foam surface compared to some ICF systems where the surface consists of both EPS and the material used for ties, making it tougher to finish it.
- Quad-Lock's unique and patented tie design offers low likelihood of problems by positively connecting the EPS panels at both the horizontal and vertical seams where the pressure during concrete placement is most likely to cause failures.

# Quad-Lock ICF vs other Insulating Concrete Forms Cont.

- Quad-Lock has very strong corners because of ingenious [metal brackets](#) - no additional bracing or zip-ties needed!
- Quad-Lock costs less to ship and store compared to most ICF block systems because it is a flat panel & tie system.
- Up to 100% more wall area can be shipped per truckload. With Quad-Lock, you're not shipping air!

# Quad-Lock ICF vs other Insulating Concrete Forms Cont.

- Quad-Lock is [ISO 9001 and 14001 certified](#) to ensure and improve product and service quality and minimal impact on our environment.
- Quad-Lock offers great technical and instructional support and material. Local dealers and distribution partners are equipped to answer your questions, prepare detailed estimates, and assist at the jobsite.
- Quad-Lock Field Representatives are also ready to assist with quantity pricing, job site training, product seminars etc. Their website, [Installation Video](#), [Product Manual](#), and other informative [technical](#) and [promotional literature](#) reveal exactly how to build with Quad-Lock.

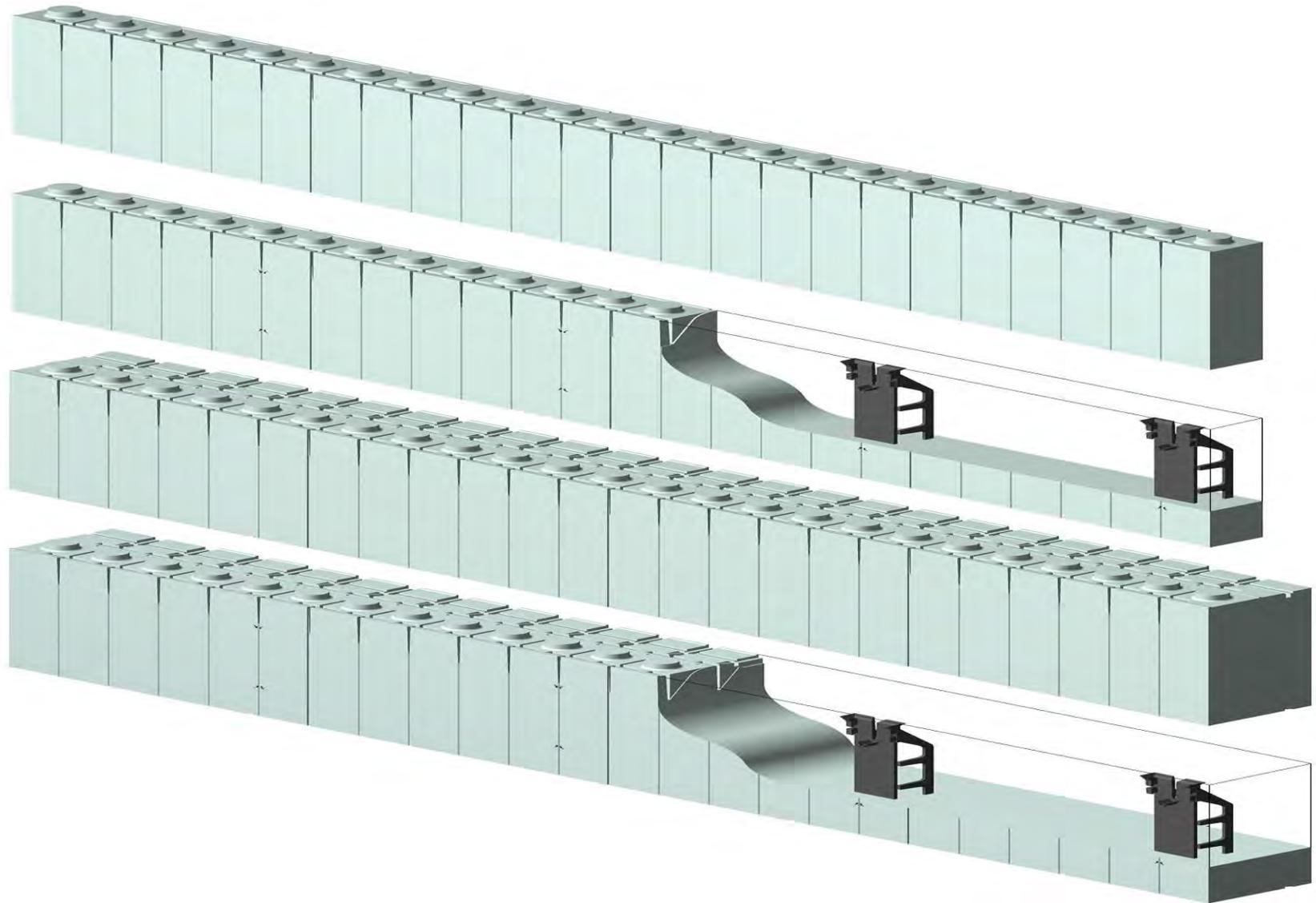
# Commercial & Multi-Story Advantages over other ICFs

- No other ICF can build around pre-tied rebar as easily as Quad-Lock.
- No other ICF can be assembled with as little laborers' exposure to the outside of a multi-storey structure.
- Quad-Lock's unique [Corner, Angle](#), and [T-wall](#) solutions allow building from the safety of the inside of the building. This minimizes the amount of outside scaffolding required and the risk of long falls for workers.
- No other ICF can build columns and pilasters like Quad-Lock. Almost every commercial project needs them.
- Few other ICFs can offer the range of wall thicknesses that Quad-Lock offers. See [Quad-Lock Ties](#) & [Extender Ties](#).

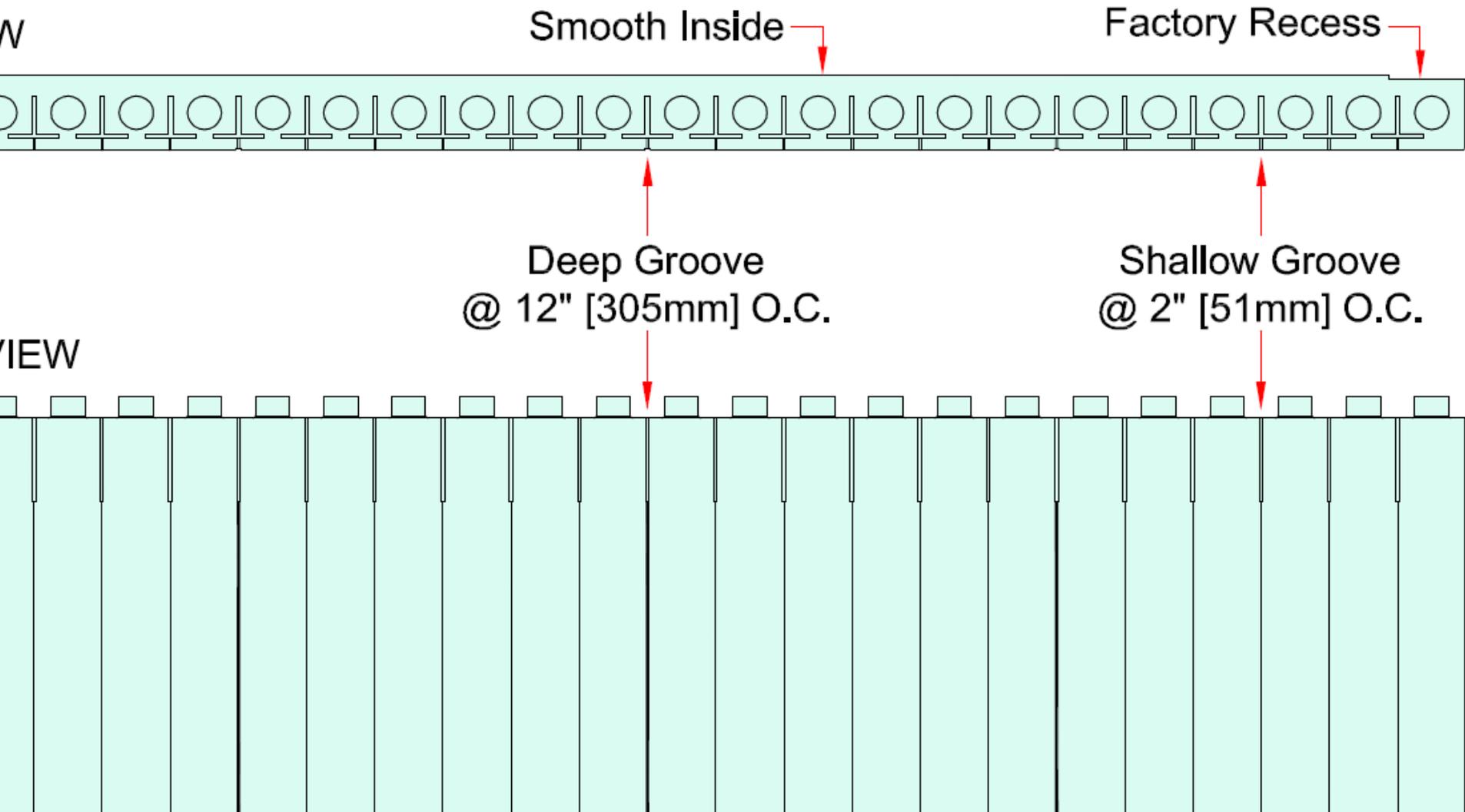
# Commercial & Multi-Story - Advantages over other ICFs cont.

- No other ICF can provide Quad-Lock's unlimited range of wall angles with so little labor.
- No other ICF integrates concrete walls and concrete floors or roofs as well. Quad-Lock developed and tested unique solutions, such as [Slab Brackets & Ties](#), and actively sells and supports an [ICF for concrete floors & roofs](#), allowing lower freight costs by combining wall and floor shipments.
- Few other ICF companies offer access to a LEED AP (Accredited Professional) who can help designers identify & accrue LEED points for Quad-Lock projects.
- Quad-Lock offers Green Roof technology with a rot-resistant roof structure that will carry the loads imposed by these designs. Learn more about [Green Roofs](#).

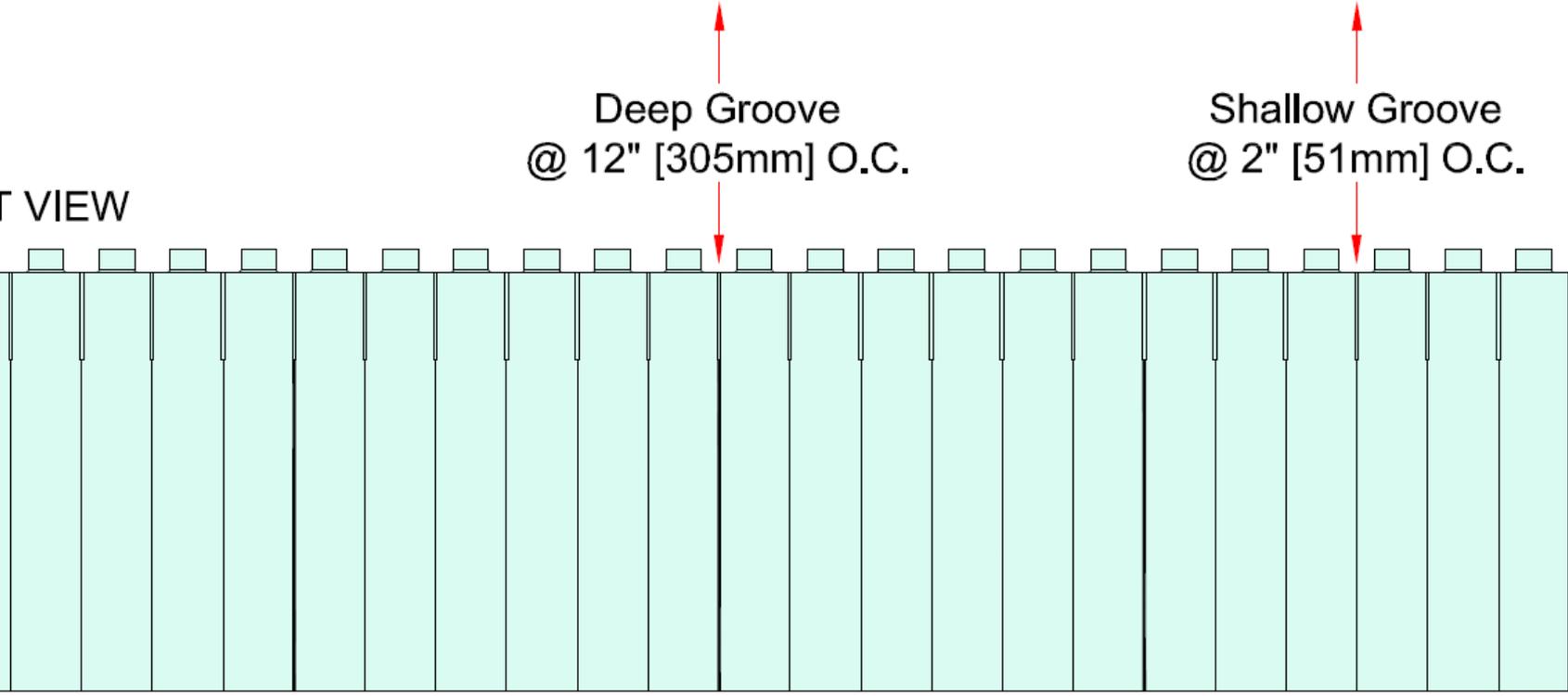
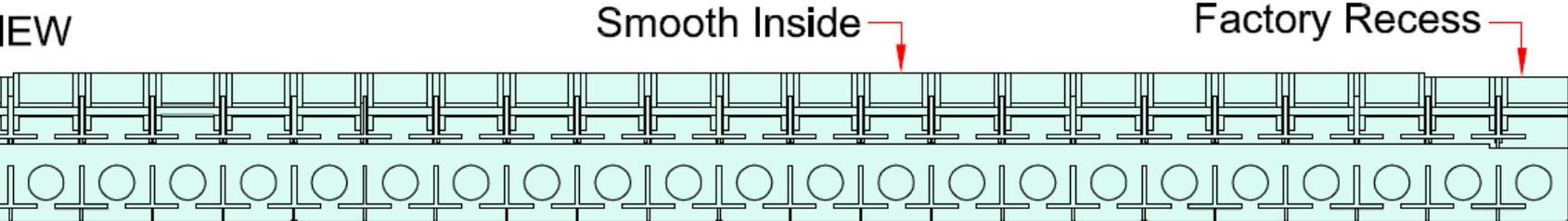
# Quad-Lock ICF Wall Panel Design



# Quad-Lock Panel Dimensions



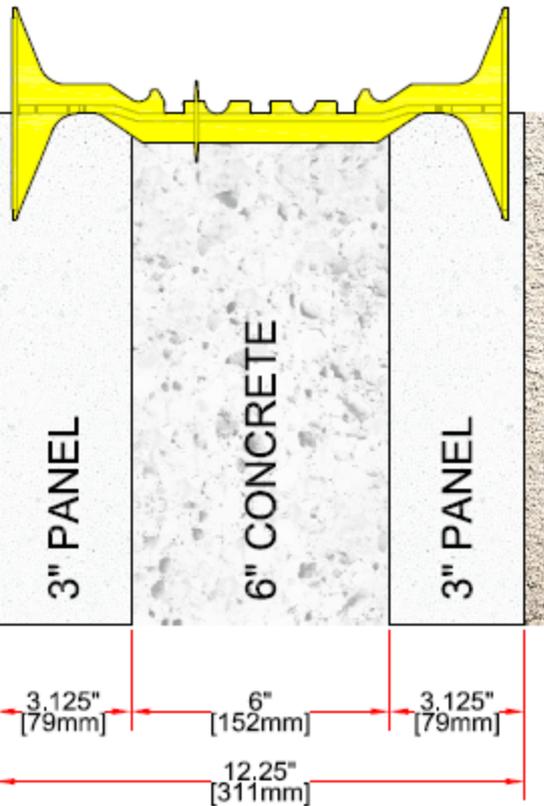
# Quad-Lock Plus Panel Dimensions



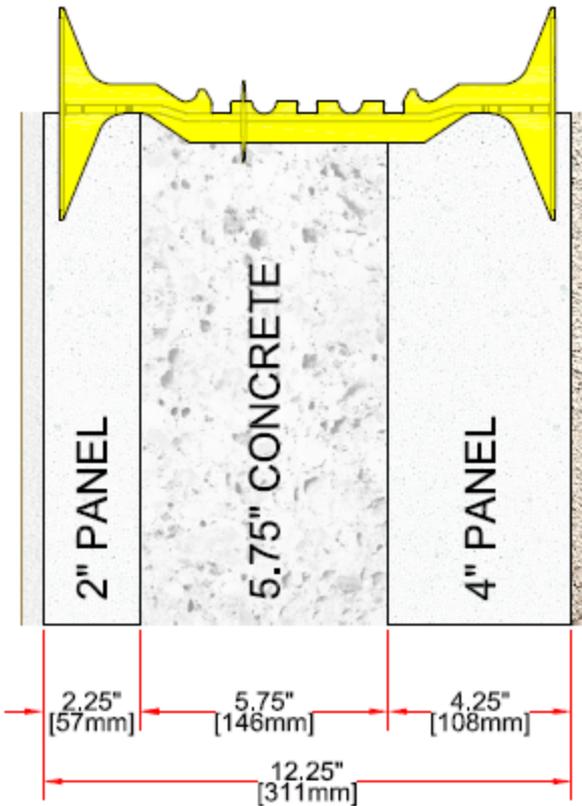
12.00"

2.00"

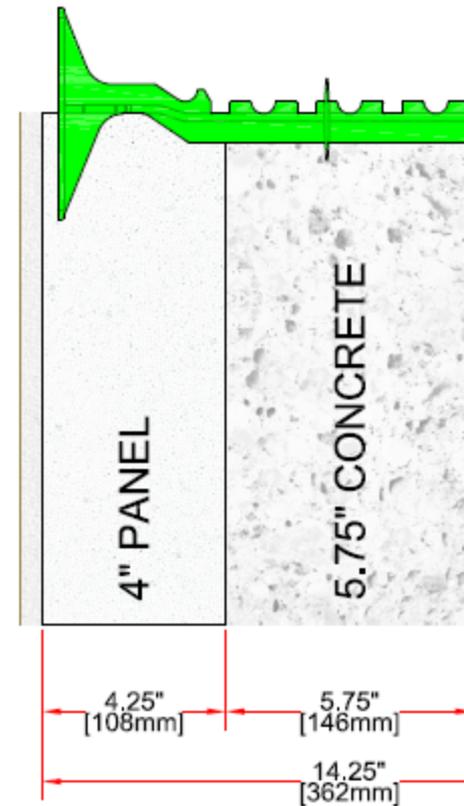
# Quad-Lock Wall Panel Configurations & Dimensions



R-28



R-30



R-38

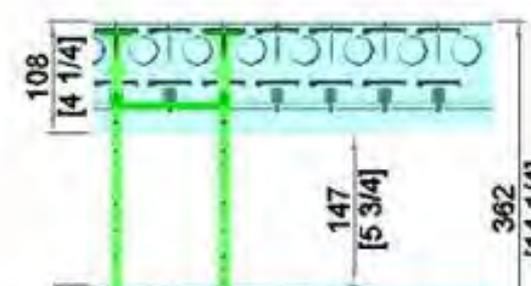
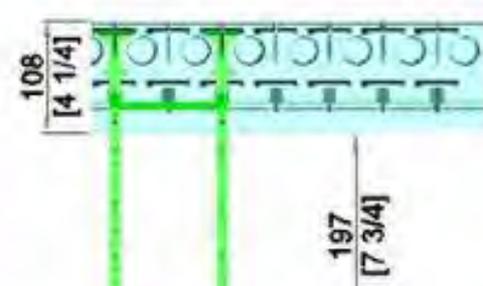
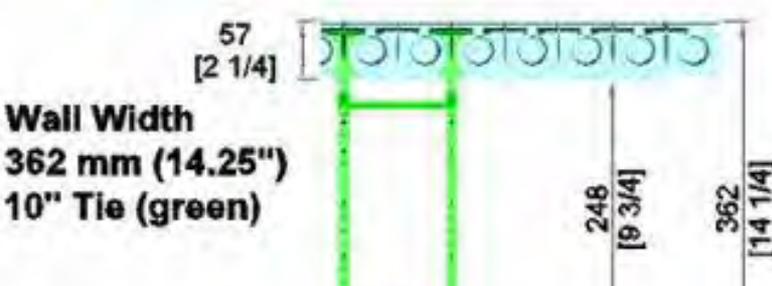
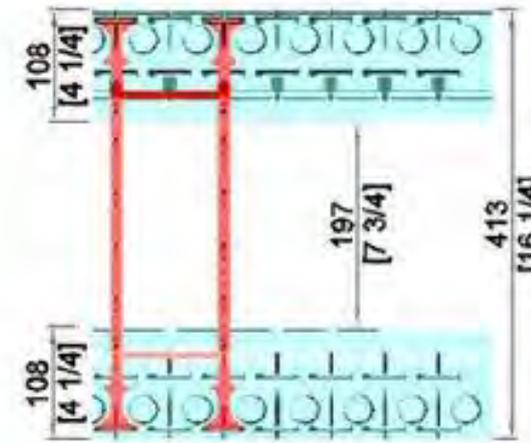
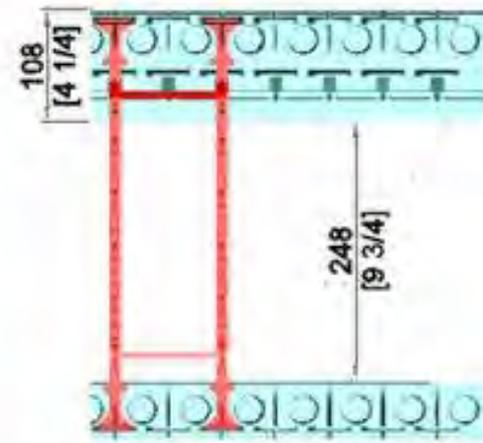
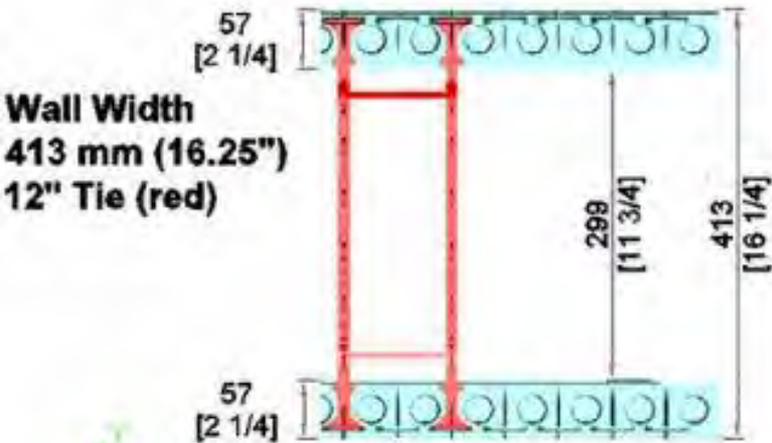


# Additional Quad-Lock Configuration Data

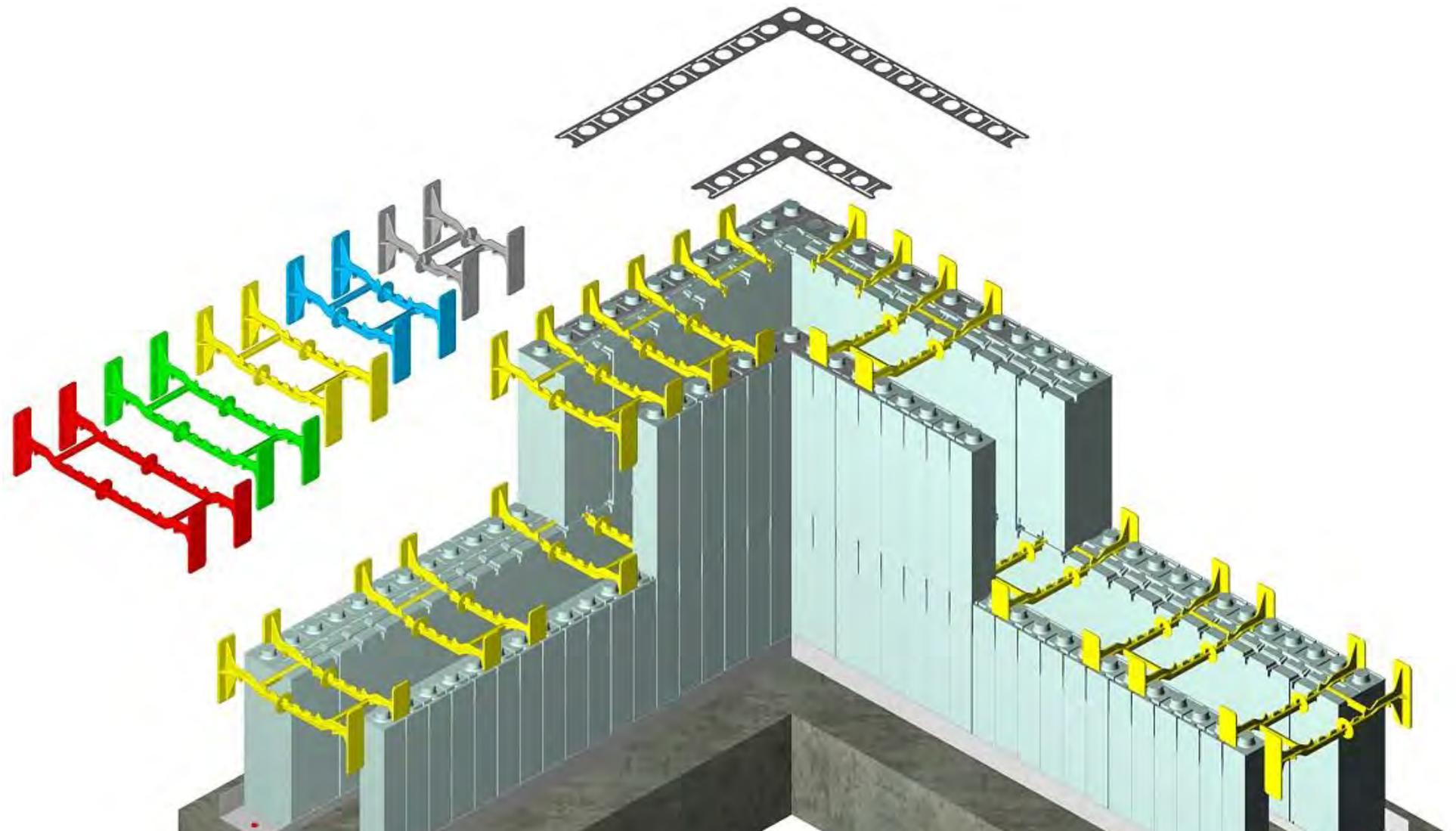
**R = 22**  
**(2 x QL)**

**R = 32 (°F.ft<sup>2</sup>.h/Btu.in)**  
**(QL+QLPlus)**

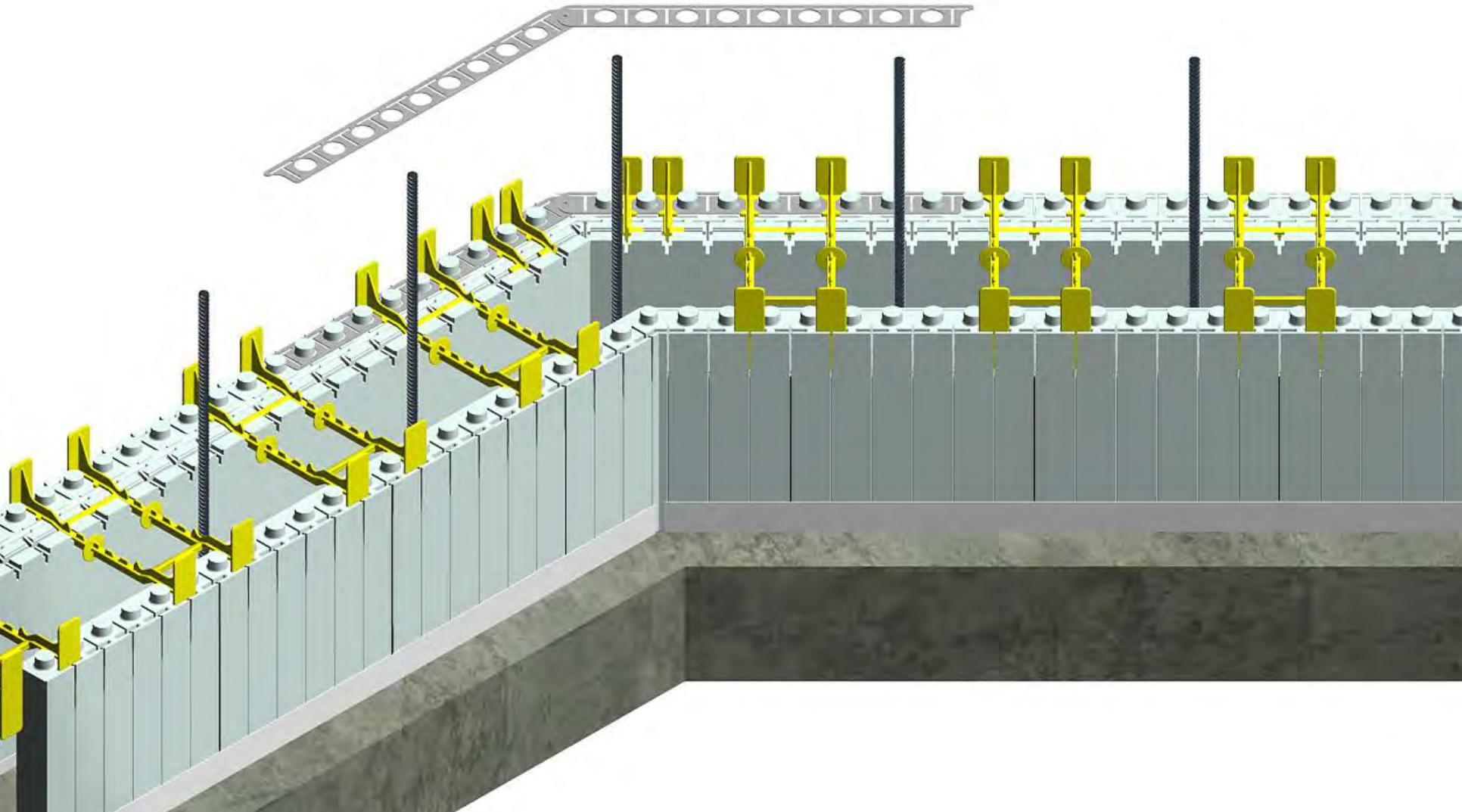
**R = 40**  
**(2 x QLPlus)**



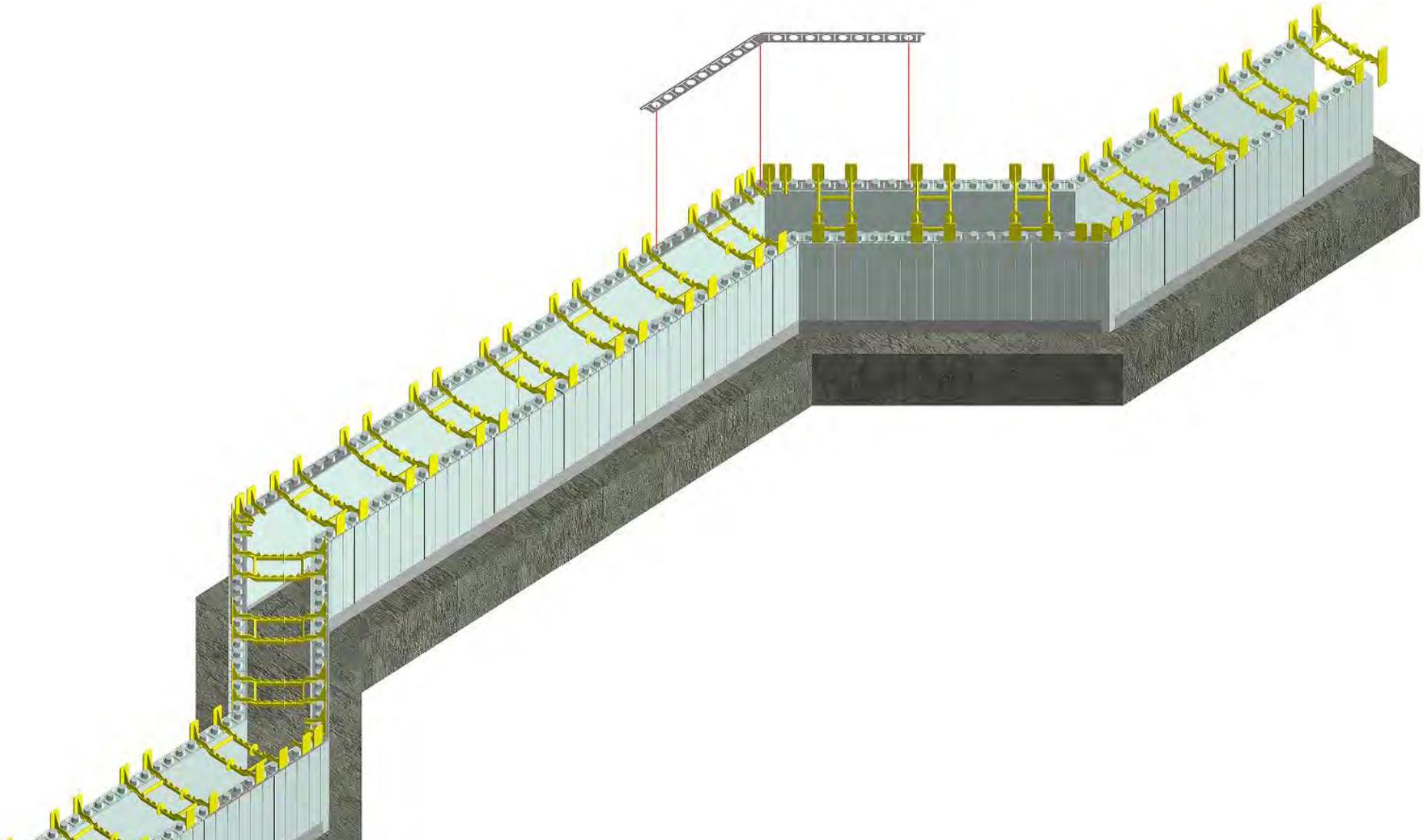
# Quad-Lock Plus Corner



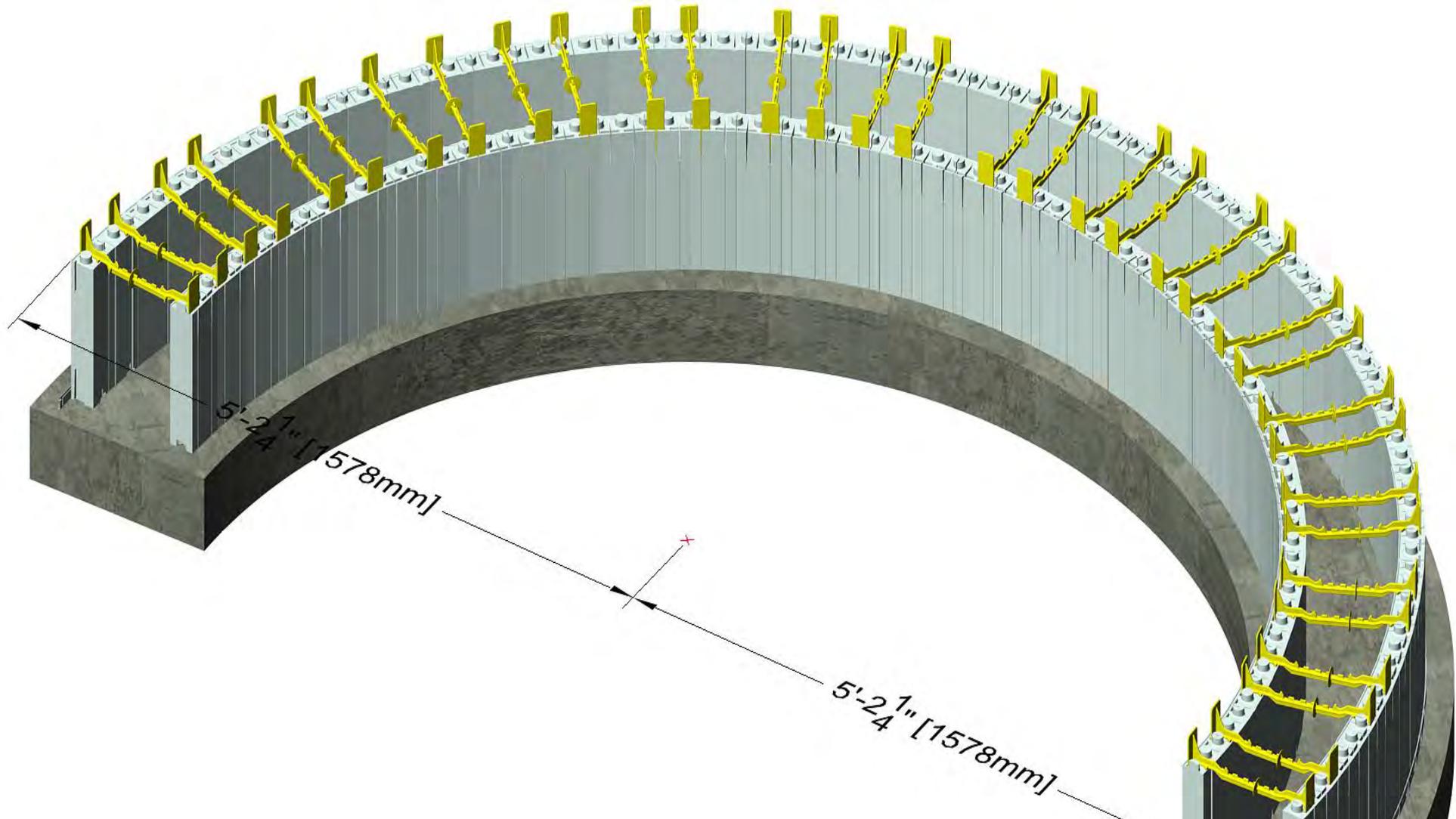
# Quad-Lock Plus Angle



# Quad-Lock Bay Window

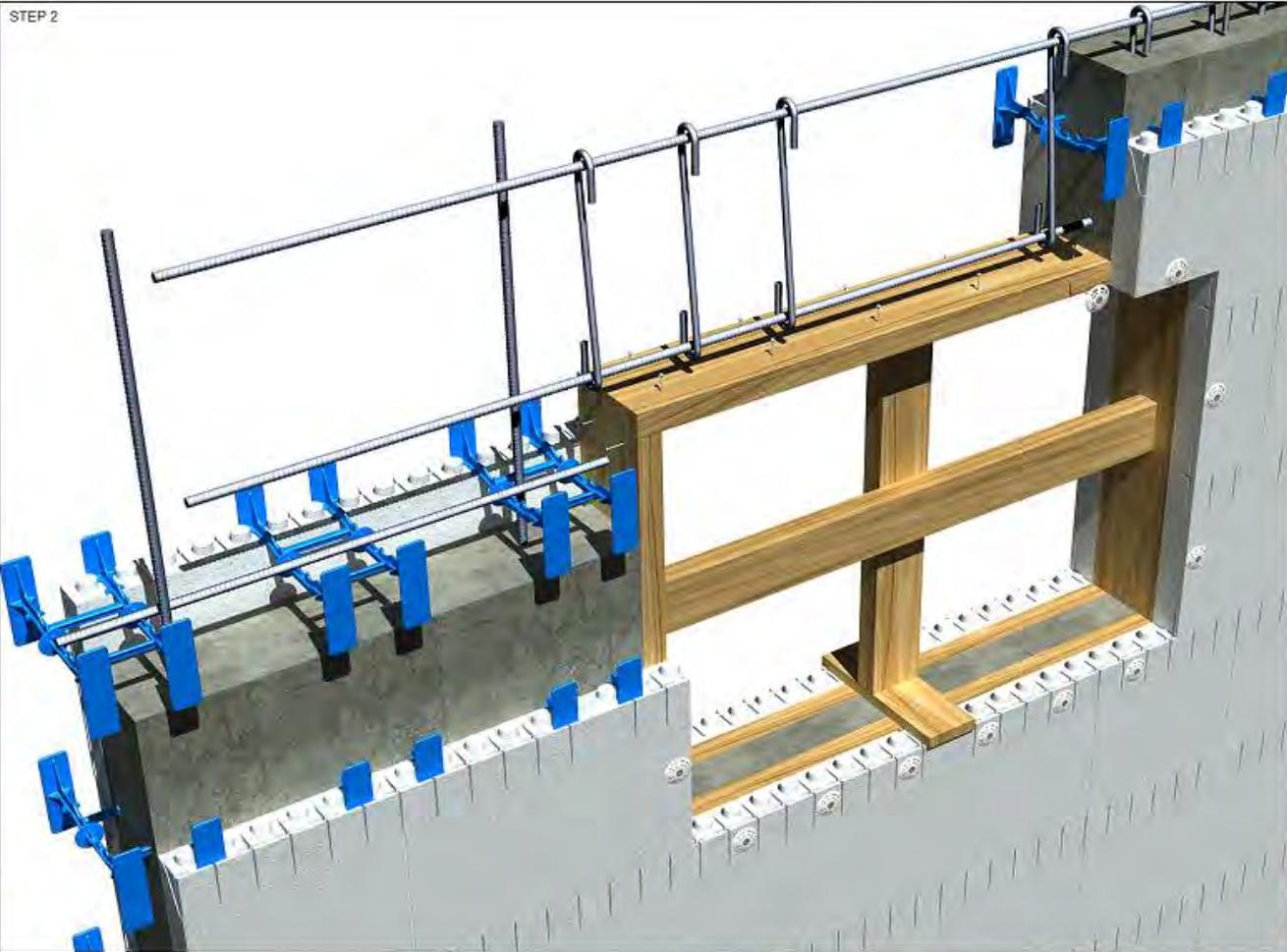


# Quad-Lock Radius

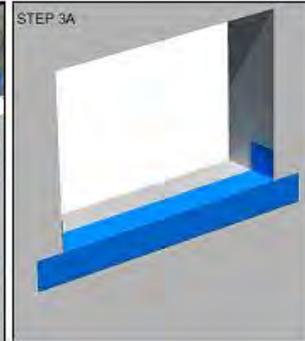


# Quad-Lock Window Buck

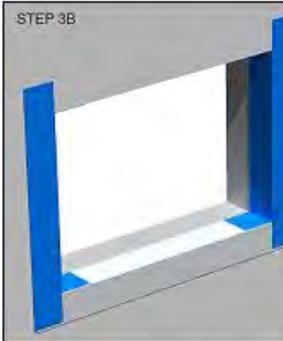
STEP 2



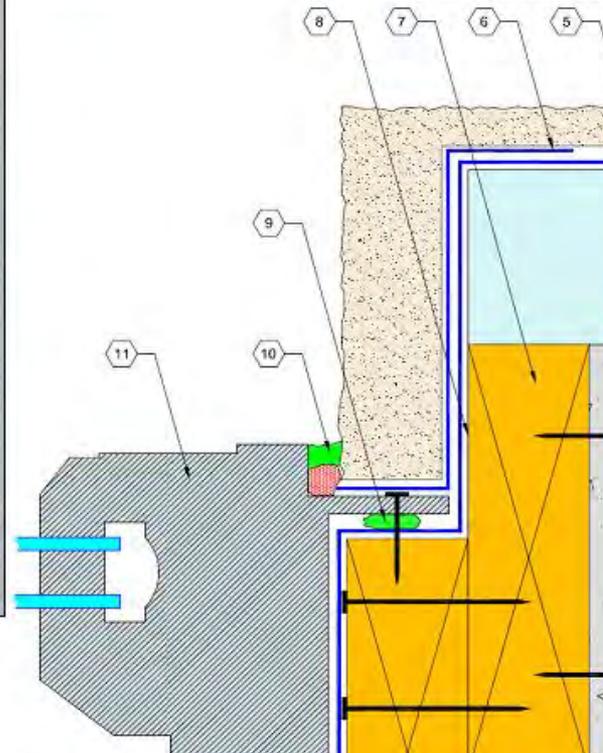
STEP 3A



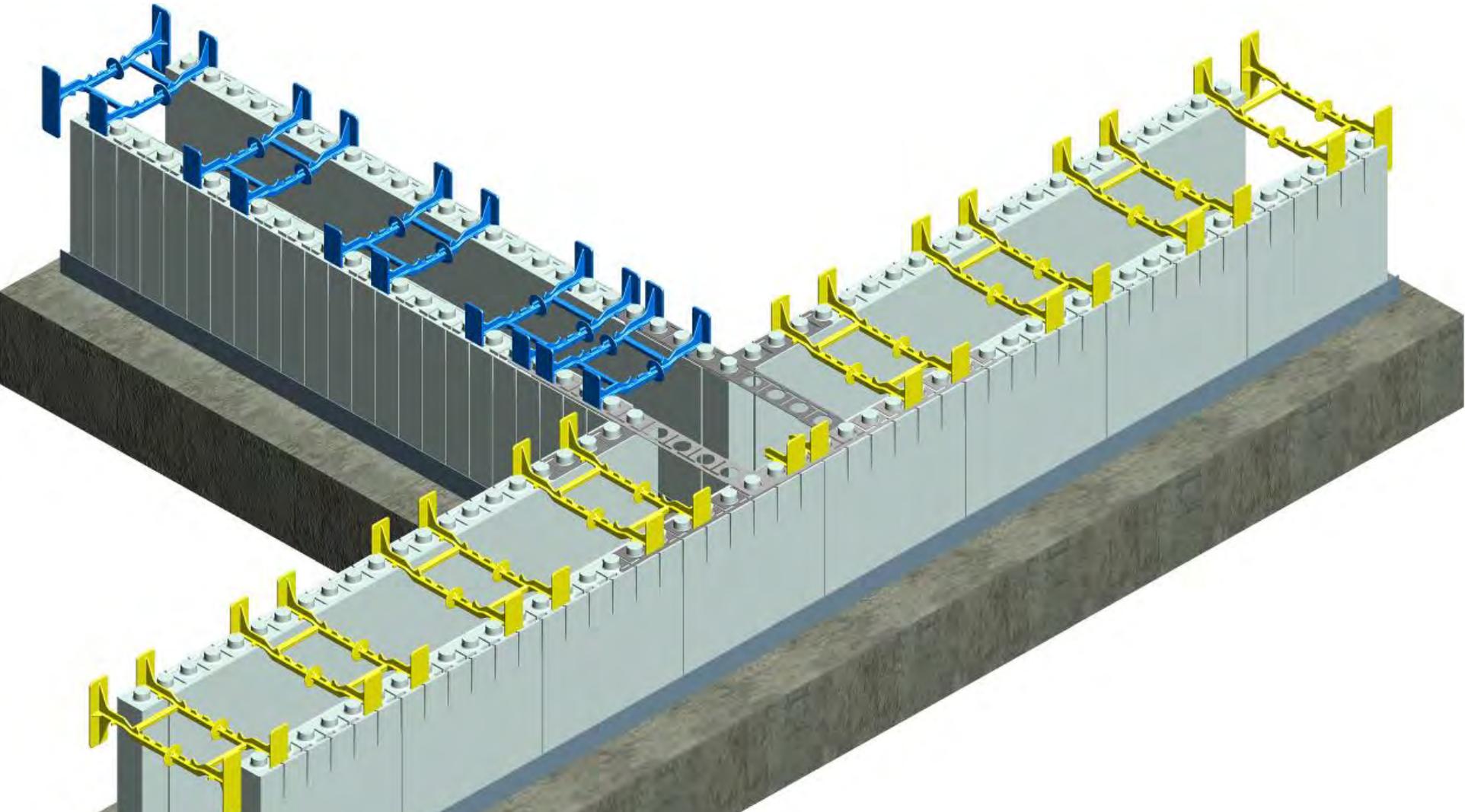
STEP 3B



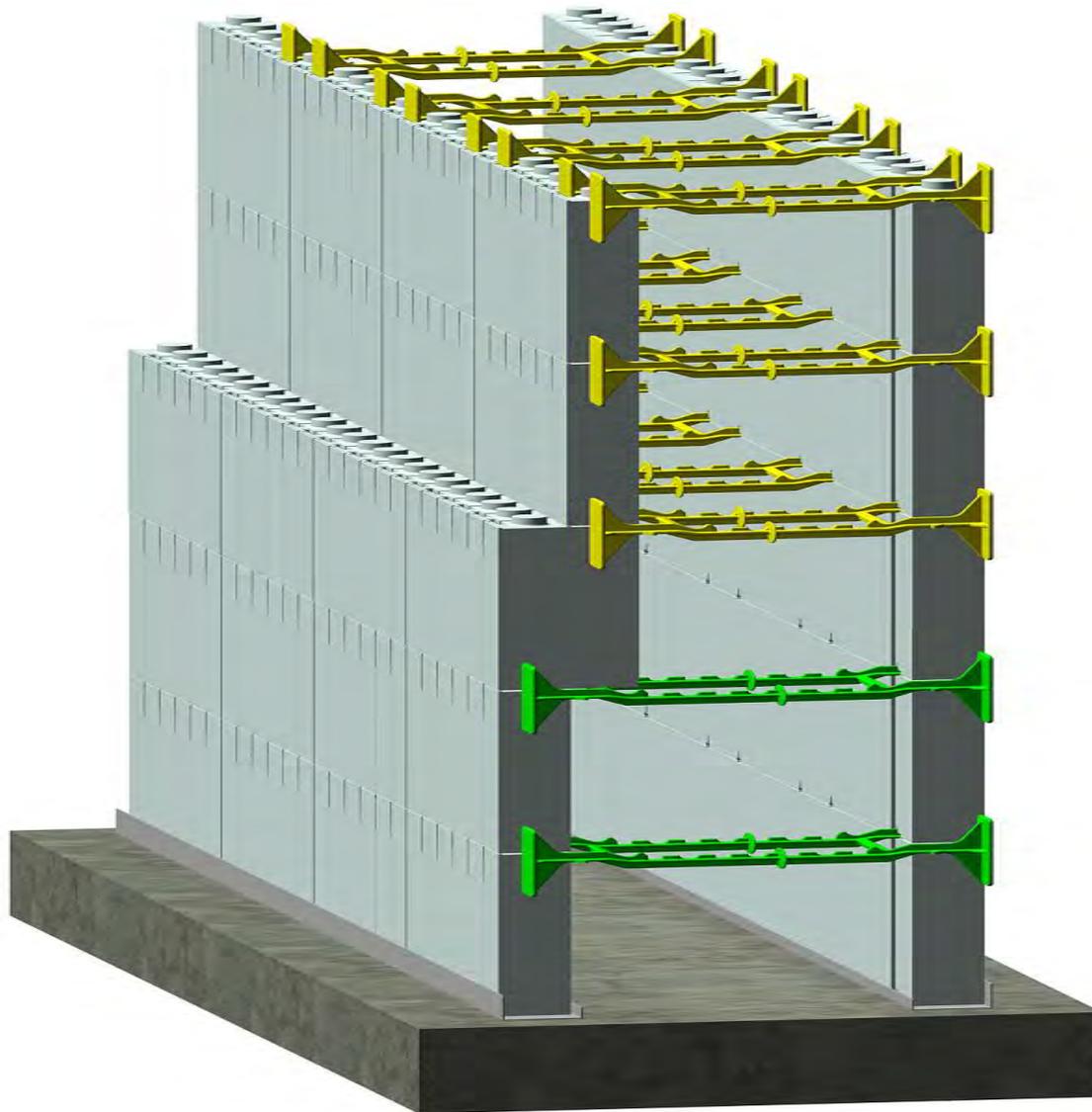
STEP 5



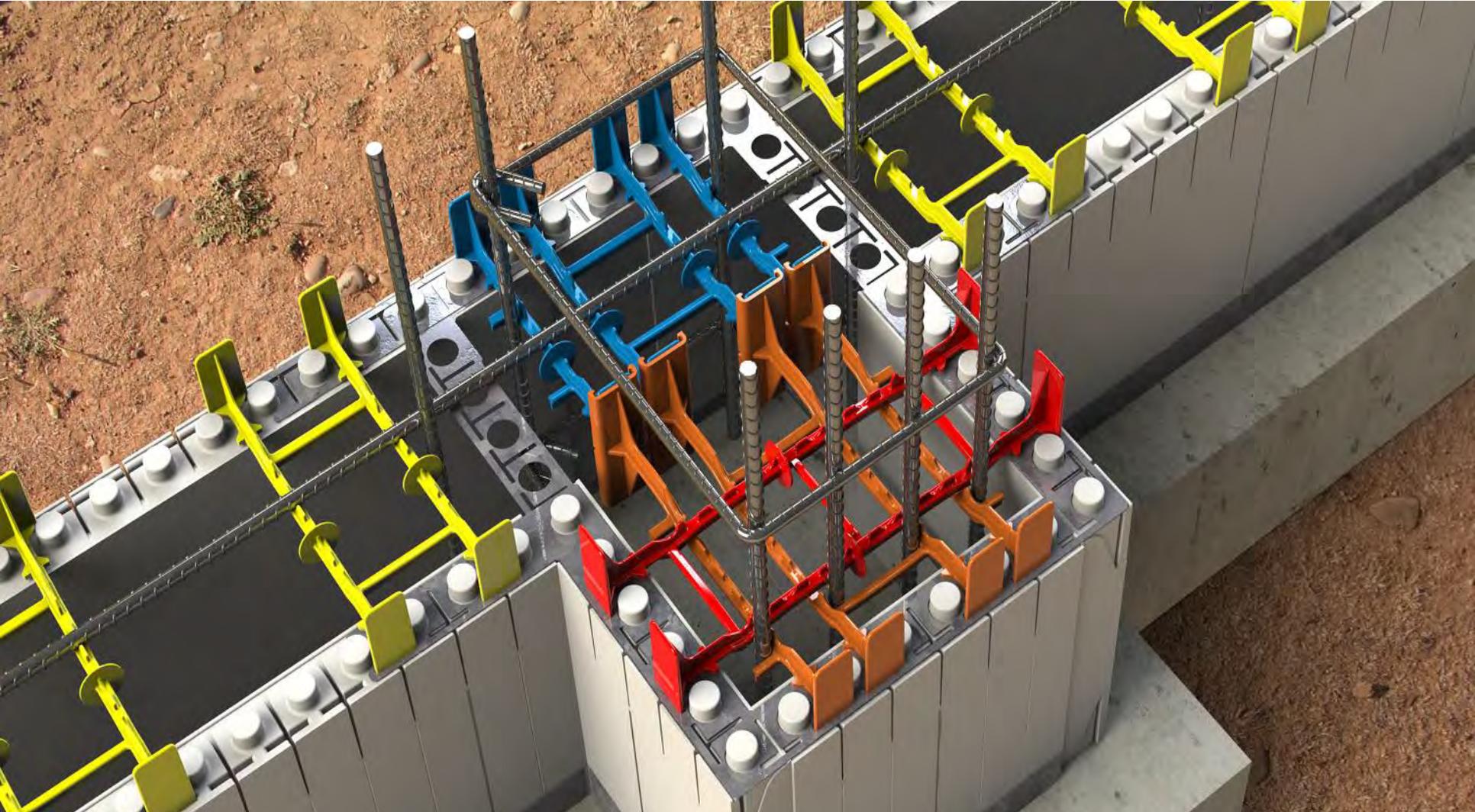
# Quad-Lock T-Wall Connection



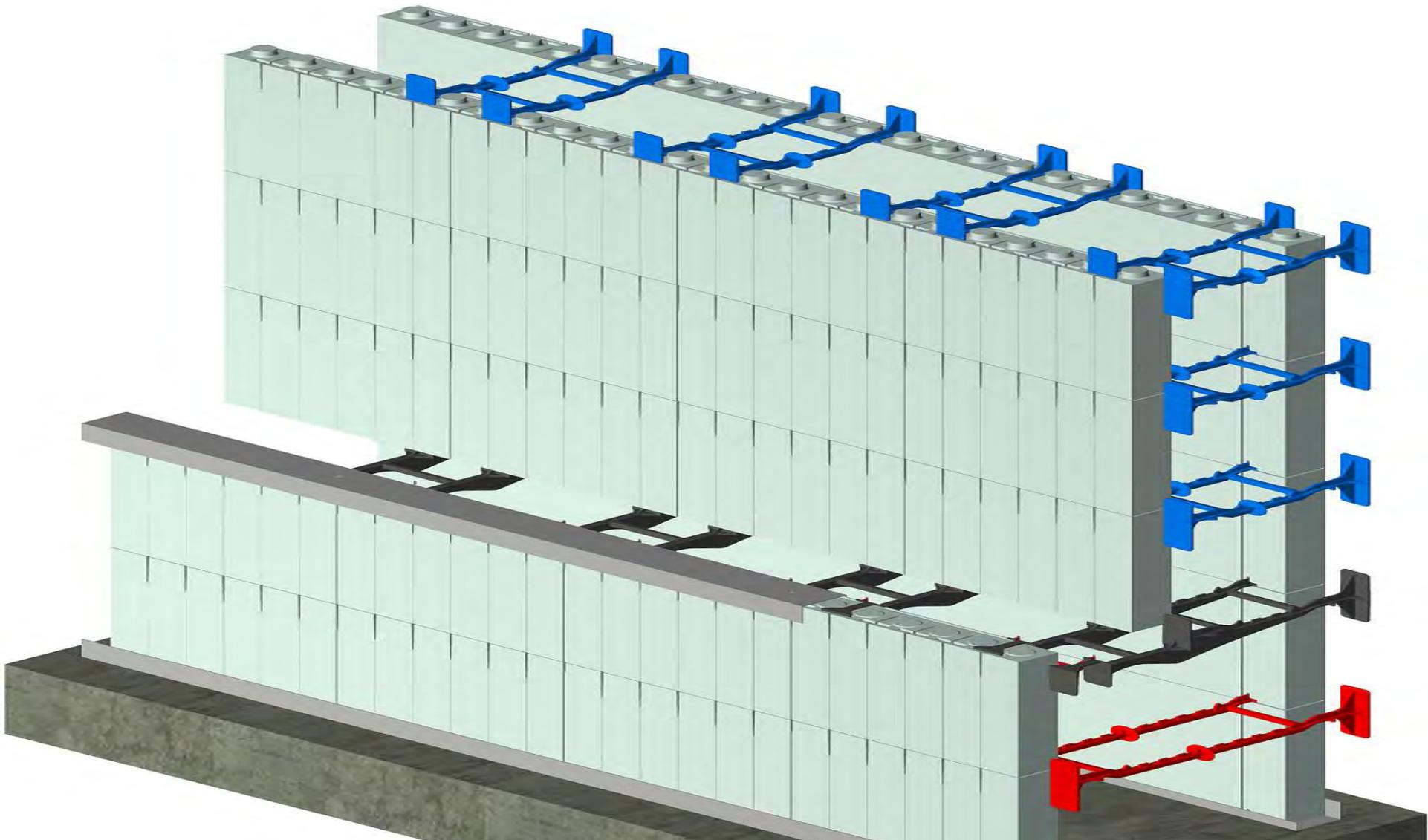
# Quad-Lock Wall Width Transition



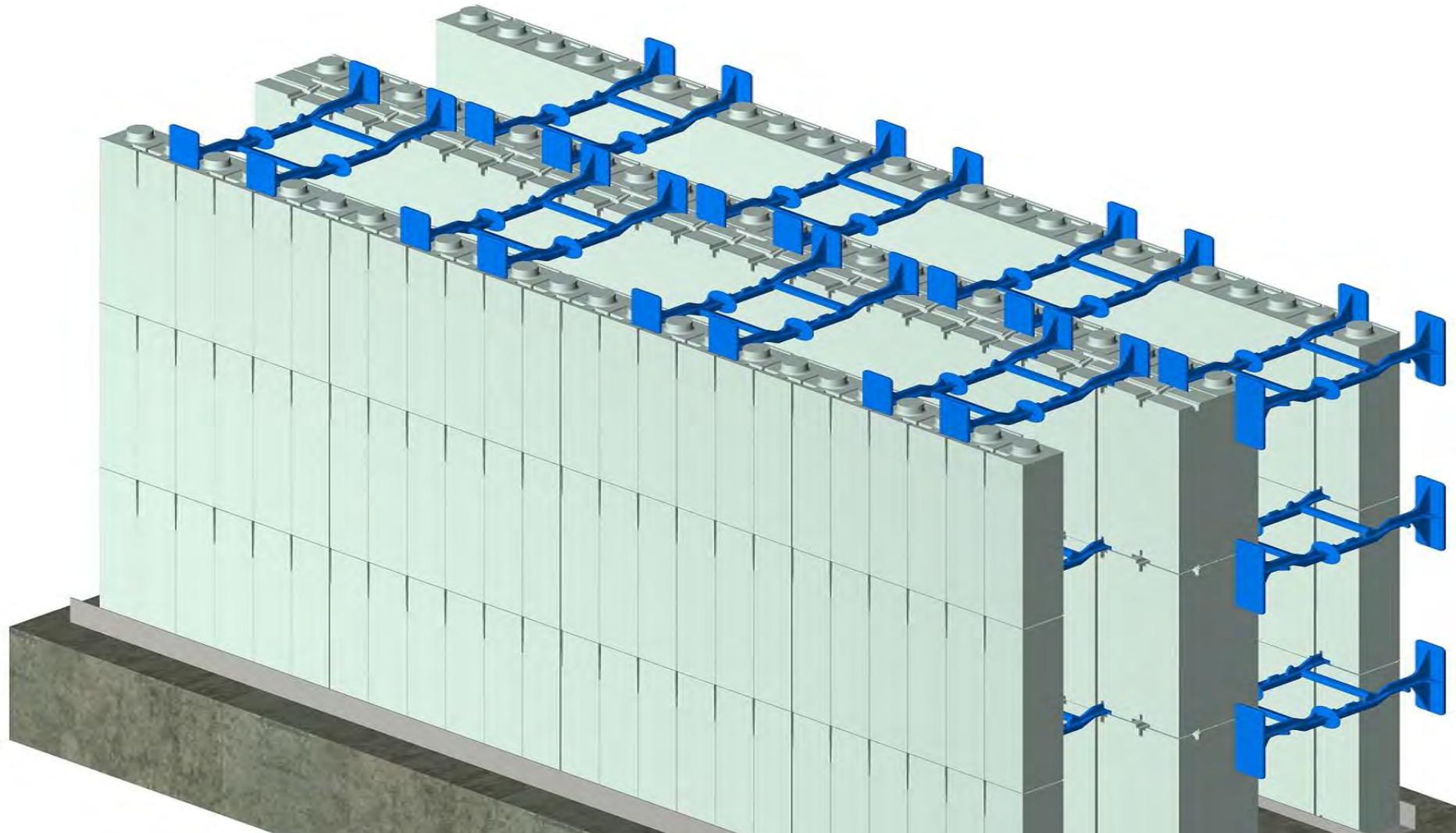
# Quad-Lock Pilaster Configuration



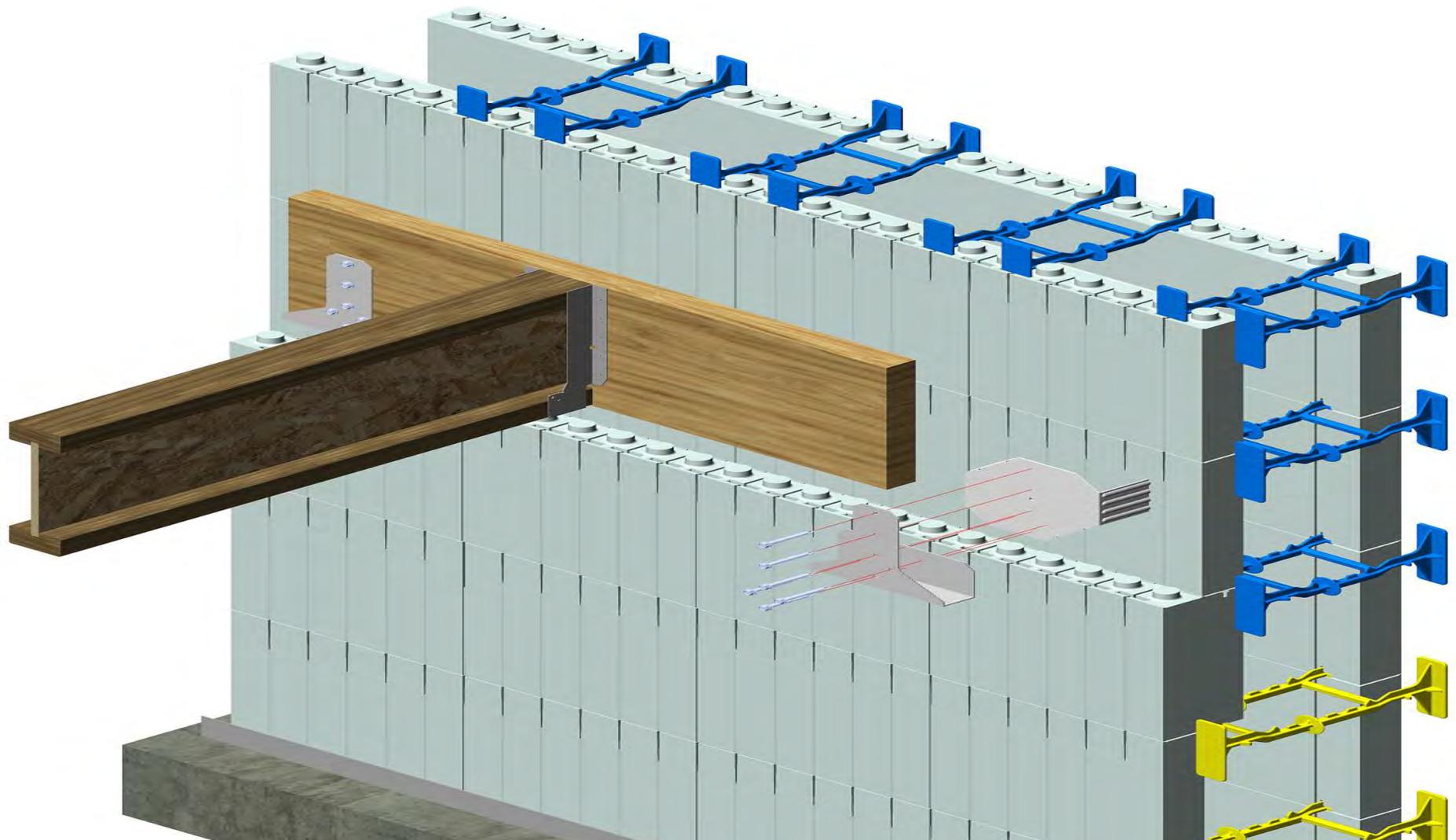
# Quad-Lock Brick/Masonry Ledge



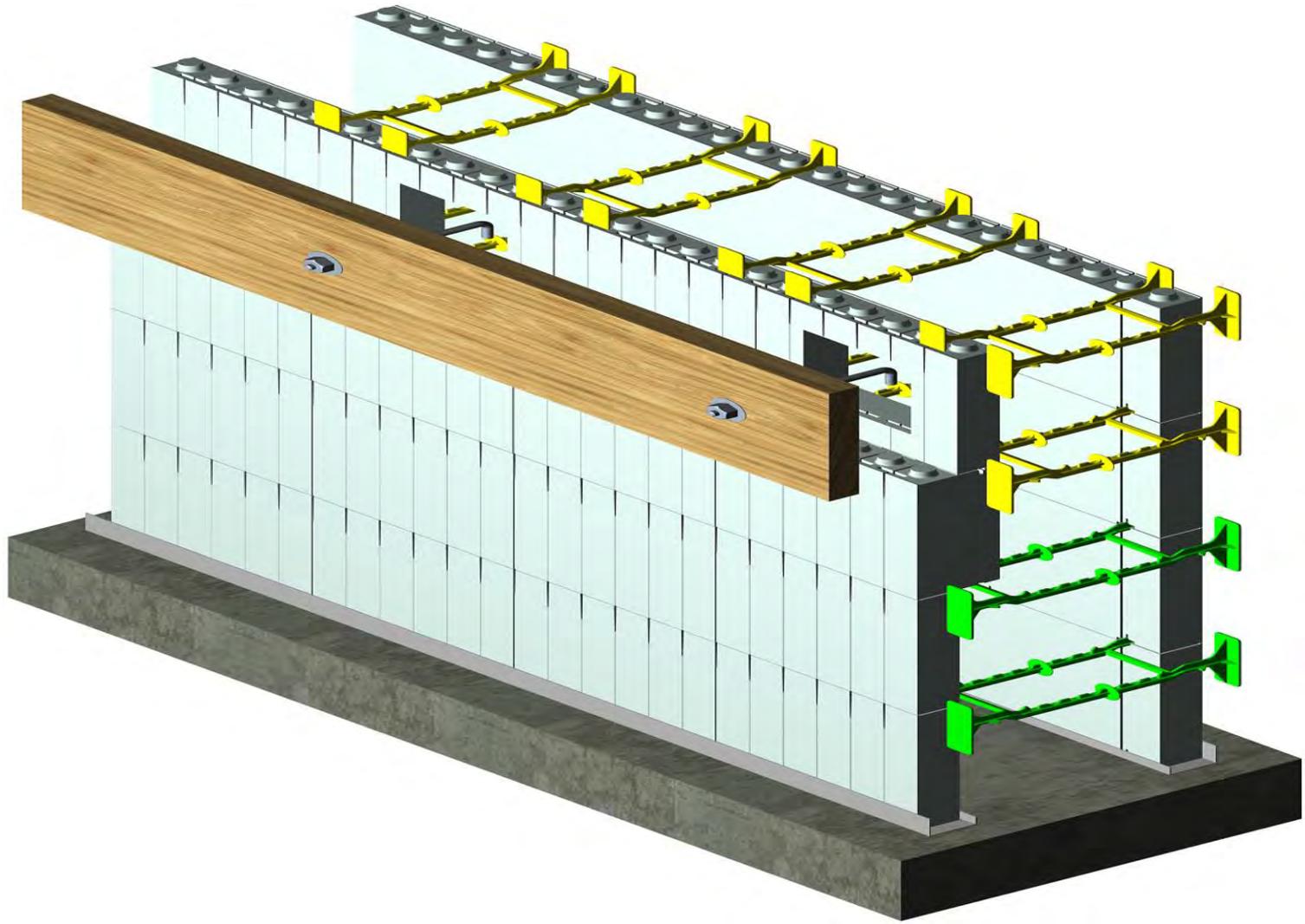
# Quad-Lock Double/Common Wall



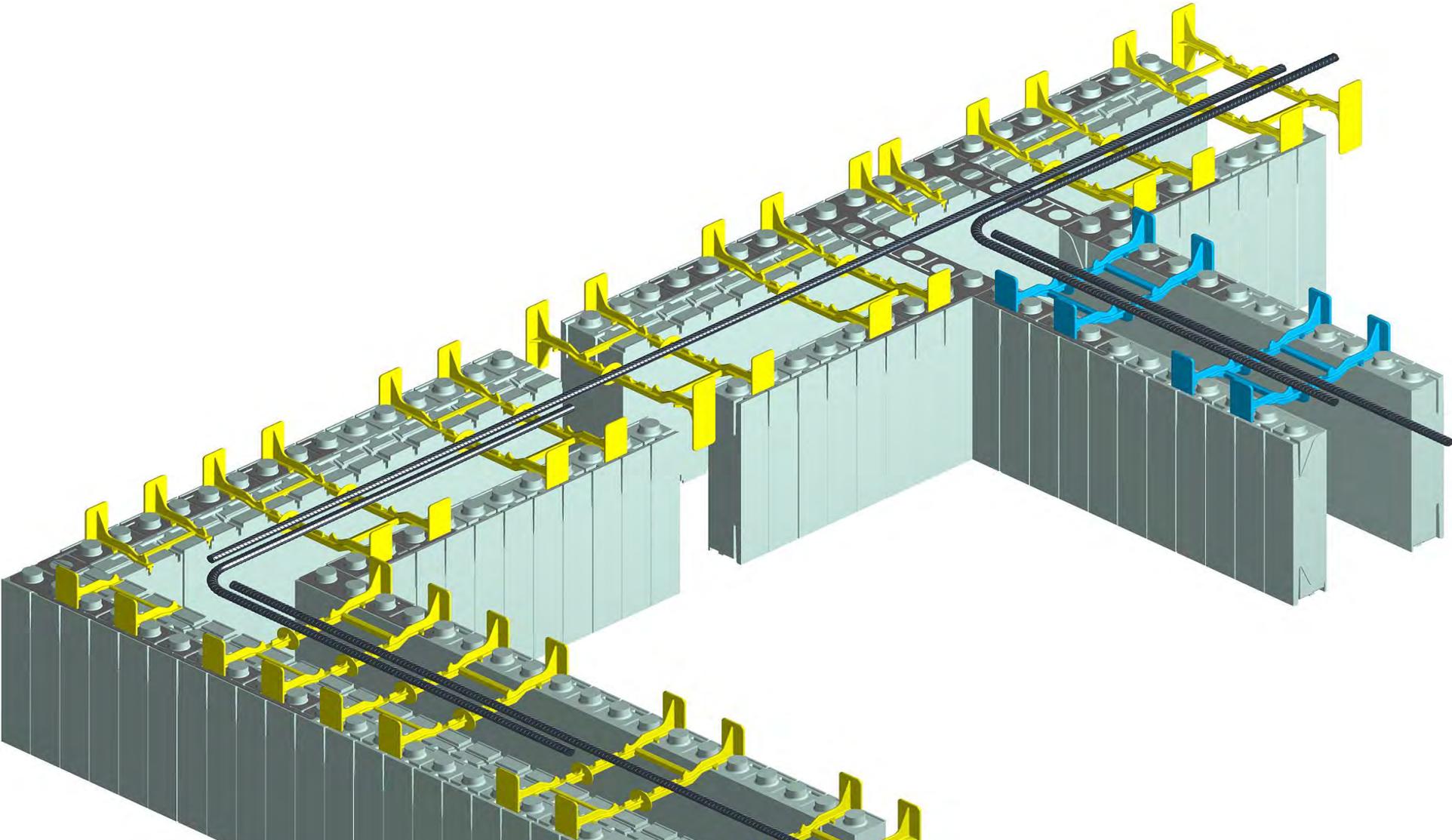
# Quad-Lock Ledger Attachment (Simpson ICF Ledger Connectors)



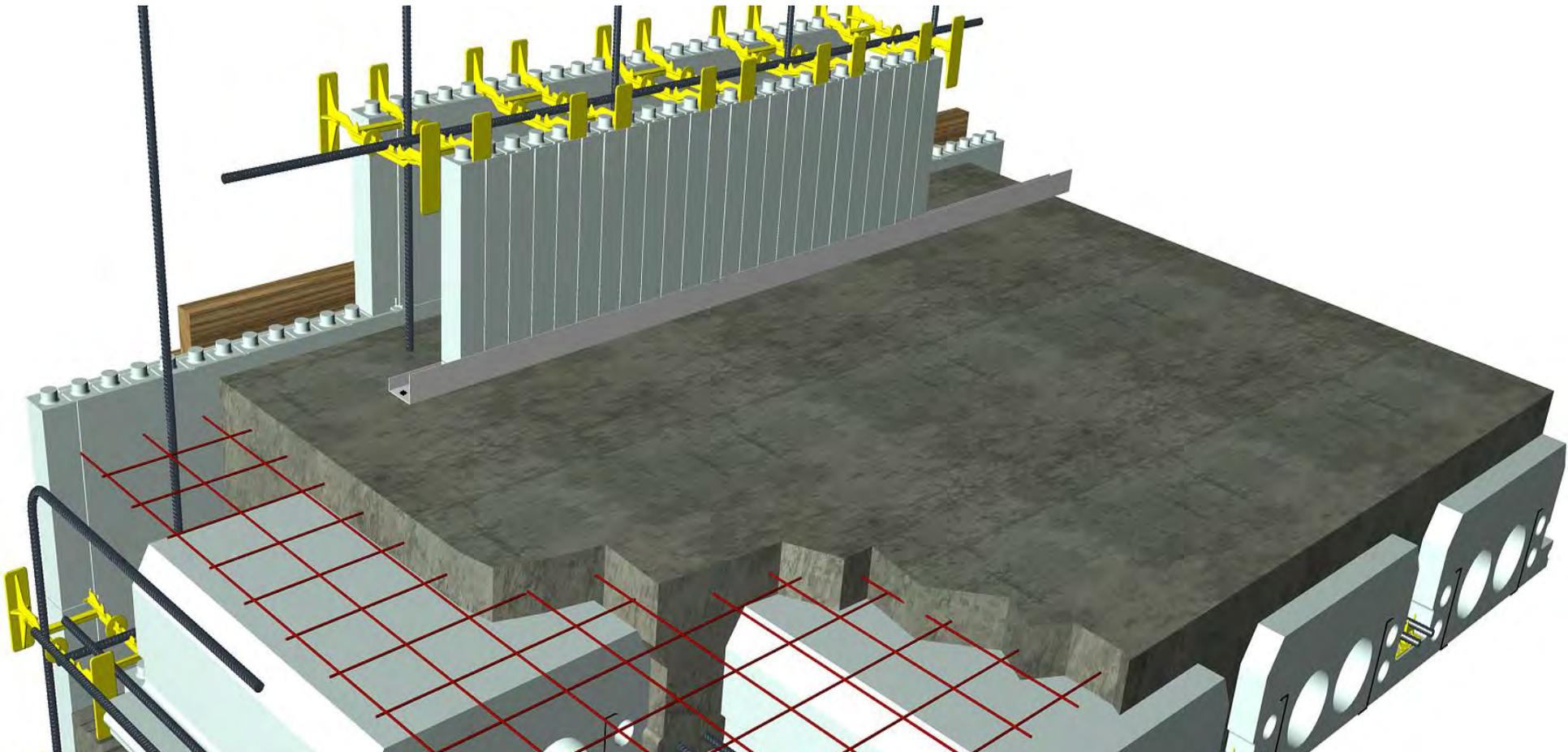
# Quad-Lock Ledger Attachment (Pre-Set Board with Bolts)



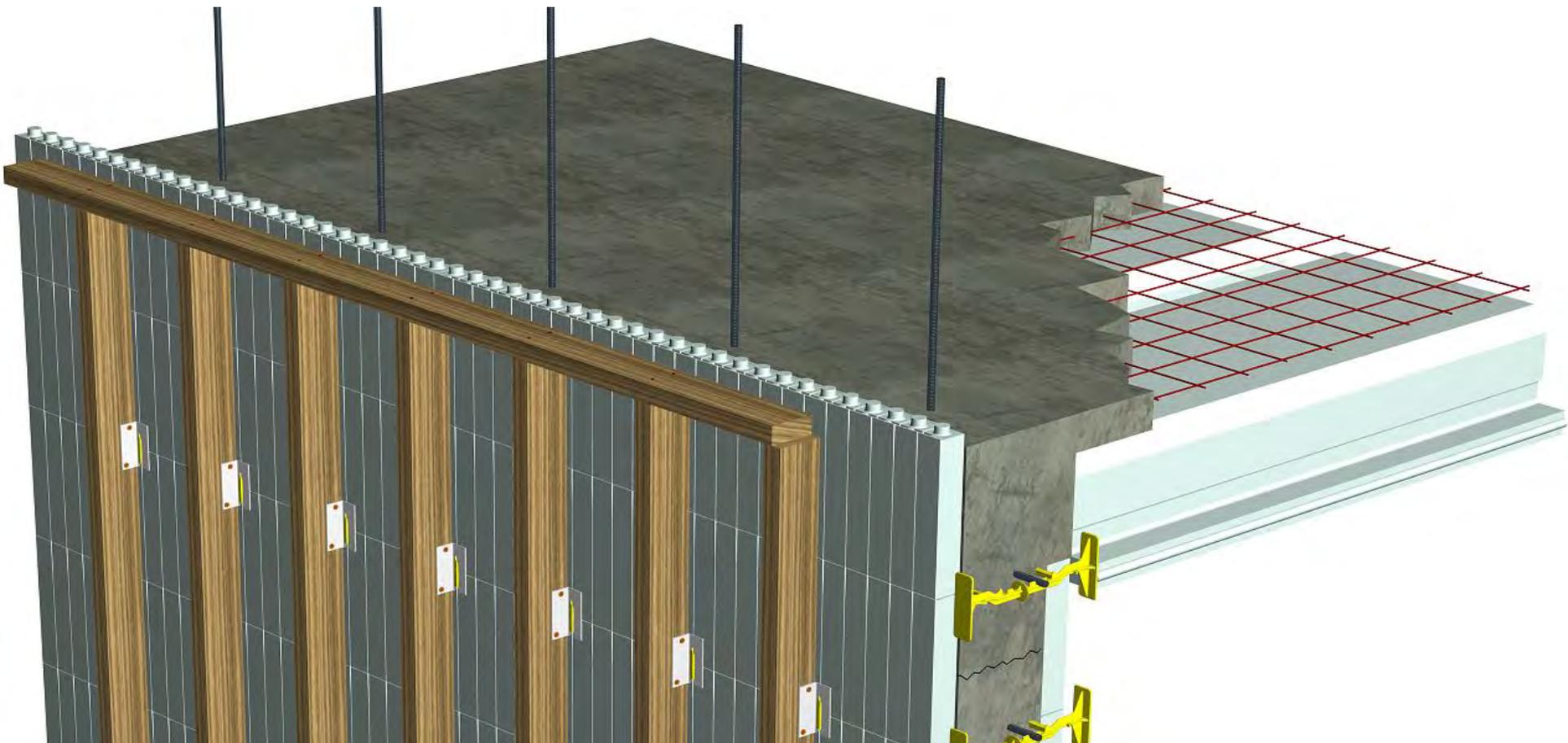
# Quad-Lock Horizontal Rebar Placement



# Quad-Lock to Quad Deck Connection & Slab Installation using Slab Ties



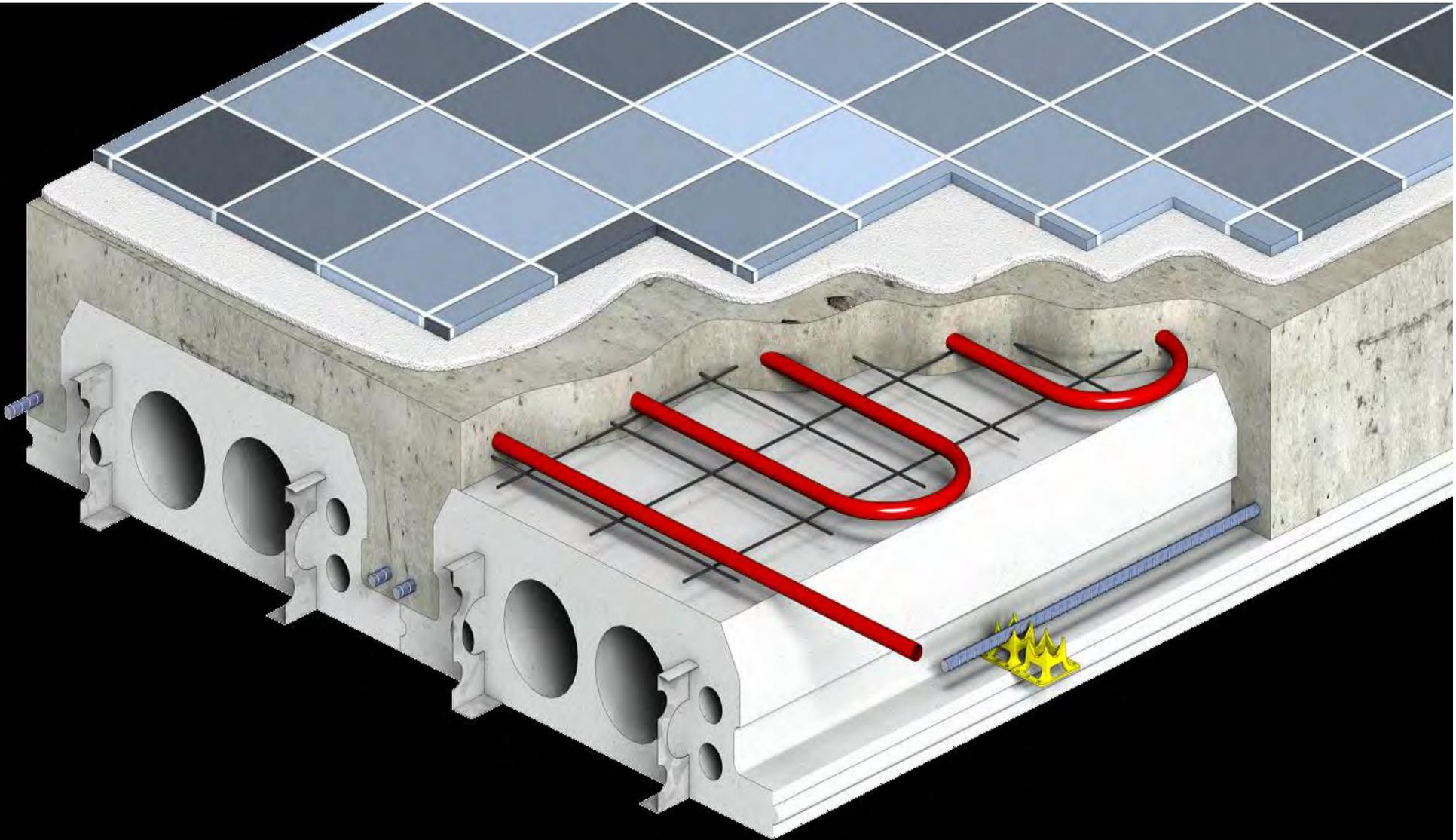
# Quad-Lock to Quad Deck Connection & Slab Installation using Slab Ties



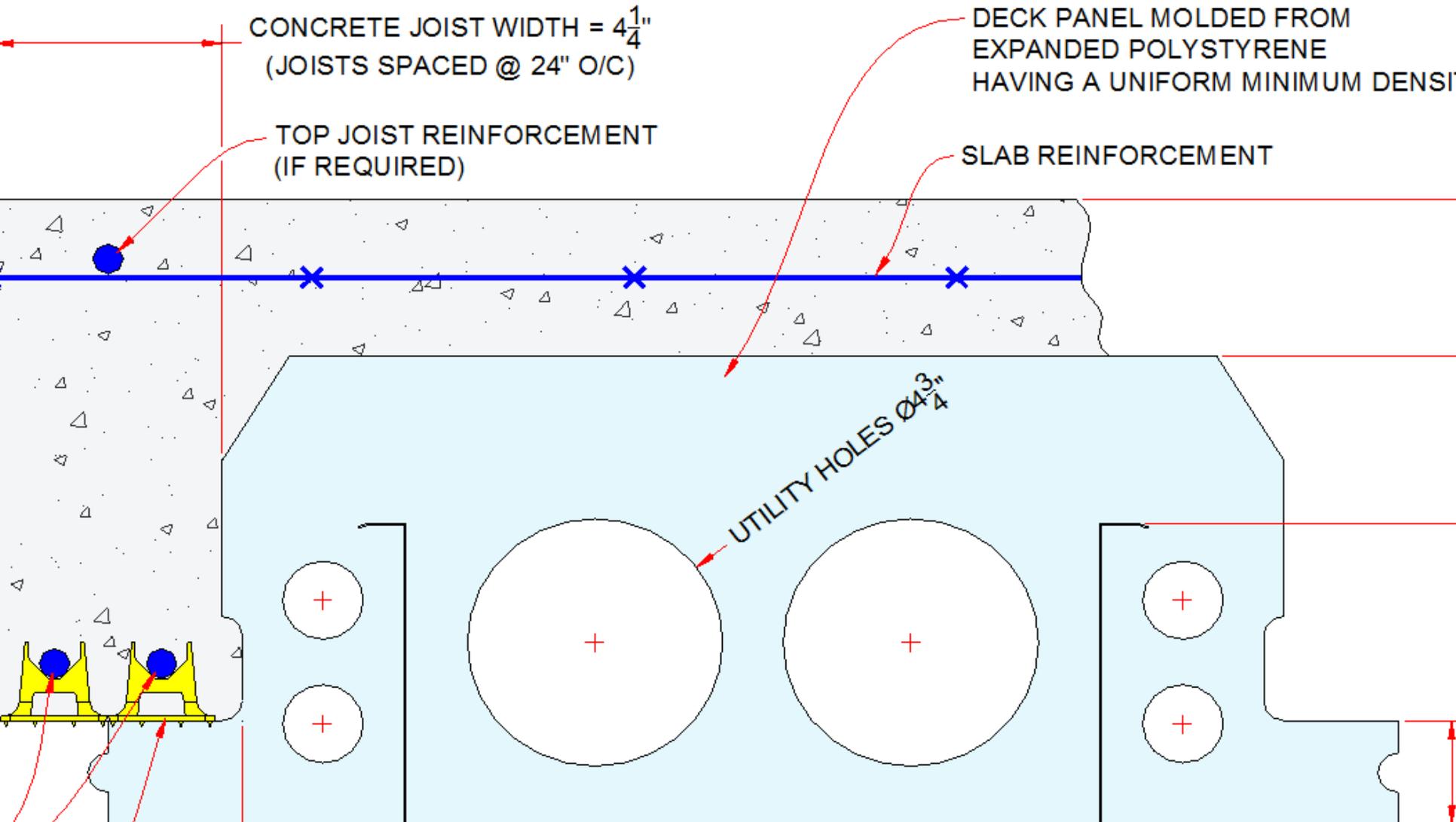
# Quad-Lock Wall Panel Pricing

- Comparable to stick frame for high R-value ICF.
- 2-4” foam modules are added to increase R-value.
- R-28 = \$3.25 sf with 6” concrete wall
- R-38 = \$        sf with 5.75” concrete wall
- R-59 = \$        sf with 6” concrete wall

# Quad-Deck Flooring & Ceiling



# Quad-Deck Panel Dimensions



# Integrated Metal Furring Joists

- 28 gauge steel Z strips contained in Quad-Lock panels provide structural strength and eliminate the need for secondary shoring members.
- 6-8' spacing of primary shoring is required and will support workers, steel reinforcement, and concrete.
- Quad-Lock panels are constructed to building specifications and delivered onsite ready for assembly.

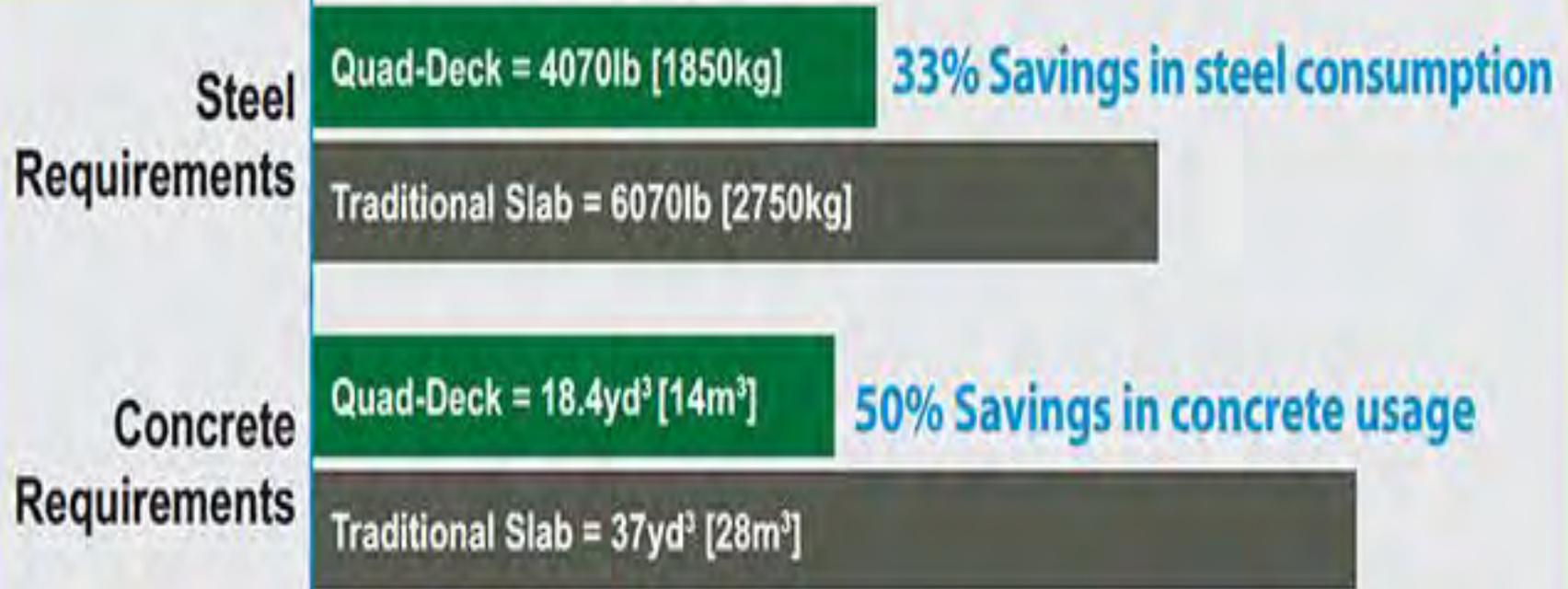
# Quad-Deck Utility Holes

- Hollow cores in the Quad-Deck panels allow for running plumbing and electrical conduit/insulated wire through the ICF floor and ceiling structures.
- The foam can be removed to install shared ducting for the ERV system and forced air cooling provided via integration with the geothermal heat pump.
- Quad-Deck panels allow for using up to 40% less concrete than full depth suspended slabs.

# Interior ICF Bearing Walls

- The PHMH will include interior Quad-Lock walls for both the basement and main floor floors/ceiling structures which will limit need for shoring.
- Uniform sized logs and ICF block-outs will be utilized for supporting the Quad-Deck floor/ceiling structures and vaulted ceiling over the second floor during pouring/curing, and subsequently used for aesthetics.
- 9' walls will accommodate up to 12" lodge logs used for floor/ceiling support.

# Quad-Deck Economics



**By reducing your Steel & Concrete Requirements with Quad-Deck, you also reduce your Mass by over 50% and use 50% less Shoring.**

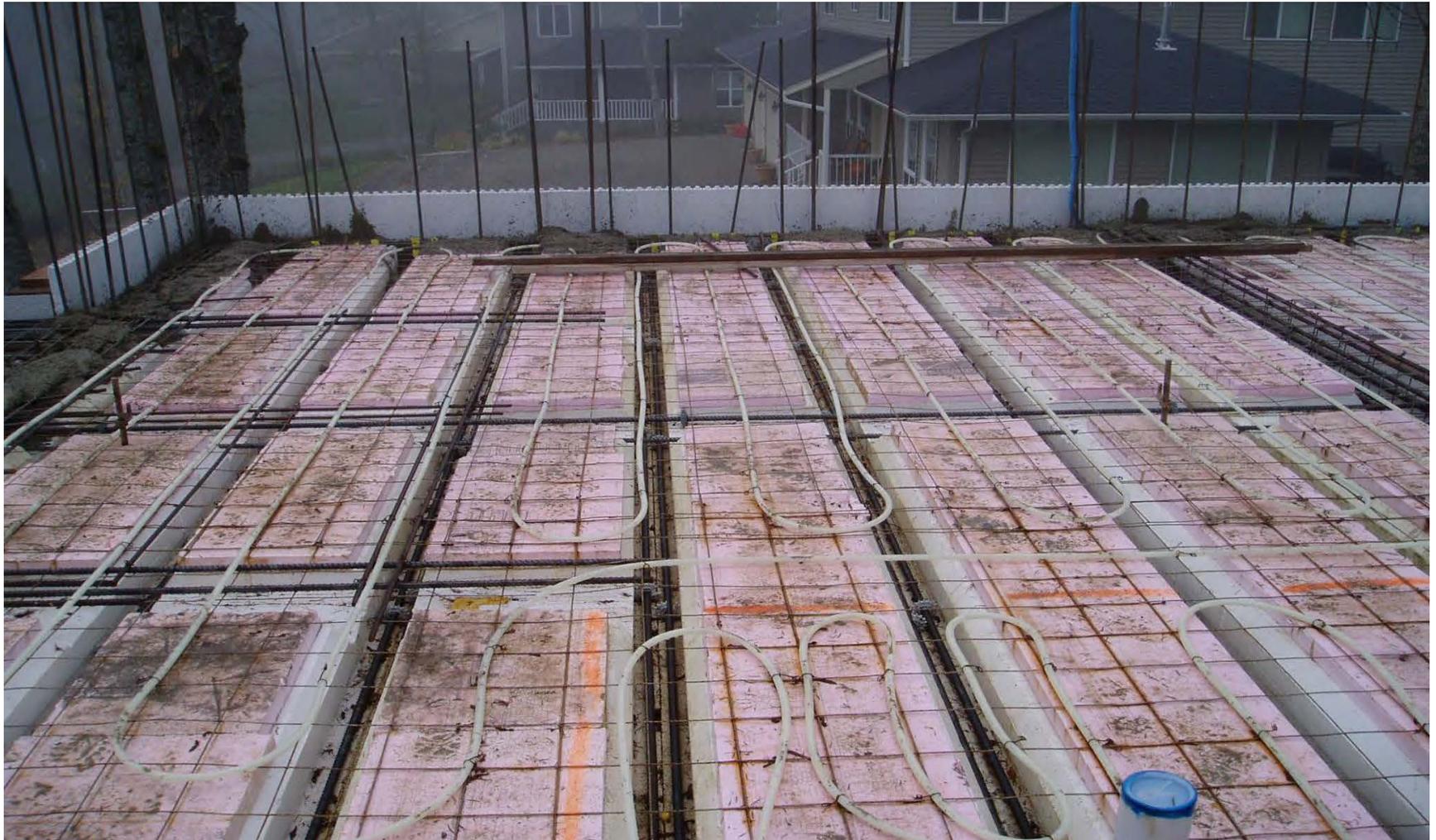
# Quad-Deck Panel Pricing

- 7” foam panel engineered for a 3” concrete slab = \$3.00/sf for beginning R-value 16
- 12.5” foam panel engineered for a 3” concrete slab = \$ /sf for up to R-value 34
- 12.5” foam panel engineered for a 5” concrete slab = \$ /sf for up to R-value 34

# **Radiant Concrete Floor & Forced Air HVAC**

- Will be integrated with ICF and geothermal heat pump systems providing HVAC and hot water heating in the model home.
- Providing high efficiency radiant heating and cooling.
- ERVs coupled with heat pump coils may be used in addition to radiant technology to enhance air-flow and performance for the model home.

# **Radiant Heating & Cooling System inserted into ICF Quad-Deck Flooring**



# Radiant Heating & Cooling System Manifold to Geothermal Heat Pump



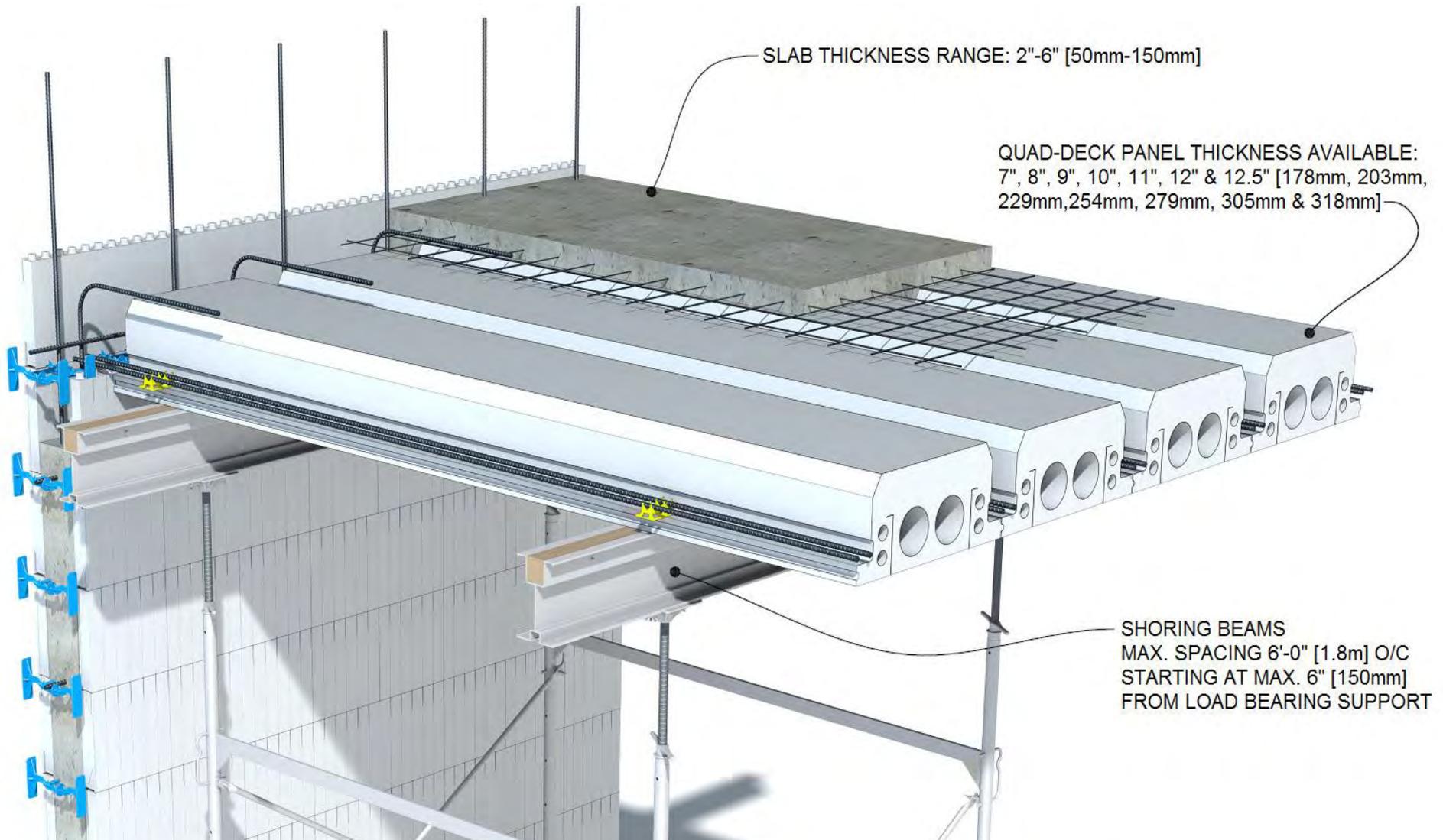
# Electrical Conduit cut into Foam



# Plumbing cut into Dense Foam



# Quad-Deck Ceiling Application



# Quad-Deck Stair Opening

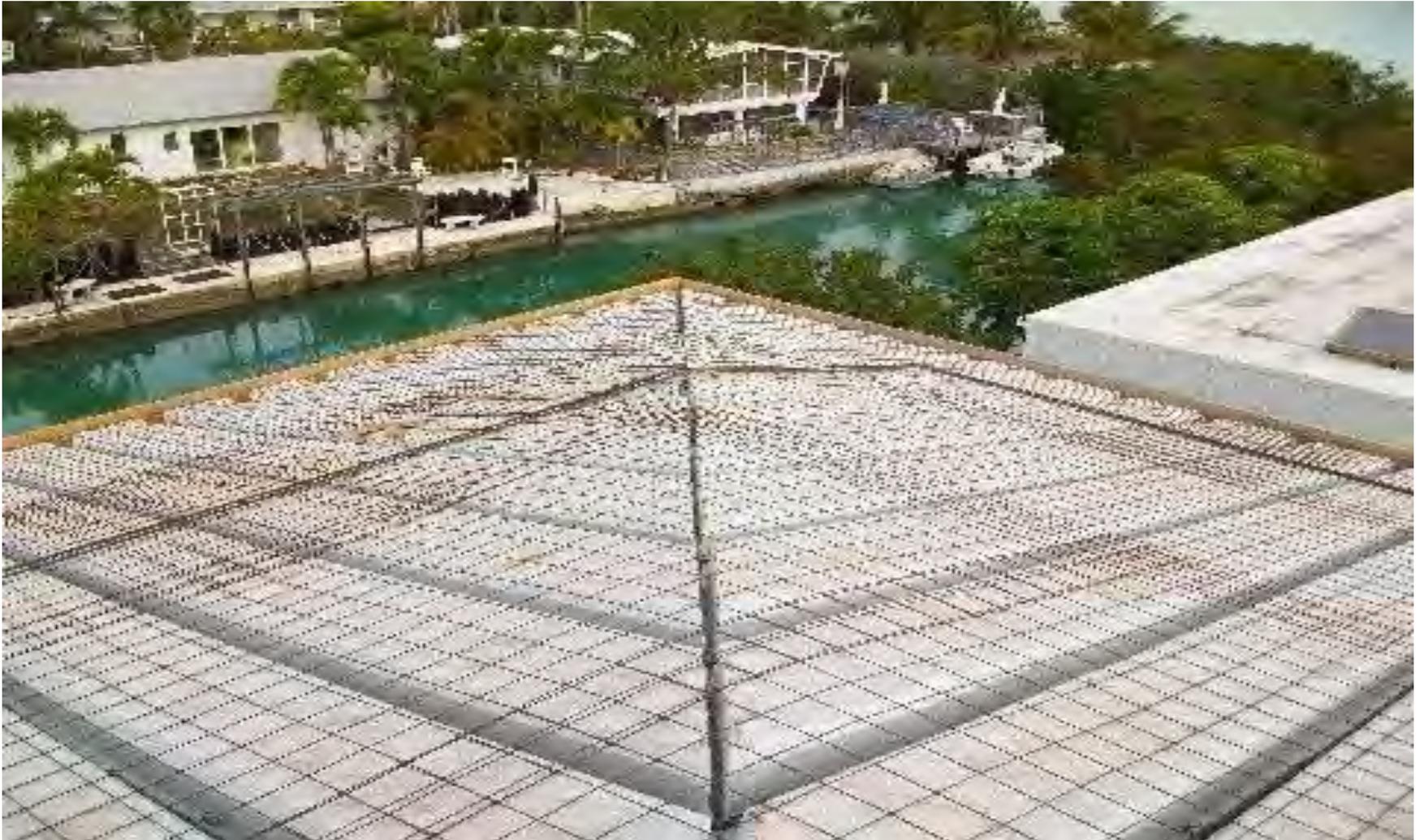


# **Pitched Roof for Vaulted Ceilings using Quad-Deck Panels**



**4-sided hip roof, ridge beams NOT needed**

# Pitched Roof Ready to Pour



# Pitched Roof Pour Completed



# Custom Manufacturing

- Quad-Deck panels are custom manufactured to size of spans according to building plans.
- 4-sided hip roof, ridge beams NOT needed

# Advantages of Quad-Deck

- Quiet, Healthy, Safe & Comfortable
- More consistent indoor temperatures
- Perfect for in-floor radiant heating
- High STC ratings; deadens sound transmission
- Minimized air infiltration - fewer allergens, improved indoor air quality
- Inert materials: doesn't support the growth of mold or mildew
- Rated Fire Resistance (using ACI 216.1)
- Not a food source for insects
- Superior protection against disasters

# Durable & Sustainable

- High R-Values (R-16 to R-33); Low U-Values (0.35 to 0.17)
- Reduced HVAC requirements, heating and cooling costs
- Thermal mass properties; ideal for passive solar designs
- Lower life-cycle costs
- Long-term building durability; life-cycle measured in centuries

# Fast & Flexible

- Lightweight, easy to handle - no forms to be stripped
- Delivered to site ready to install - pre-cut at factory to exact specifications
- Self-reinforced forms - temporary shoring only every 6'
- Available in thicknesses of 7" to 12½", up to 34' [10.3m] free spans (and more with additional EPS caps or post-tensioning)
- Slab thickness from 1¾" to 6" [45mm to 152mm]
- Easily integrates with Quad-Lock ICF system

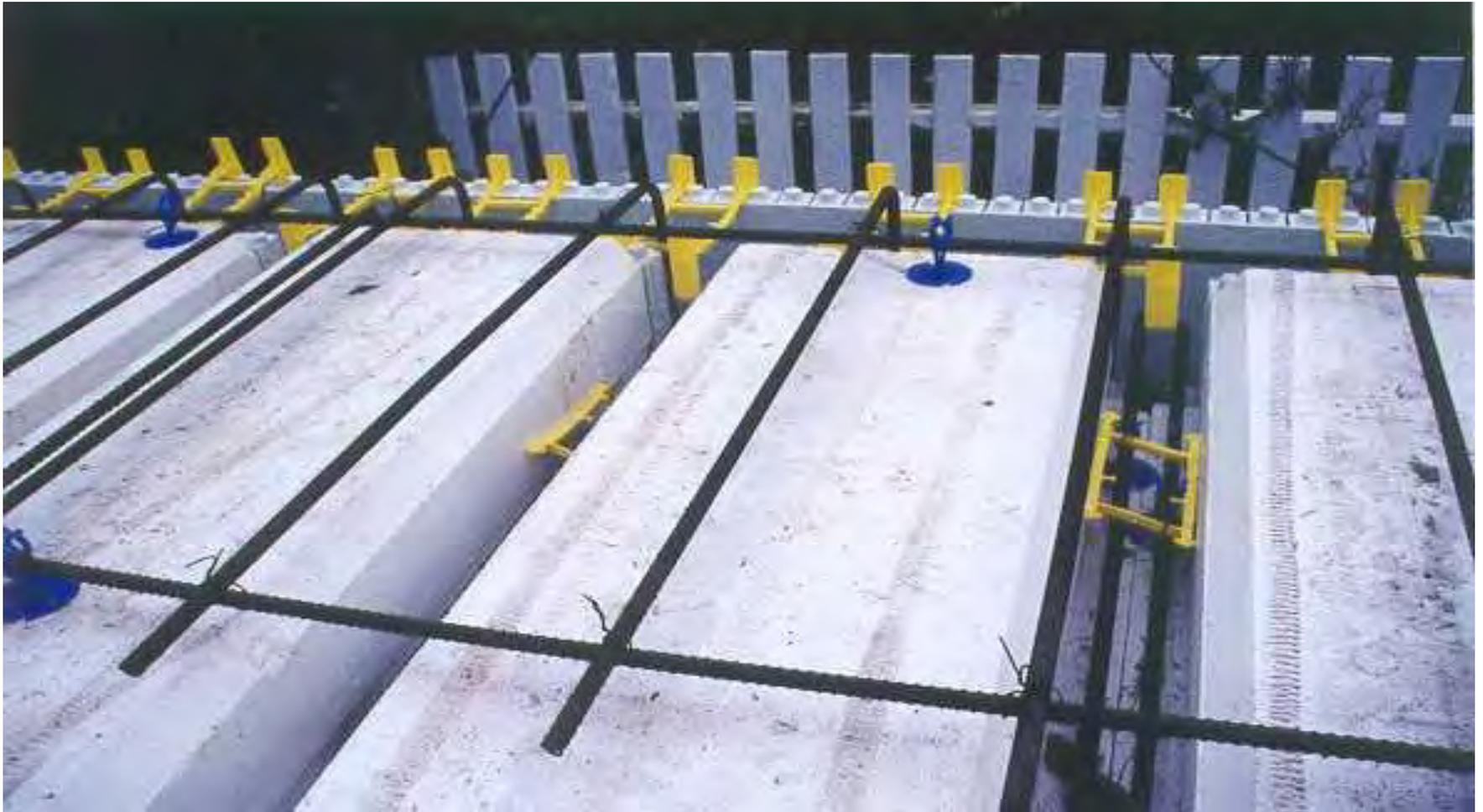
# Lightweight

- Lighter structure; eliminates 50% of conventional shoring
- Reduces floor mass dead load by up to 50%
- Reduces structural requirements for foundations and walls

# Reduced Costs

- No site waste
- Uses less concrete & steel compared to traditional concrete slab
- Lower workers-comp due to lightweight forms

# Quad-Lock to Quad-Deck Connection



# Quad-Lock to Quad-Deck Connection cont.



# Quad-Deck Crossbeam



# Quad-Deck Pour



# Quad-Lock & Quad-Deck Installed



# Stronger Concrete Structures

- Water does not evaporate as quickly from Quad-Lock in comparison with other ICF systems.
- This higher moisture content during curing results in a 50-70% increase in compressive strength (e.g., 5,700 lb/in<sup>2</sup> vs. 3,600 for conventional plywood concrete forms).
- Removal of bracing can occur about 48-72 hours after pour.
- 80% curing is required before backfilling.

# Fly Ash & Blast Slag

- Relatively high percentages of fly ash and blast slag will be utilized for substituting cement in Quad-Lock ICF.
- Addition of these substances will affect slump, cure time, and initial compressive strength and thus will be taken into account.
- Use of Pozzolans to concrete mix generally makes the mix more flowable which is advantageous for ICF construction. However, this may affect the dosage of plasticizers or other agents used to improve flow characteristics and care must be taken not to exceed recommended 6" slump.
- Engineers will take this into consideration.

# Cold Weather Pouring

- Quad-Lock Plus panels allow for pouring with temperatures as low as  $-75^{\circ}$  F.
- This is achieved by placing concrete and maintaining surface temperature at  $50^{\circ}$  F for 3 days.
- This is possible due to increasing EPS insulation (R-59 Quad-Lock Plus panels) and by increasing cement content to  $600 \text{ lb/yd}^3$ .

# Cold Weather Curing

- Concrete must arrive at the site sufficiently warm to be placed at or above certain minimum temperatures according to Quad-Lock ICF configuration and cement content.
- Air entrainment should be included in the mix design if concrete is being exposed to freezing temperatures. Under these conditions, the insulating qualities of the Quad-Lock panels should sufficiently insulate the concrete long enough for the curing process to complete.
- Tops of walls should be covered with insulation immediately after pouring.

# Recessed Lighting

- The recessed cans will be cut into the concrete floor/ceiling ICF structures and conduit will be run before or after pouring concrete.
- We will utilize low heat/low energy LED bulbs.

# Low Voltage Boxes & Conduit

- Wall outlets and wiring for telephone, Internet, home music/theatre, home security, and TV cables will be inserted into the ICF prior to pour.
- In accordance with building codes, these low voltage wires and cables will be run in separate conduit and run perpendicular to high voltage conduit in order to avoid electrical interference.

# Sheetrock, Flooring, & Siding Alternatives

- Aesthetic tongue and groove pine can be used as a cost effective alternative to sheetrock for ceiling and wall coverings, particularly in conjunction with using aesthetic lodge logs (10-12” in diameter) in place of conventional shoring.
- Material costs can be less than drywall, e.g., as little as \$16 per 4x8 area using 1x6 or 1x8 tongue and groove pine or fir with less labor required for the finished look (no taping, mudding, or texturing).
- Similar products can also be used for flooring and siding.

# Pine Tongue & Groove Ceiling



**These beams would be replaced with lodge logs that run perpendicular to Quad-Deck panels in the loft/2<sup>nd</sup> story of the PHMH (replacing inefficient attic space with value added living space).**

# Elimination of Conventional Shoring

- Once aesthetic lodge logs are used to provide shoring for custom engineered Quad-Deck panels, inexpensive and beautiful natural pine or fir decking will be used (in place of more expensive sheetrock) prior to putting Quad-Deck panels in place.
- This innovative technique can largely reduce labor associated with conventional shoring while adding substantial value and warmth to home.

# Paneling, Edge V roof Decking, and Flooring



# Flooring & Siding Alternatives

- Natural pine and fir products can also provide economic alternatives to conventional hardwood flooring and siding.
- Treated products can be used in similar fashion as conventional siding, providing either a modern look or a rustic pine look.
- Covered areas sheltered from the sun and elements are ideal for exterior applications using softwood siding.

# **1x6 Douglas Fir End Matched Flooring**



# Wavy Edge Bevel Siding



# Wavy Edge Bevel Siding



# Cabinets & Heavy Items

- Chalk lines will be utilized to mark location of cabinets on ICF walls before decking, paneling and drywall installation.
- 1/2-3/4" plywood (or other thickness depending on paneling, decking, or drywall thickness) will be fastened to the ICF wall using spray foam and screws via the plastic tie flanges inside the cabinet area.
- Decking or drywall will then be installed by butting up to the cabinet plywood.
- When necessary, concrete anchor bolts can be utilized to secure heavy items.

# Closed Loop Geothermal Heat Pump

- Ground coils for the geothermal heat pump will be shared with the ERVs.
- Coils will be placed under the basement and around the footings of the PHMH.
- 2-3' of soil will be placed over the coils and R-33 Quad-Deck panels with additional foam insulation (for about R-50 rating) will be utilized for the basement floor and radiant heating and cooling system.

# Earth Coupled Heat Pumps

- Heating, cooling and hot water can account for as much as 75% of the total energy cost in a typical home or commercial building.
- Capacity-on-demand heat pumps are the most cost effective solution to all three energy sources.

# GeoWise Heat Pump System

- In conjunction with using Quad-Lock ICF and collaboration with EnergyWise design and engineering, the GeoWise heat pump manufacturer has agreed to provide their new variable capacity heat pump for showcasing at the PHMH.
- A 2.5 ton variable heat pump system will be installed in about a 2,000-2,500 sf home with either unfinished or finished basement (abt 4,000-5,000 sf) and 2<sup>nd</sup> story loft.

# Variable Speed System Control

- The variable capacity system control consists of developing an automated operating system (software) integrated with a control board (hardware) that replaces the current three phase operating systems.
- This automated system will provide seamless variable speed control for secondary circuits including the compressor, fan/blower, and possibly the water pump.

# Revolutionary Heat Pump Efficiency

- The GeoWise® unit automatically matches the energy draw with energy demand in real time, optimizing energy efficiency unlike any other HVAC system available today.
- With ECM motors and options for multiple compressors (GeoWise 3Star) or a 100% variable speed compressor (GeoWise VStar), you consume energy at a level comparable to the production of your system... every minute of every day.
- In a compelling side-by-side comparative analysis at Langley Air Force Base, the GeoWise® VStar Capacity-on-Demand system used significantly less power (an average of 51% less power) than a leading national brand to condition the same space. The test was conducted during July 2011 at Langley Air Force Base, Hampton, Virginia.

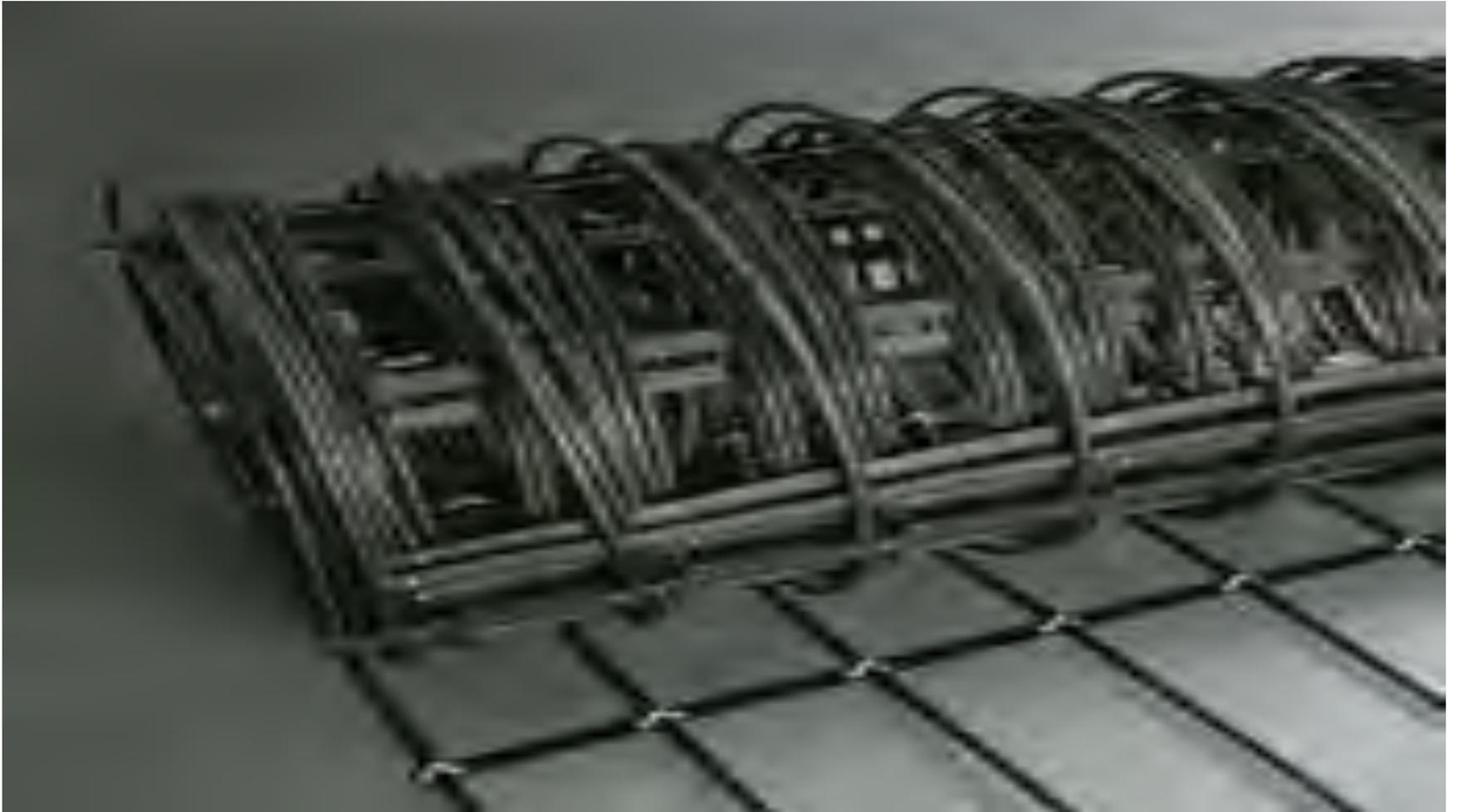
# **Geothermal Heat Pump Energy Tax Credit through 2016**

- Taxpayers installing systems for their residence are eligible for the Residential Renewable Energy Tax Credit, a tax credit equal to 30% of the geothermal system including installation costs.
- Taxpayers installing systems on commercial property are eligible for the Business Energy Investment Tax Credit (ITC), and tax credit equal to 10% of the geothermal system including installation costs.
- There is no cap on either of the federal tax credits and the 2016 time frame may be extended.

# Viega Climate Mat & Climate Control Technology

- State-of-the-art radiant heating and cooling solutions.
- AutoCad designed by manufacturer for each installation for commercial and large residential applications.
- Reduces labor time for installation by 80%.
- Works well with virtually any floor covering including wood floors and carpet for heating.
- However, wood floors and carpet are no recommended for radiant cooling.
- Manufacturer provides on-site training for contractors.
- Will be used with Waterfurnace's NSW hydronic heat pumps for radiant floor installations.

# Viega Pre-assembled Climate Mat



# Viega Hydronic Mixing Block

- Simplifies wiring, piping and programming for installation of radiant heating systems.
- The highly engineered hydronic mixing block is a user-friendly and economical solution for controlling radiant heating systems. The first of its kind, it combines mixing, control, air elimination and a circulator in a single, simple unit that makes wiring, piping and programming easy.

# Viega Hydronic Mixing Block cont.

- The hydronic mixing block features only three connections for simple installations, with clearly labeled fittings and ports.
- Piping and controls are often the largest obstacles for installing radiant systems. The hydronic mixing block removes the obstacles with increased functionality, minimized settings and easy connections for piping and wiring.

# Viega Hydronic Mixing Block



# Viega Hybrid Copper & PEX

- Time saving PEX tubing and fittings can be used for entire residential applications with the exception of the water meter.
- Both labor and material costs are reduced.

# Viega ProPress System

- The ProPress System is the fastest, most reliable, flameless way to press copper tubing.
  - Much faster than soldering (reduce labor by 75%).
  - Safer—no flame.
  - Cleaner—no solder, flux.
  - Convenient—one tool, one source of fittings.
  - Over 25 years of proven performance worldwide.
  - Highest quality.
  - Patented Smart Connect® feature.
  - Wide selection of sizes, types.
  - Meets/exceeds industry standards.
  - Guaranteed reliability.

# **Viega Hybrid Copper & PEX System**

- Provides flexibility and versatility by combining copper and PEX tubing and fittings.

# Centralized Parallel Water Distribution System

- A Viega parallel system provides the lowest pressure and temperature fluctuations in a plumbing system. Since each tubing line is dedicated to an individual fixture, interference between fixtures is eliminated. Additionally, specific fixtures can be supplied by smaller diameter tubing depending on the actual amount of water needed.
- For this type of installation, Viega offers the revolutionary MANABLOC parallel water distribution system, incorporating ViegaPEX tubing and Viega PureFlow PEX Press or PEX Crimp fittings. The Viega MANABLOC system provides a central location to control all plumbing lines and helps homeowners save energy costs and reduce water waste.

# **Viega MANABLOC parallel water distribution manifold**

- Incorporates a system of PEX distribution lines dedicated to individual plumbing fixtures. Because dedicated tubing lines are plumbed specifically to each individual faucet, wait time for hot water is significantly decreased.
- Viega MANABLOCs arrive fully assembled and factory tested. They include individual quarter-turn port shutoff valves, which allow the end user complete control over the entire plumbing system from one central location. Fewer behind-the-wall fittings make it easy to install and less likely to leak. Flexible ViegaPEX tubing in 3/8" and 1/2" ensures optimal efficiency required to supply fixtures.

# Energy & Water Conservation

- The choice to install 3/8" PEX tubing for low-demand fixtures instead of 1/2" will determine how much water an end user can save with a Viega MANABLOC system. In a length of 50 feet of PEX tubing, 3/8" PEX stores only .32 gallons of water (as opposed to 1/2" PEX tubing's .46 gallons). Storing less volume of water means less time is required to purge the line and deliver hot water twice as fast as with a 1/2" PEX line.
- Viega MANABLOC is a complete plumbing system that is easy to install and provides fast hot water delivery by decreasing energy costs and reducing water waste.

# Viega MANABLOC system



# **Viega MANABLOC**

## **features and benefits**

- Easy to install on each floor for residential applications
- Reduces wasted water
- Increased energy savings
- Delivers hot water fast
- Greater temperature and pressure balance during multiple fixture use
- Complete control of the plumbing system from a central location
- 1-1/4" internal reservoirs help maintain equal pressure during operation
- PLS plastic (polysulfone) resist aggressive water and corrosion
- 10 year limited warranty

# SW Orientation

- In order to optimize solar energy (photovoltaic panels and solar radiation via passive windows during the winter) the PHMH will be oriented to the southwest.
- In the summer, exterior shades will be utilized in addition to 4-5' Quad-Deck eaves to reduce the effects of solar radiation.

# Photovoltaic Panels & Wind Turbines

- Though relatively expensive to install, solar photovoltaic panels, wind turbines using wind cells, and net-metering can provide an opportunity to achieve net zero homes without investing in expensive battery systems.
- Similar to geothermal heat pumps, currently there is a 30% tax credit available for installation of solar panel systems.

# Solar Panel Load & Costs

- The average home in the US uses about 1,000 kWh of electricity monthly.
- Passive house design and energy conservation can reduce this to as little as 100-200 kWhr.
- A Grape 200 kWhr solar photovoltaic system (15% energy efficiency) can be purchased for about \$1.50/watt from Lowes, Home Depot or Amazon.
- The solar power system can be installed in a grid-connected solar system (which can be expanded) using a DC to AC inverter, providing net-metering for about \$3.50/watt, e.g., \$700.

# Sun Power Energy Systems

- Alternatively, a solar powered system can be purchased directly from the manufacturer, e.g., SunPower to provide the highest energy efficiency (21.5%) in the industry.
- The system comes with an industry leading 25 year warranty and no down payment leases are available.
- There is currently an opportunity to become a distributor/dealer in the Boise, ID area.

# Net-Zero Homes

- By reducing the energy load via Passive House design, grid-connected solar power systems for net-zero homes are affordable.
- The power provided by the net-metering system eliminates the need for charging batteries.
- For backup power a natural gas or liquid fuel powered generator can be installed.

# **Additional Solar Energy System Benefits**

- New research by the U.S. Department of Energy's Lawrence Berkeley National Laboratory finds that installing a residential solar energy system increases a home's value by an average of \$17,000 in California.
- Though the average increase in value may be considerably less in other states, there is no doubt that it adds value to almost any home.

# Smart Home Control Systems

- From geothermal and solar energy sources to forced-air and radiant distribution systems, and combinations thereof, the options for achieving indoor comfort are increasingly complex and the targets for efficiency increasingly rigorous.
- Smart Controls system, designed for residential and mid-range commercial buildings, enables intelligent integration and optimization of a building's appliances and HVAC system components.

# Internet Accessibility

- Smart Control Systems can be accessed with any Internet-accessible device. This allows for making adjustments to your indoor climate from practically any location in the world. Even if you're not on-site, you can still be sure your HVAC systems are optimized for maximum energy efficiency and comfort.
- While the appeal of the Smart Control system to homeowners may be primarily its convenience, for a commercial building where a few optimization adjustments can add thousands to the bottom line, Smart Controls is smart business.

# Working 24/7 to Optimize HVAC System Performance

- Smart Control systems are programmed to react to changes in your home/building's environment, so it is working 24/7 to optimize HVAC system performance and indoor comfort.
- From your smart phone or any other Internet-enabled device, you also have access to monitor and update system settings, making system control even smarter.
- Allows you to set individual temperatures for each controlled zone.
- Stores and maintains your settings in a database accessible from anywhere in the world via the web.
- Optimizes and manages the combined use of heating, cooling and ventilation systems to achieve comfort with the lowest possible energy use.

# **Working 24/7 to Optimize HVAC System Performance cont.**

- Interfaces with weather services, automatically adjusting settings in advance of changing weather conditions.
- Constantly monitors the health and functioning of the HVAC system and reports problems immediately.
- Permits you to define specific on/off events in your settings, so operation of water heater, forced-air and radiant systems can be coordinated to ensure the highest level of efficiency.
- Makes sophisticated controls technology user friendly with an easy-to-use, point-and-click interface accessed through a standard web browser.
- Allows service contractors to access your system and efficiently diagnose potential issues before arriving at your site.

# Eragy Energy Management

- Eragy provides connected home and energy management solutions for residential and light commercial applications.
- Their energy management solutions work in conjunction with easy to install power sensors for appliances, HVAC/geothermal heat pumps, solar power systems, etc., and a broadband internet connection.
- Eragy monitors energy usage 24/7 and sends this information to their secure web site; and provides the consumer with information on you're their home's energy consumption and costs.

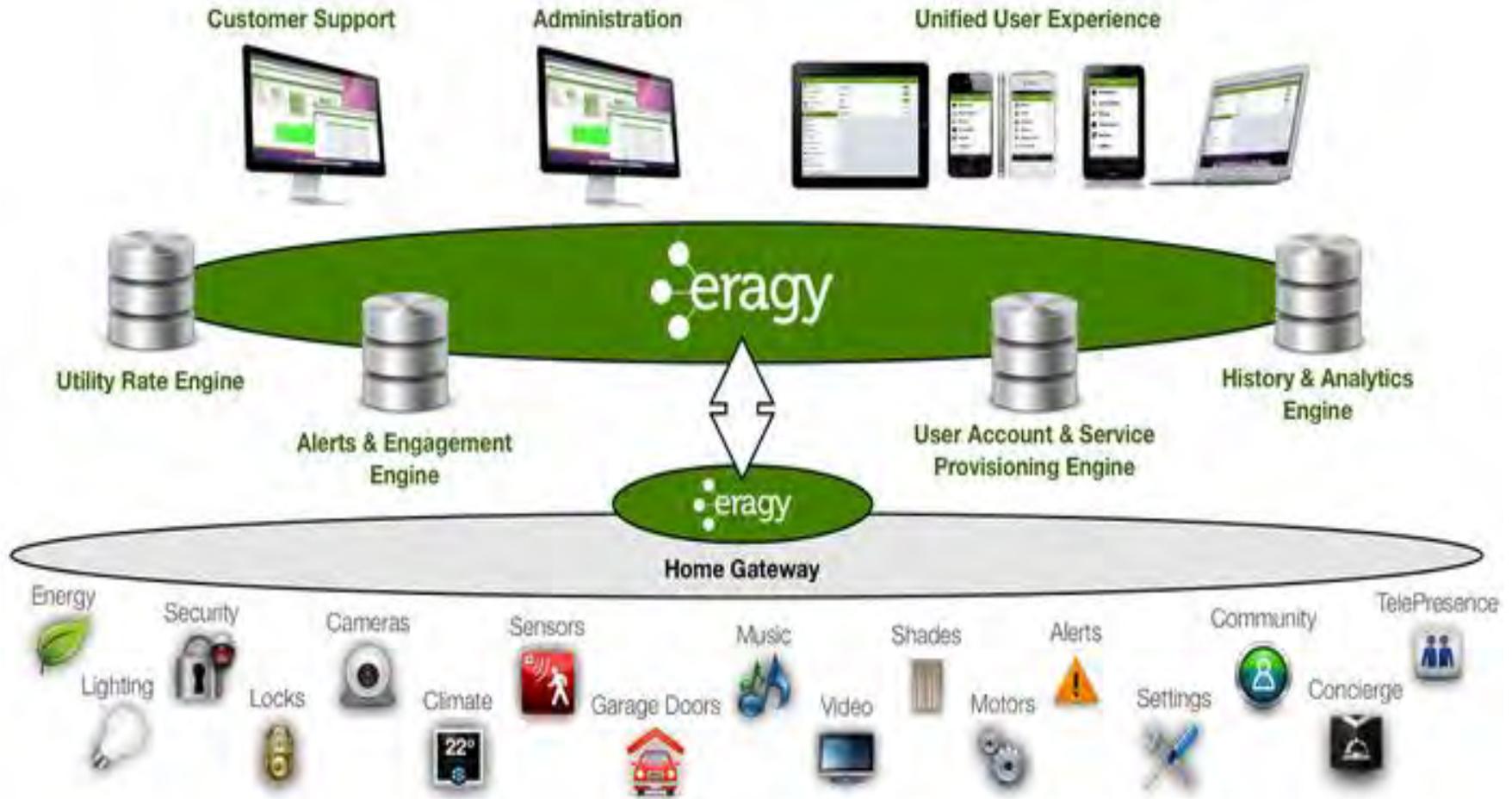
# Eragy Orbit & Control4

- [Eragy Orbit](#) and Control4 and their connected home platforms work in tandem with a home gateway which enables homeowners and businessmen to monitor and control their homes and businesses from anywhere using their cloud-based mobile platform.
- Orbit and Control4 users can monitor and control their energy, cameras, lighting, thermostats, door locks and more -- all from their mobile device!

# **Control4 Home Automation and Control**

- Provides home automation and control to homeowners and small businesses.
- This includes partnering with Eragy for improving energy efficiency, continuous monitoring, and proactive management of energy resources.
- Allows for building on the foundation of Eragy and Control4 solutions to include home security, management of home resources; and addition of whole-house music and home theatre, etc., by building on that foundation.

# Eragy & Control4 Solution



# High Efficiency Windows & Doors

- REHAU & Marvin are leading the US industry in passive house design and architecture by developing state-of-the-art windows, doors, and HVAC smart control systems.
- Triple pane casement or tilt-windows will be utilized along with retractable awnings for southern Idaho's desert climate.
- When possible, emphasis will be on orienting homes on building lots to take advantage of southern exposure.
- Both are interested in showcasing their passive house technology in a model home in the Boise, ID area.

# Passive Window Awnings

- Marvin has designed awnings specifically for their passive house certified windows (Ultimate Casement).
- They come with remote control motors that raise and lower blinds at night and mornings as well as during storms (and thus require a total of 5.5” larger window opening beyond the size of the window).
- In addition to blocking solar radiation during warm seasons, these awnings provide additional insulation via dead air space for winter and summer months.

# Marvin Passive Window Awning/Shade Exterior



# Marvin Passive Window Awning/Shade Interior



# Passive House Entry Doors

- Groke Doors range up to 94 mm (abt. 3 inches) thick, constructed of aluminum and dense foam insulation.
- Their highest energy efficiency door has achieved a U-factor of 0.13, e.g., and inverse R-factor of over 8.
- These doors come with an aluminum and foam frame, providing increased security and virtually eliminating air leakage via 3-5 point locking systems
- .

# Groke Door Construction



# Hammer & Hand Doors

- Passive wood entry doors made in the US lead the industry in energy efficiency.
- Provide an R-factor of 14 via a 3.5” wood and EPS foam insulated door.
- Includes a 5 point locking system and comes with a custom door jam to insure air-tight seal and provide added security.

# Flush View of Passive Wood Door



# Hammer & Hand Entry Door Production



# Quality Design & Production

- Vacuum clamping bag used in lamination of Passive House door
- Door jamb of custom Passive House door features in-kerf weatherstripping.
- Five point interlocking hardware.

# High Efficiency Appliances

- The Consortium of Energy Efficiency publishes a yearly list of the most efficient appliances (tier 3) for residential and business applications which substantially exceed federal standards.
- The top performing manufacturers will be invited to contribute and showcase their appliances in our model home (for demonstration of passive house technology).

# Energy Star Appliances

- Appliances account for nearly 20% of the average household's energy use.
- A comprehensive package of ENERGY STAR qualified appliances can save up to \$80 a year in energy costs compared to standard appliances.

# Beautiful Concrete Floor Designs

- Can be developed for a variety of colors and designs for concrete floors.
- Providing unmatched quality and craftsmanship similar in decorative looks to polished marble or granite.
- Can be designed and applied to fit any homeowner budget.
- Ideal for use with radiant heating and cooling via Quad-Deck technology.













# Concrete Dying & Polishing

- Conducted after the concrete is poured and cured, and bearing walls are in place.
- An extremely flat surface is required for best finish.
- Sub-contractor fees run from \$4-5/sf.  
(primarily labor)

# Concrete Countertops

- Relatively low-cost substitute vs. corian and granite while much higher quality than laminate.
- Materials are low-cost.
- Concrete coloring and design allow for very attractive floors and countertops and very competitive pricing.
- Sinks can be constructed with concrete and integrated with kitchen and bathroom countertops.

# Drop In & Undermount Sinks

- Both are available for use with pour in place concrete countertops.

# Pour in Place with PVC Edging

- There are significant economic advantages for pouring in place using PVC edging forms that also serve as guides for screeding to provide a level and flat surface.
- This eliminates grinding, moving, and transporting heavy concrete countertops.
- The following photos of pour in place concrete countertops use a variety of edging form styles, coloring, and dyes from Z Counterform Concrete Countertop Solutions .













A close-up photograph of a concrete countertop with a checkerboard pattern dyed into it. The pattern consists of a grid of squares in two shades of brown and tan, set within a white border. The countertop has a weathered, reddish-brown finish. Below the countertop is a wall made of stacked, rounded stones. In the background, a white door and a wicker chair are visible.

**Checker/Chess Board Dyed into Concrete Countertop**

# Residential Energy Tax Credits

- 30% for geothermal heat pump systems
- 30% for solar power systems
- 30% for wind power systems

# Energy Efficiency Mortgages

- More and more lenders provide so-called "Energy Efficient Mortgages" (EEM).
- These mortgages recognize the fact that highly energy efficient homes cost less to operate.
- This in effect increases a borrower's income - money in your pocket or to qualify for higher mortgage amounts/shorter terms.

# How an Energy Efficient Home more than Pays for Itself

	Standard Mortgage	EEM
- Borrower finances 100% of energy improvements - 6.0% 30-year mortgage		
Energy Improvement Costs	-	\$6,000
Appraisal Value	\$200,000	\$206,000
Down Payment	\$20,000	\$20,000
Mortgage Amount	\$180,000	\$186,000
P & I	\$1,079	\$1,115
Monthly Energy Savings	-	<b>-\$80</b>
Total Monthly Payments	<b>\$1,079</b>	<b>\$1,035</b>

# Passive House Savings

- This means that after paying for the additional cost of Quad-Lock ICF there is an additional savings of \$44/month, \$528/year, and more with rising energy costs...
- Savings would be even greater with integration of geothermal heat pump, radiant heating, cooling, hot water heating systems, efficient windows and doors, and high efficient appliances via passive house design

# Prequalifying via EEM Lender

## Steps:

- Pre-qualify with an EEM Lender (see [Dept. of Energy Listing](#))
- Evaluation of home's energy efficiency (e.g., inspection by a professional energy rater, see [RESnet Rating Providers](#))

# Builder Incentives

- A credit of \$2,000 is available to home builders who build high-efficiency homes (including both site-built and manufactured homes).
- Qualifying homes must be designed so that heating and cooling energy used will be 50% less than a home that meets the standards of the 2006 International Energy Conservation.
- In addition, a \$1,000 credit is available to manufactured home producers producing models that save 30% or that qualify for the federal Energy Star Homes program.
- **These credits are available for buildings or systems placed in service from January 1, 2006, through December 31, 2013 ([IRS Form 8908](#)).**

# Idaho Home Sales

- Idaho property values have increased by 30% over last year.
- New homes sales in Boise, ID have dramatically increased, many are selling before construction is complete.

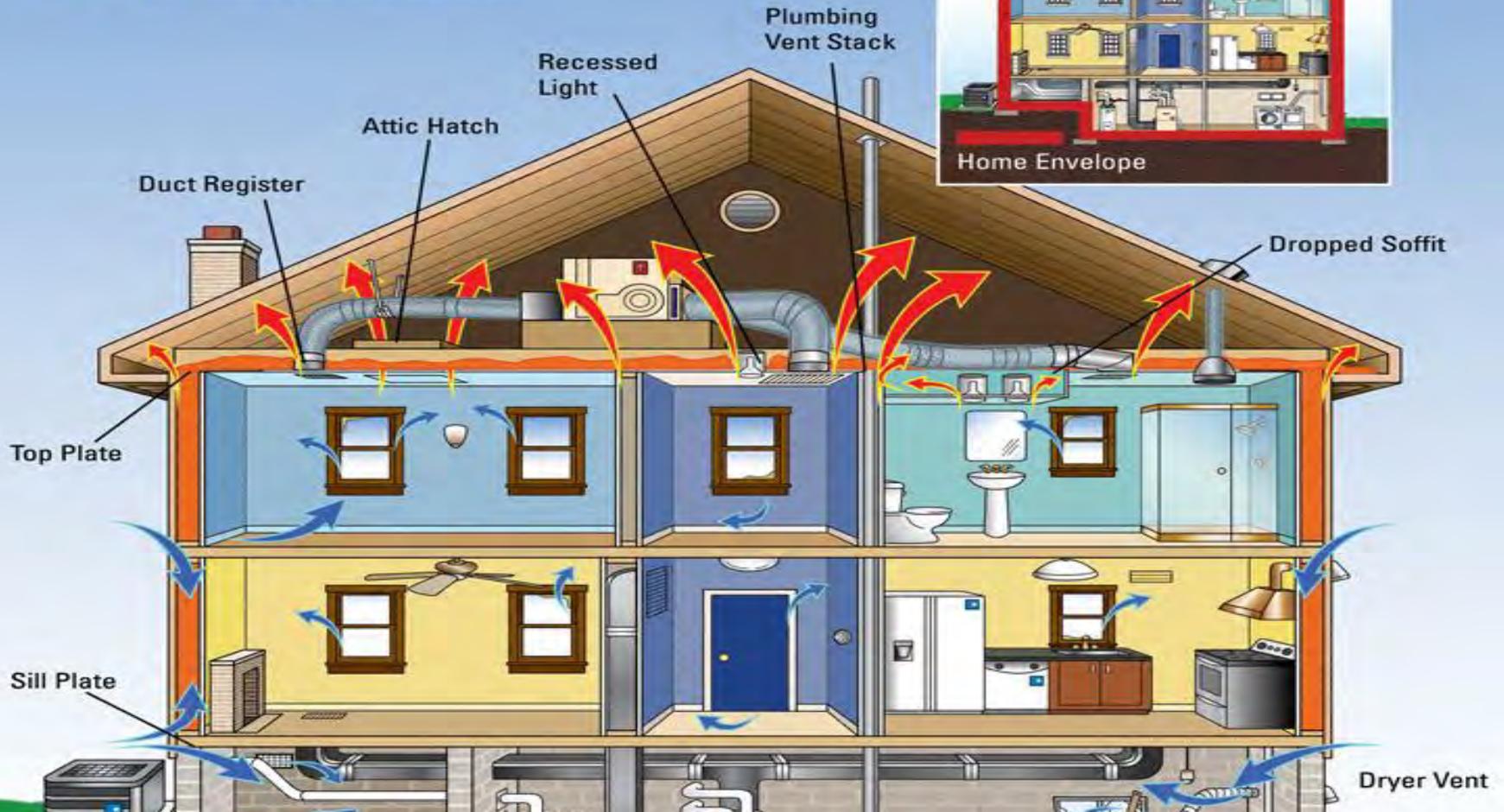
# Passive House Model Home Design

- Roof overhangs, window size and placement, and overall home shape have a major impact on achieving net-zero homes.
- Focus will be on managing solar gain.
- A strategic portion of the roof will face south and west.
- Placement of porches, garages, trees, and nearby buildings will be included in strategic plans for passive house design.

# Avoiding Air-Leakage

## COMMON AIR LEAKS

-  Air Leaking into the house
-  Air Leaking out of the house



# Sources of Energy Loss in a Wood Frame Building

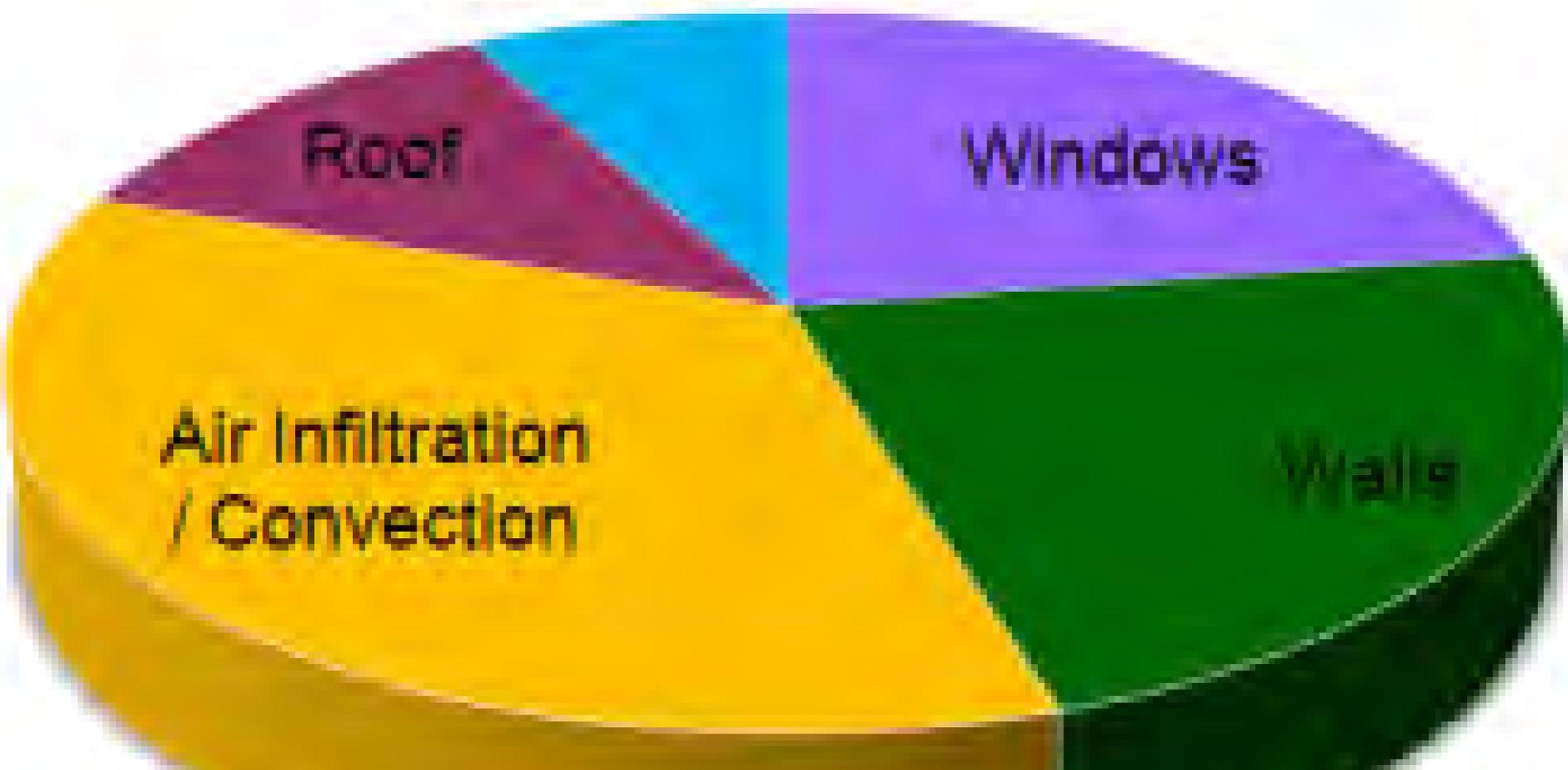
Slab / Floor

Roof

Windows

Air Infiltration  
/ Convection

Walls



# **ICF, Passive Windows & Entry Doors will Minimize Air-leakage**

- ICFs will ensure airtight walls and ceilings.
- Passive windows and doors will be utilized.
- Kitchen and bathrooms will be provided with adequate ventilation while maintaining energy efficiency.  
Triple glazed windows with minimal air-leakage and well insulated or external doors in covered/protected entry ways will be utilized.
- Passive gain of incoming solar heat through strategically placed windows will recoup close to 40% of heat losses.

# **Ranch Style Floor Plan with Full Basement & Loft**

- A full basement provides the most cost effective use of building materials and labor resources.
- When a sloped lot is utilized, a walk-out basement is ideal.
- Using Quad-Lock and Quad-Deck ICF technology also allows for efficient use of loft space as a relatively inexpensive 2<sup>nd</sup> story.
- This almost triples floor space for the average home or office building.

# Vaulted Ceiling & Loft

- Vaulted ceilings will be constructed using Quad-Deck and milled/sized logs to reduce shoring and enhance beauty for the upstairs loft/bonus room and venting/utility allies along all four sides of the structure.
- Eaves will be extended 4-5' beyond walls using a 4-5" cement slab insulated with 5" of 4' x 8' sheets of dense foam glued to the concrete roof.
- The foam will be covered with OMB, anchored to the cement roof, and covered with a roofing membrane.

# Boise Lodge Logs

- Milled logs from Boise Lodge Logs will be utilized to provide accurate sizing and uniform circular block-outs for ICF.
- Logs are cured using a 6-8 week solar energy process to minimize cracking and warping.
- Logs will come pre-drilled for anchoring to Quad-lock walls to provide shoring during pouring of floors and roof ICF structures.

# Why Use Ventilation?

- To provide enough fresh air to keep the occupants healthy
- To remove odors
- To dilute indoor pollutants
- To lower the indoor relative humidity

# Air Circulation

- Air circulation in a building ensures that dampness is minimized so that mildew does not grow.
- This is especially important in an ICF house where the walls themselves are significantly more air-tight than in stick-frame construction (which is one of the reasons for lower energy costs).

# Heat Exchanger

- Proper air circulation can be accomplished by installing a heat (HRV) or energy recovery ventilation (ERV) system in conjunction with radiant heating, cooling, and hot water.
- Such HRV systems utilize a heat exchanger to transfer heat from outbound air to inbound air using geothermal loops similar to ground to air heat pump systems.
- This allows for preheating air in the winter and cooling it in the summer.

# Managing Humidity

- To prevent moisture damage to a house, lower humidity levels are always preferable to higher humidity levels.
- In other words, dry is always better than damp. However, some people begin to complain if the indoor relative humidity is too dry — say, 20% or below. (Of course, people have lived healthy lives for thousands of years in climates where the relative humidity is often below 20%, so it's not at all clear that low humidity levels are unhealthy.)

# Managing Humidity cont.

- Ventilation can only reduce the indoor relative humidity if the outdoor air is dryer than the indoor air.
- Since cold air can't hold as much moisture as warm air, ventilating a house helps lower the indoor relative humidity only when it's cold outside (or on dry days during the spring and fall).
- In most parts of the U.S., ventilation during hot weather actually introduces *more* moisture into the house — that is, it tends to raise rather than lower the indoor relative humidity.

# Mechanical Ventilation Systems

- A balanced ventilation system with an HRV or an ERV is the preferred ventilation system for a [Passivhaus building](#).
- Although balanced ventilation systems are relatively expensive to install, they have the lowest operating cost of any ventilation option.
- The purpose of an HRV or an ERV is to deliver fresh air to a home's interior without losing or using more energy via a heat exchanger.
- Neither appliance is designed to provide makeup air for combustion appliances or kitchen exhaust fans.

# Ventilation Strategy

- Use state-of-the-art mechanical ventilation system (HRV or ERV >90% efficient)
- Design duct runs to maximize efficiency of the ventilation system while sharing ducts (and possibly ground to air coils) with forced air cooling provided by the geothermal heat pump.
- Eliminate all dedicated local exhaust systems for bathrooms, kitchens and laundry rooms that are ducted directly outside.
- Eliminate all other dedicated appliance exhausts that are ducted directly outside.

# Minimum Requirements for Passive House Ventilation

- Air to Air Heat Exchanger must have:
  - Minimum 75% efficient heat recovery
  - Less than 0.8 watt/cfm, and
  - Meet a minimum air filtration level of F7
- Strongly encouraged by Passive House to use products that have electronically commutated motors

# Minimum 75% Efficiency

- A 75% efficient unit exchanges 75% of the heat from the indoor air with the cold air coming inside.
- The closer that figure is to 100%, the closer the fresh, incoming air will be to the existing indoor temperature.
- Efficient electrical consumption is basically referring to the type of motor used in the ventilator.
- European models typically are using the most efficient DC motors available, while unit made in the US will suck a bit more power.

# High Efficiency ERVs

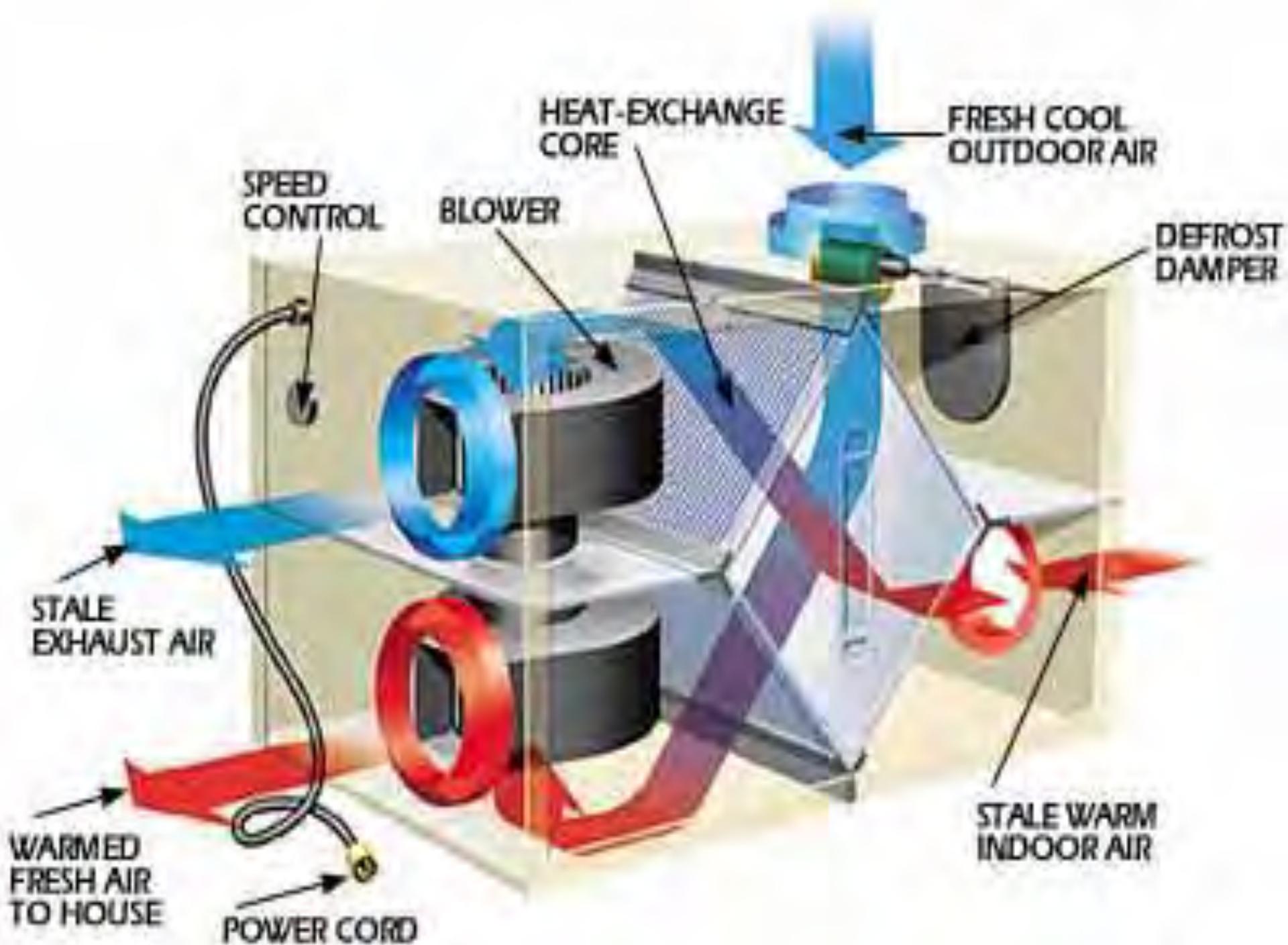
- For optimizing energy efficiency in a Passive House design, there are two primary choices:
  - UltimateAir RecoupAerator 200DX ERV (which draws 40 watts to deliver 70 cfm, or 1.75 cfm/watt)
    - The RecoupAerator is 200DX is 96% efficient
    - High efficiency electronically commutated motors
    - Capable of less than 0.8 Watt/CFM
    - MERV 12 Filtration
  - Venmar EKO 1.5 HRV (which draws 24 watts to deliver 49 cfm, or 2.04 cfm/watt).

# Current PHPP inputs for the RecoupAerator® 200DX

- (Inputs currently under review)
- Heat Recovery Efficiency----- 83%
- Efficiency Humidity Recovery--- 43%
- Electric Efficiency----- 0.72  
watt/cfm

# High Efficiency Mechanical Ventilation (ERV or HRV)

- Ventilation systems can be either a Heat Recovery Ventilator (HRV) or Energy Recovery Ventilator (ERV), both of which can substantially reduce energy loss.
- HRV's exchange heat only while ERV's exchange both heat and humidity.
- UltimateAir's state-of-the-art RecoupAerator ERV works equally well in humid or dry climates and helps prevent moisture buildup, particularly in bathrooms and/or when using radiant cooling.



# HRV Technology

- Both the fresh air stream and the stale air stream flow through the HRV. The core of the appliance allows some of the heat from the warmer air stream (the stale air in winter, the fresh air in summer) to be transferred to the cooler air stream.
- In winter, in other words, the appliance “recovers” some of the heat that would have otherwise been exhausted. This heat transfer occurs without any mixing of the two air streams.

# ERV Technology

- An ERV does everything that an HRV does. In addition, an ERV allows some of the moisture in the more humid air stream (usually the stale air in winter and the fresh air in summer) to be transferred to the air stream which is dryer.
- This transfer of moisture — called enthalpy transfer — occurs with very little mixing of the two air streams. (The cross contamination rate for one well-regarded ERV, the UltimateAir RecoupAerator, is 9.6%.)

# UltimateAir<sup>®</sup> RecoupAerator 200DX

- The RecoupAerator 200DX is a whole-house air filter and ventilator that circulates fresh air into an average-sized home every two hours.
- It serves as both ventilation and filtration, capturing virtually all pollens and mold spores. This makes the RecoupAerator uniquely suited for asthmatics (MERV 12 filtration).
- It continuously exhausts stale air while capturing it's temperature, conditioning and recycling it into the incoming fresh air.

# RecoupAerator 200DX cont.

- Pre-filter: Washable aluminum mesh.
- Motor: General Electric ECM brushless motors.  
Electrical Rating: 120 VAC, 60 Hz., 6.0 amps.  
Mounting: Operates in vertical or horizontal position.
- May be suspended from joists or placed on floor or wall-mounted shelf. Connects to 6 inch ducts.
- The RecoupAerator® leads the air filtration industry with the highest energy recovery and highest filtration at the lowest amount of energy used.

# EconoCool Feature

- **The Ultimate Air Recouperator** features an “EconoCool” feature that can be used during the summer to reduce cooling loads.
- Flick this switch on and the unit will recognize when the temp drops below 65° F and automatically shut off the energy recovery and begin swooshing cool night air directly into the house.
- In the summer time this feature can substantially reduce air conditioning loads when activated.
- Similar to capturing solar energy via windows in the winter, as much as 40% of energy lost during the warm season can be captured via cool nights in desert climates using this EconoCool feature.

# Accommodating Multiple Floors

- Since the RecoupAerator is designed to move 200 CFM, it may be necessary to install more than one ERV to accommodate a basement, main floor and 2<sup>nd</sup> story.
- In this case, the geothermal heat pump could be integrated with the ERVs to provide forced air cooling for the main floor and 2<sup>nd</sup> story of the PHMH.

# Passive House Duct Layout

- The ERV will remove (suck) stale air from the kitchen and bathrooms and deliver fresh air to bedrooms and living areas simultaneously.
- PHIUS (Passive House Institute US) consultants recommend categorizing suckers and blowers (technical postgreen terms) as follows:
  - Stale Air Exhausts (**Suckers**)
    - Bathrooms
    - Kitchen near Washer/Dryer
  - Fresh Air Inlets (**Blowers**)
    - Bedrooms
    - Living Room

# Duct Layout Design

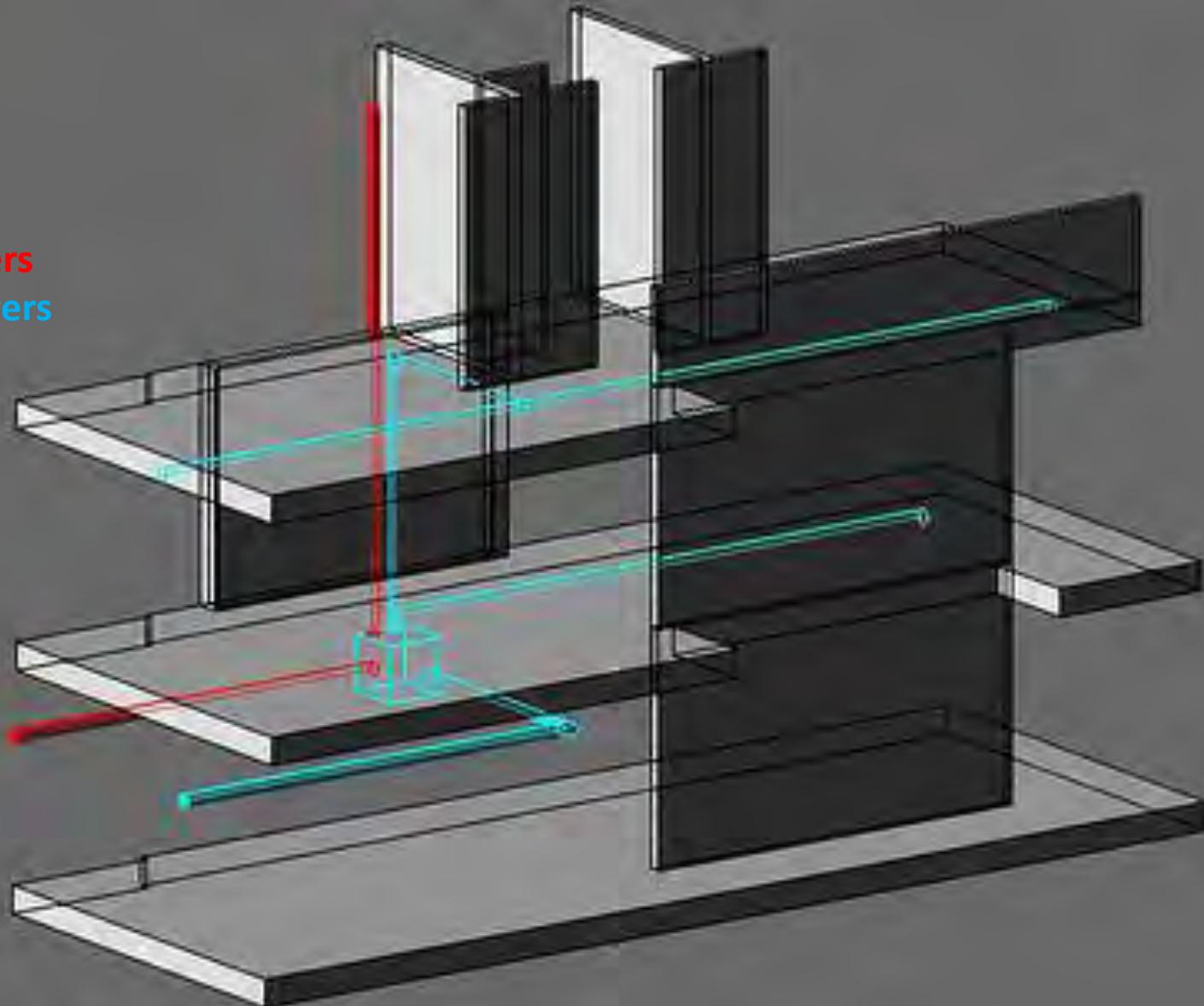
- Locate the ERV at a central location of the structure to minimize length of duct runs and keep air flow rate less than 10 ft/s.
- Minimize 90° angles and have straight runs as much as possible. Basically a 90° turn is equivalent in resistance to airflow as 25' of straight duct and a 90° register termination can add as much as 80' to calculations.
- Recommendations of both PHIUS and the manufacturer of the UltimateAir<sup>®</sup> ERV are as follows:
  - Keep it SHORT
  - Keep it STRAIGHT
  - Keep it SMOOTH

# PHMH Strategic Floor Plan

- The floor plan of the PHMH will be developed to optimize duct layout:
  - Bathrooms and laundry room will be located in the same vicinity in order to share ducts.
  - Bathrooms on different floors will be located directly above and below each other.
  - Kitchens on different floors will also be located directly above each other.
  - The same goes for additional laundry rooms.

# 3D Duct Layout

Red = Suckers  
Blue = Blowers



# PHMH Duct/Utility Access

- Quad-Lock ICF will extend 2' above the floor of the 2<sup>nd</sup> story. There will be a utility access for a 4/12 pitched roof measuring about 4' high x 18" wide on the 2<sup>nd</sup> story of the PHMH, extending around the entire perimeter of the home.
- The blower ducts and exhaust ducts as well as forced air (for air conditioning of the main floor and bonus room) will service the main floor as well as the 2<sup>nd</sup> story through block-outs cut into the Quad-Deck ICF floor/ceiling (which provides radiant cooling and heating).

# Optimizing ERV System Performance

- We will use smooth, hard duct and avoid flexible duct as much as possible.
- We will insulate the two lengths of duct running between the exterior and the ERV. This will prevent condensation from forming on these ducts.
- If noise is a concern, we will add one 3' section of insulated flex duct to the supply side of the ERV. It will be installed as straight as possible and it will act as a silencer without the need to buy an expensive silencing duct section.

# Eliminate Dedicated Local Exhaust

- Passive ventilation strategies require increasing the amount of intakes/exhausts inside and eliminating the local exhausts in bathrooms and kitchens.
- PHIUS highly recommends doing away with any local exhaust that is basically removing conditioned air directly out of the homes and replacing it with outdoor air (due to air-leakage).
- Eliminating local exhausts also reduces exterior penetrations through the home by at least two sources (more for multiple bathrooms).
- To compensate for the lack of dedicated local exhausts, intake vents will be installed in the bathrooms and kitchens.

# ERV Boost Switch

- An ERV boost switch tied to the light switch will be installed in each of the bathrooms so that occupants can boost the ERV fan to max setting (around 200 cfm for UltimateAir) while they are in use.
- Basically when you turn on your bath light, the ERV will automatically boost to high. When you leave the bath and turn off the light, the ERV will remain on boost for another 10-20 minutes to fully clear out remaining fumes.

# **Eliminate Exhausts for All Appliances**

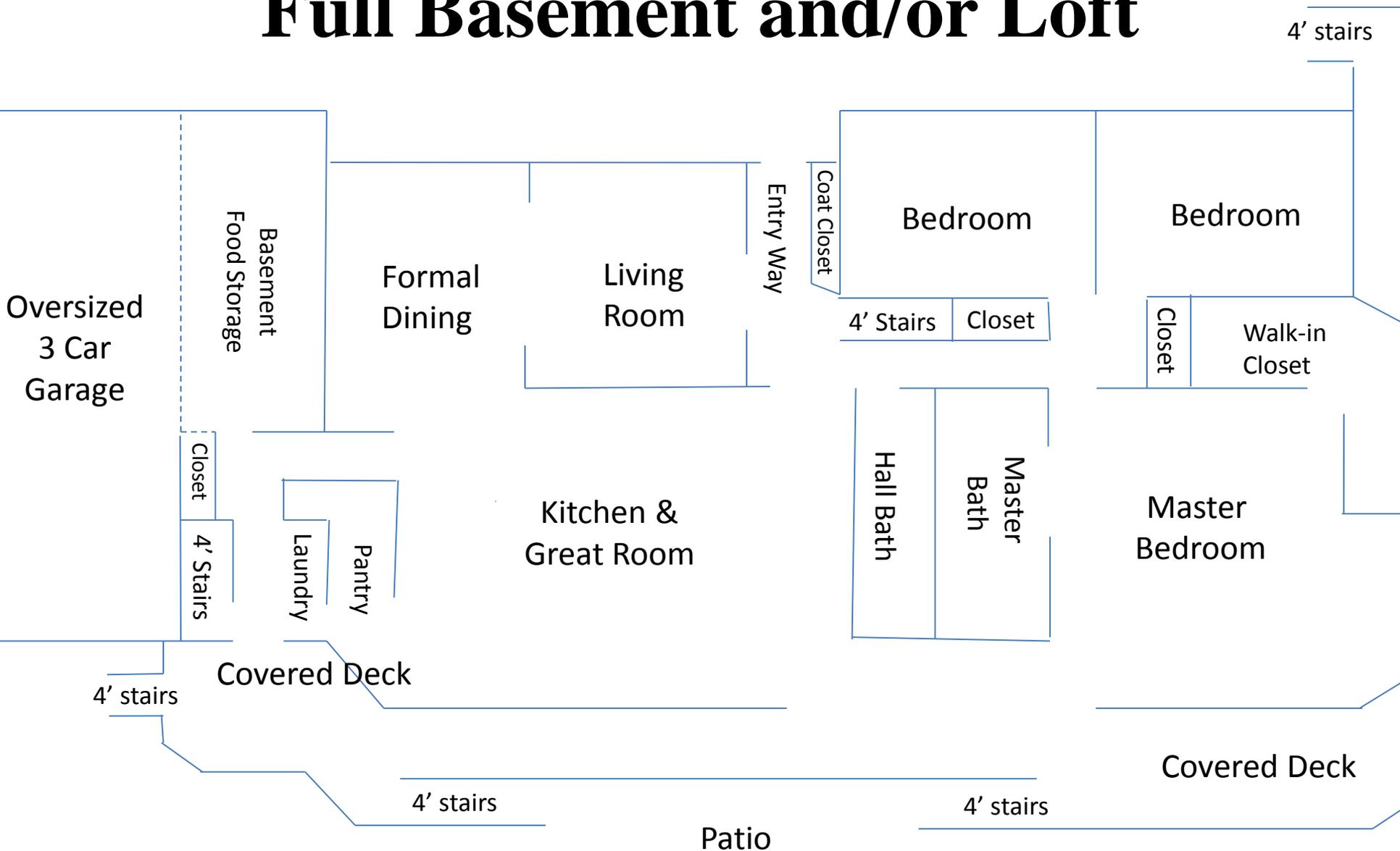
- This is less of a ventilation system design aspect and more of a whole house envelope and mechanical design strategy.
- By using the geothermal heat pump for hot water and a condensing dryer that does not require venting, we will eliminate all appliance ducting to the outside of the home.

# Heat Pump, ERV & Radiant System Control

- Teckmar's tN2 406 House heat pump control and teckmarNet Thermostat 557 zoning will be used for the radiant heating, cooling, hot water, and coil backup system integrated with the UltimateAir RecoupAearator ERV.
- The teckmar controller comes with a dew point reset and humidity regulator for using radiant cooling in conjunction with a hot/cold coil that will be integrated with the ERV.
- Due to the 200 CFM air flow limit of the ERV, two ERV systems may eventually be employed to accommodate the basement, main floor and 2<sup>nd</sup> story.

# PHMH Floor Plan

## Full Basement and/or Loft



# Hayden Homes

- Very small lots in South Hill Subdivision
- Homes ranging from \$77/sf to \$103/sf:
  - **Parkland** - 1889 sf plus 365 sf optional bonus room, 3-4 bedrooms, 2.5 baths, 2-3 car garage - \$195,000
  - **Waterville** - 2 story – 3195 sf, 4-6 bedrooms, 2.5-3.5 baths, 3 car garage - \$245,000

# **Target Home Price - \$75-100/sf in the Greater Boise Area**

- Need to work with developer or establish own development to keep lot prices down and energy efficient homes competitive via EEM and tax credits.
- Medium price of homes available on 0.33 to 0.5 acre lots should be in the \$250,000-350,000 range
  - 2,000 - 4000 sf with finished basement or 2<sup>nd</sup> story loft
  - 3-6 bedrooms, 2 family rooms, food storage, home office and/or home theatre
  - 2.5-4 baths
  - 2-3 car oversized garage

# Reducing Material & Labor Costs

- Training in ICF construction and decorative concrete flooring and countertops will be conducted during the building of the PHMH.
- This will allow experienced ICF and decorative concrete crews to reduce labor costs.
- Expensive sheetrock will be replaced with attractive ceiling decking and paneling using pine tongue and groove.

# Geothermal Heat Pump System

- Reducing the energy load by 90% may allow for using a 2.5 ton variable capacity geothermal heat pump for over 4,000 sf.
- The labor intensive process of excavation and burying field loops will be minimized by laying horizontal loops around footings and under the basement when possible.
- The field loops and geothermal heat pump system will be integrated with radiant cooling, heating, hot water, and the ERV.

# Adding Value via Reduction of Energy Expenses

- Tax credits, the savings in monthly energy costs, and sweat equity will allow for homeowners to upgrade energy efficiency, e.g., passive windows and doors and the purchasing of \$30,000-70,000 more home.
- Additional upgrades could include:
  - photovoltaic panels for achieving net-zero homes
  - smart home technology including home security and home theatre
  - energy efficient appliances

# Developing Net Zero Community

- Brooklyn NY and Issaquah WA (<http://www.z-home.org/>) have both successfully developed Passive House and Net Zero communities.
- Both of these communities have sold out.
- In order to insure that we are competitive and successful with our PHMH, we will find investors who are willing to develop such a community in Boise, ID.

# zHome Condos Sold Out

- zHome is a revolutionary, 10-unit townhome development that uses smart design and cutting edge technologies to radically reduce its environmental impacts.
- zHome will prove that homes that use zero net energy and 60% less water, emit net zero carbon emissions, have clean indoor air and use only low-toxicity materials are possible and scalable to mainstream home production.