High Performance Homes
A Simpler Design Strategy

Presented By:
Mike Schwab
Fox Blocks Regional Advisor
Objectives:

Identify the complexity in the assembly of wood framed walls to meet current and future high-performance standards.

Review the impact of thermal bridging versus thermal mass to achieve an efficient passive design strategy for sustained indoor comfort in all climate zones.

This presentation will identify the building science and practical advantages of Fox Blocks insulated concrete forms for health, safety and comfort as a quality solution for your business, and your clients, in building a high-performance home, simply and more efficiently.
Defining High-Performance

Keys to designing and building for ‘high-performance’ are applications that address building science enabling controls for the following:

- Infiltration of water, air, and vapor
- Thermal – stable comfort and operational efficiency
- Indoor Air Quality – healthy and safe
- Resiliency – weather event safety and durability
- Sustainability – life-cycle stability

Plus as a bonus – build for the future to be Net Zero Ready
Defining High-Performance

The building enclosure is a system of materials and assemblies that must act and react to separate the exterior and the interior environments. This diagram lists the major enclosure control functions and associated critical barriers.

Control Functions
- Water
- Air
- Heat
- Vapor
- Sound
- Fire

Critical Barriers
- Water Shedding Surface
- Water Resistive Barrier
- Air Barrier System
- Thermal Insulation
- Vapor Retarder/Barrier
- Building Form & Features

Air Barrier is the most critical control barrier

Primary Relationship
Secondary Relationship
Focus for High-Performance Homes

Markets and codes are driving for ‘high-performance’ construction, forcing the building industry to move away from code minimum conventional construction in order to meet on-site evaluation and testing standards:

- Air Infiltration
- Enclosure evaluation and testing
- Improved efficiencies for windows and doors
- Continuous insulation to combat thermal bridging
- Energy Modeling, ERI, HERS, Energy Star Ratings
Defining Passive Design

Key building science principles for ‘passive buildings’ are an advantage for high-performance by adding thermal mass to the envelope design:

- Airtight building envelope
- Continuous insulation for whole building envelope
- No thermal bridging
- Utilize *Thermal Mass* to absorb and store heat energy
- Balanced heat and moisture recovery ventilation
Energy Code Focus

Code focus is on conventional wood framed construction and how to improve the overall thermal performance and building science attributes by creating a more complex and costly - ‘multiple component wall assembly.’

✓ Adding more materials and skilled labor to the building envelope

24” o.c.

![Diagram of wall assembly](image)

- Larger studs more exterior insulation
- Double studs more interior insulation
Material Comparisons – Above Grade Walls

**ICF**

- Vinyl siding
- ICF Exterior EPS 2 ⅝"
- 6" Reinforced concrete
- ICF Interior EPS 2 ⅝"
- Gypsum board

**Simple Wood Frame**

- Vinyl siding
- Exterior R5 insulation
- Air / WRB
- Sealant tape
- OSB Exterior Sheathing
- R20 Batt insulation
- 2x6 wood studs at 16" o.c
- Poly vapor barrier
- Tape on VB
- Sealant
- Gypsum board

4 Materials – 3 Trades

11 Materials – possibly 6 Trades
Path Toward High-Performance

Factors that are influencing the construction industry on this path to change:

- Status Quo – don’t rock the boat
- Business Realities – perceived cost, training
- Local Policies / Regulations not moving forward
- Adoption of latest Building and Energy Codes
- Local climate – all climate zones
- Local Market – cost, design…..
- Customers focus – frills, price, …..
- Influence by material suppliers and manufacturers
- Traditional Builders – complexity in of building science for new assemblies
Path Toward High-Performance

For the **Contractor** - Factors in changing from conventional:

- Complexity of changes in home design and construction
- Training
- Complexity of changes in building materials
- Application / interface techniques for new building materials
- Complexity of mechanical systems and air circulation
- Supervision of trades for proper material installation
- Supervision of trades for integrated air sealing
- Liability on contractor to meet evaluation standards
Path Toward High-Performance

Main focus for high-performance for conventional construction is on three main attributes of a wall assembly:

- Addressing thermal bridging with wood framing
- Thermal transmittance of the whole wall assembly
- Air tightness – membranes, sealants, tapes

Plus the requirement for testing and evaluation to meet specific standards
Thermal Bridging - R-Value

Realistic / Effective R-Values for Wood Framing

Wood has a R-Value of 1.41 per inch
- 2x4 = R 4.9
- 2x6 = R 7.7

Batt Insulation R-20 installed perfectly
- 67 to 70% Effective = \pm R14

Wood framing wall assembly operational overall R-Value is less than R-14

Add R-5 on the exterior bumps up the presumed effective thermal resistance to R 19
Thermal Bridging

Evaluations have come to recognize the influence of thermal bridging and poor installation of batt insulation on the effective thermal resistance of a wood framed wall assembly.

Figure 2: Assembly Type & Nominal R-Value

- Wood Frame R-14
- Wood Frame R-20
- Wood Frame R-24
- Wood Frame R-20+5
- Steel Frame R-20+5
- 6" ICF R-23

CAN Best Laboratories – Hot Box Testing, 2017 (icfma.org)
Thermal Bridging - Fox Blocks

Plastic ties (webs) –
- Made from 100% recycled post industrial polypropylene plastic
- Molded into the EPS panel
- 6 webs per blocks at 8” o.c.
- Continuous fastening strip for interior and exterior finish attachment

NO THERMAL BRIDGING
Building and Energy Codes include and recognize the advantage of mass walls construction.

ICFs are recognized as a Mass Wall:

- Monolithic reinforced concrete
- No thermal bridging
- Continuous high-performance insulation
- Hot box tested assembly 6” ICF effective R-23.3
ICF Insulation Advantage

EPS Insulation Panels –

- Type II Expanded Polystyrene
- 2 5/8” thick panels
- Reversible interlock
- EPS is molded into panels around the webs
- Standard block 16” x 48”
- Two panels have an R-value of 21.4

EPS is an inert product:

- Does not absorb water
- Does not promote mold or mildew growth
- Does not deteriorate over time
- UL Certified as an Environmental Product
ICF Construction Advantages - Fox Blocks

- Simple and fast, modular building system
- Innovative product for below and above grade
- Versatile for all building types and heights
- Sustainable, healthy product
- Resilient building system
- Provides Life Cycle operational cost savings
- Proven track record of fantastic buildings – residential and commercial
Fox Blocks - 6 in 1 Design Advantages

- Structure
- Insulation – Thermal Resistance
- Air Barrier / WRB
- Vapour Barrier
- Attachment
- Reversible Interlock - Speed
Structure

- Reinforced concrete wall assembly
- Residential is typically 6” or 8” concrete core size for below and above grade walls
- Reinforcement – typically #4 or #5 rebar
- Engineering is for flat wall concrete design
- Engineering tables for residential are in the building code, commercial follow ACI 318
- Designs for seismic requirements and high winds
- Building with strength adds resiliency and safety
Structure

Inherent values of **Concrete** within the ICF as a building envelope:

- Resiliency and strength as a monolithic enclosure
- Does not rot or deteriorate (always enclosed)
- Provides a continuous air barrier
- Provides *thermal mass* which *does* influence energy efficiency
- Does not promote mold or mildew
- Has the ability to handle condensation (dew point) within the ICF cavity
- Non-combustible
Structure

“ICF Walls have always been structurally conforming with lateral load provisions in high wind and seismic zones”
Murray Frank

- Fox Blocks provide reinforced concrete walls, the strongest wall assembly available
- Reinforced concrete engineering for 200 mph high-winds and seismic zones
- Fox Blocks is endorsed by the NRMCA in the ‘Build with Strength’ program
Insulation - EPS

- Expanded polystyrene rigid insulation
- 2 panels 2 5/8” thick
- R-value of R4.1 per inch
- Two continuous layers – exterior and interior
- Does not deteriorate or lose thermal resistance
- Does not absorb moisture
- Does not promote mold or mildew
- Does not off gas, healthy foam
- Recyclable

- Webs are polypropylene plastic
- 100% recycled material
- NO THERMAL BRIDGING
Insulation – Effective Thermal Resistance

- Simple ICF wall assembly exceeds code minimum requirements on below and above grade wall assemblies – EPS insulation R-Value 21.6
- No deductions in effective thermal resistance calculations
- ICF recognized as MASS walls

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<tr>
<th>Below Grade Wall Assembly Components</th>
<th>Fox Block 6&quot; (150mm)</th>
<th>Fox Block 8&quot; (200mm)</th>
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<td>Fox Blocks</td>
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<td>Fox Blocks +</td>
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Energy Stick adds R8 >
## Insulation – Added Thermal Resistance

### Options for Enhanced Thermal Resistance:

- Add Fox Blocks Energy Sticks or Panels

### Fox Blocks Energy Stick –

- 2” EPS insert, adds R-8 reaching an R-30 value
- Additional EPS exterior layer
- Add 2 Energy Sticks = R-40 wall assembly

### Above Grade Wall Assembly Components

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**Equivalent U-Factor**: 0.0318
Current studies on ICF wall assemblies have proven that the insulated thermal mass within an ICF does influence the temperature change through the wall assembly.

Test concluded that a 2x6, R-20 wood framed wall would consume more than 40% energy than an ICF wall to maintain the indoor temperature over a 13.5 day period.

Minimizes temperature changes, less load on HVAC

Interior 21°C

Exterior -35°C

CLEB Thermal Performance Testing – ICFMA 2016
ICFMA has conducted comparative thermal performance studies on various wall assemblies. Tests identify heat energy $W$(Btu/hr) required to maintain a steady state temperature for one hour.

**2x6 – R20 Batt + R5 Rigid on Exterior**

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**6” Standard ICF**

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<td>77.94</td>
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Total Energy Input - 346.2 $W$(Btu/h)
Overall Thermal Resistance – R19.43

Total Energy Input 177.6 $W$(Btu/h)
Overall Thermal Resistance – R23.3

6” ICF requires half the energy input as compared to the wood framed wall assembly.

This Thermal Report available on ICFMA website
www.icfma.org
Simplicity for Basements

Codes have increased the thermal requirements for below grade walls.

Basements require full height insulation which requires strapping, vapor barrier, Extra material and labor:

- 2x6 stud walls with full height batt insulation

ICFs with a 6” or 8” concrete core exceeds building code with R21+ thermal rating.
Insulation – Continuous Insulation

Wood Framing -
Thermal bridging at floor connections plus additional material and labour to insulate and seal joist cavity.
Continuous Insulation - Openings

Wood Framing – Thermal bridging at lintel, jamb and sill, plus additional material and labour to air seal

Fox Buck – EPS Insulation

No thermal bridging at heads or jambs

Fox Buck – Continuous Insulation

No thermal bridging at sills
Weather Resistant Barrier

- ICF concrete core provides a continuous air barrier from top of footing to underside of roof
- ICF continuous air barrier eliminates the requirements for caulking, sealants and tape on interior and exterior
- ICF have passed testing as a weather resistant barrier, (ASTM E2634, E331)
- No additional WRB membranes are required.
- Exterior finishes may be directly applied to the ICF

Eliminate labor and material for WRB and sealants
Air Tightness

‘Airtightness has been determined as the single most cost-effective way to reduce heating energy consumption.’  Code Consultant

IECC 2018 code testing:

✓ Climate Zones 1 – 2: 5 ACH @ 50 Pa
✓ Climate Zones 3 – 8: 3 ACH @ 50 Pa

Wood Framing Tools of the Trade Publication on where to look for air leaks:

☐ Top and bottom plates
☐ Sill plates, rim boards and band joists
☐ Partition intersections
☐ Subfloor and wallboard joints
☐ Exterior wall corners
☐ Door frames and thresholds
☐ Window frames
☐ Soffits
☐ Service penetrations
☐ Electrical outlets in exterior walls
☐ Exterior wall at bathtubs and showers

Combination of materials required to fix or seal air leaks:

☐ Spray foam
☐ Caulking, backer rods
☐ Gaskets
☐ Weatherstripping
☐ House wrap
☐ Sealant tape
☐ Mastic
Air Tightness – Framing Use of Sealants

• Code upgrades focus on required applications of sealant in multiple locations on wood framed buildings

• This adds considerable material, labour and time to the construction of the building envelope, plus responsibility and liability

• Wood framing requires exterior and interior sealant and taping to maintain a continuous air barrier
Air Tightness – Material Durability

Complexity of design and application for the long-term

- Durability of air barrier materials - house wraps, sealants and tapes
- Strength, and possible degradation from weather and mechanical forces created by wind and stack effect pressures
- Interface degradation with other materials
- Correct installation techniques

ICFs and concrete as an air barrier do not degrade over time
Air Tightness

An ICF home and building will have a high-performance building envelope complimenting the energy efficient windows, doors and roof assembly.

Air infiltration rates on ICF homes are exceeding the proposed code minimums for Net Zero Ready Homes and Energy Star ratings.

ICF homes typically -
change rate not greater than
1.5 ACH @ 50Pa
ICFMA 2019 survey, identified in an Airtightness Study, by a recognized third-party lab - RDH found on average, over 50 typical ICF homes with the following results:

✓ Average airtightness was 1.26 ACH@50 Pa.
✓ All the ICF data results an average of 2.57 ACH@50 with a median of 1.56 ACH@50

The following are ICF homes blower door test results:

- Hampton, Fl  ACH 1.44
- Bancroft, Fl  ACH 0.15
- Biscayne, Fl  ACH 1.09
- Ferrier, Fl    ACH 0.95
- Gardiner, NY  ACH 0.28
- Valley, Fl    ACH 1.65
- Glenridge, Fl ACH 1.81
- Ontario, Can  ACH 0.85
- Sedona, Az    ACH 0.058
Air Leakage

ICF – Advantages

▪ Continuous concrete air barrier
▪ No thermal bridging
▪ No caulking required except sealant around openings
▪ Concrete will not deterioration
▪ Concrete is resilient to high winds and pressure

NO Air Barrier or Weather Barrier required

Wood Frame Air Leakage Paths
Vapour Barrier

ICFs have been tested per ASTM E96 for a Permeability

ICF permeance rating is - 47.76 ng/(Pa.s.m$^2$) which exceeds code requirements

ICFs directly apply gypsum board to walls

No Vapour Barrier or poly is required over a Fox Blocks wall assembly
Vapour Barrier

Large temperature changes through an ICF wall assembly may create a *Dew Point* near the exterior face of concrete within the ICF.

Concrete has the ability to maintain and dry out this moisture.

There is NO condensation near the interior face of the ICF wall in cold or hot climates.

This is recognized in the building code as part of mass wall construction.
Increased air and vapour protection, from an ICF, increases the need for effective mechanical ventilation.

HRVs are recommended for high-performance in ICF homes.

Better control over the indoor air environment provides a more comfortable and healthy environment.

Better environment for control by HVAC systems.

High-Performance Building
Airtight enclosure and mechanical ventilation with or without heat recovery = High thermal performance.
Health and Comfort from ICFs

The ability of a simple Fox Blocks wall assembly to control air infiltration, vapour diffusion, sound plus effective high-performance thermal resistance provides:

- Better Indoor Air Quality
- Better Comfort with minimal temperature swings, no drafts
- Resiliency and security
- Reduction in HVAC equipment sizing due to air tightness and thermal efficiency
- Reduction in HVAC demand and operations = monthly operational cost savings
Health and Comfort

‘When designing high-performance buildings, an enclosure – first approach is commonly chosen. This entails a highly insulated and airtight building enclosure.’

The ability of a simple ICF wall assembly to control air infiltration, vapour diffusion and effective thermal resistance creates a high-performance building envelope that contributes to:

- Healthy indoor environment
- Comfort, safety and security
- Indoor Air Quality
Framing - Exterior Finish Attachment

In new high-performance wood ‘Component Method’ the increased thickness of additional exterior insulation is creating an issue for the attachment of the exterior finishes.

Longer and stronger screws are being required to address the increased deflection and stress on the attachment points to secure the finishing materials.

This adds material and labor costs.
Attachment – Continuous

Fox Blocks fastening strips:

- 1 ½” wide, (similar to wood stud)
- 8” on center, embedded in concrete
- Continuous for height of wall
- On exterior and interior side of wall
- Buried ⅝” beneath EPS
- ASTM approved testing for pull-out and lateral shear for various fasteners
- No thermal bridging
- No deterioration from moisture
Direct Attachment of Finishes

Fox Blocks EPS provides a continuous and solid substrate for the direct application of exterior and interior finishes such as:

- Acrylic stucco
- Lath and cementitious stucco
- Simulated stone
- Decorative concrete
- Masonry
- Siding
- Gypsum Board
High-Performance and Net Zero Ready

Fox Blocks homes with an integrated design are high-performance homes and can meet criteria to be Net Zero Ready.

- Third party tested – Energy Rating
- Insulated with no thermal bridging
- Airtight envelope design
- Indoor air quality with HRV to meet ‘airPlus’ standards
- Design for renewable energy source – PV systems
- Balanced HVAC designed for ICF mass walls

New code homes < 55
High-performance ICF homes < 40
Net Zero – 0
Net Zero Ready Homes (NZRH)

**Fox Blocks** as the building wall envelope enables NZRHs certification

- High performance, thermal resistance mass wall
- Continuous insulation
- No thermal bridging
- Minimal air infiltration
- Vapor and moisture control
- Better control on indoor air quality with a tight building envelope
- Structurally capable for PV systems
- Resilient, fortified structure
Net Zero Ready Homes (NZRH)

FOX BLOCKS has been building NZRH homes and commercial buildings for years

Winning Innovation Energy Awards

- very low, even minus Energy Ratings
- 5 Star Energy Star certifications

Fox Blocks rated homes can easily have HERS ratings well below the national average and with an integrated design can and have met NZR criteria.

Greenhill Contracting has won this innovation energy award 4 years in row, building with Fox Blocks in the New York area.
Construction Simplicity – Flexibility

Design and Construction Flexibility - Residential and Commercial

✓ Full line of block shapes and sizes for any design configuration
✓ Full library of CAD, BIM, specifications and technical support
✓ Modular product, 1 ICF block = 5.33 sq.ft. of wall area
✓ Full line of ICF accessories
✓ Less materials and labour for the building envelope (no air, vapour barrier, sealant, no tape)
✓ Reduced crew size, faster completion and occupancy
✓ Ability for year construction
✓ Compatible for any building type, any wall height
**Resiliency**

5 Key Elements to Building with Strength:

- **Stands the test of time**
  Concrete structures are designed to last for centuries. Unlike other materials, concrete only gets stronger over time.

- **Sustainable**
  Concrete's strength, durability and energy efficiency make it an environmentally friendly material—especially when you consider the entire lifecycle of the building.

- **Simple to use**
  If a material isn't easy to use, it doesn't matter how strong it is. Good thing concrete can be molded into any shape, size or design you can imagine.

- **Safe and strong**
  Building with concrete gives you a fire resistant structure. When combined with other fire safety systems, you can exceed building requirements—instead of just meeting them.

- **Value that lasts**
  Concrete won't rot, mold, rust or deteriorate. It's energy efficient and virtually maintenance-free—which means the resources you invest now will last for decades to come.
Fire Rated Wall Assemblies

ICF wall assemblies have fire resistant (FRR) listings from a 2 to 4-hour fire rating

Third Party Testing & Performance-Expanded Polystyrene:

ICF Flame Spread / Smoke Development Index

Flame Spread Index (FSI) is less than 25
Max. per Code is 75

Smoke Development Index (SDI) is less than 450
Max. per Code is 450
Comfort and Sustainability

Residential and Commercial:

✓ Excellent Sound Attenuation (STC50+)
✓ Energy efficiency from double insulation layers and thermal mass
✓ Security from resiliency of reinforced concrete structure
✓ Longevity, life span of the EPS and Concrete – no deterioration
✓ Typical ICF form, by weight, contains 40% + recycled material
✓ Modular product means less construction waste
✓ Compatibility with all exterior finishes
Reduction of Labor Rates

- Associated General Contractors of America claim 80% of construction companies report problems finding skilled workers, causing delays and increased labor costs.

- Report also found that 46% of construction firms are taking longer than initially scheduled to complete projects.

  - Success in construction is based on the completion timeline.
  
  - Strategy for success is to use less materials and labor to achieve the same or better deliverables.

Fox Blocks is an easy product to learn the installation techniques.

Fox Blocks can advance completion timelines by 3 weeks or more.
Reduction of Labor Rates

- Light material, minimal heavy transport equipment and no heavy metal concrete forms to transport, strip and maintain
- ICF job sites are generally clean and safe for the crew
- Laborers can be quickly trained to become certified ICF installers. Installer training is available
- Reduce staging timeframes by eliminating subtrade labor for other building elements such as - air barrier, vapor barrier, insulation, and strapping for finishes.
- Proven record for substantially reducing completion times to advance occupancy
- Expected labor rates:
  - $0.075 to $0.085 per gross sq. ft. of ICF

ICFs are much lighter than traditional form systems. This photo shows one man handling a full bundle of ICFs.

One ICF block equals 5.33 ft² of wall area.
Fox Blocks Markets

Unlimited markets for high-performance in all building types across North America:

- Below and above grade walls
- Residential, commercial, agricultural
- Multi-family, townhouses
- Tall walls
- Fire walls
- Multi-story buildings (tallest 22 floors)
Simple Design Strategy with Fox Blocks

- Flat, monolithic reinforced concrete wall
- Concrete core sizes – 4”, 6”, 8”, 10” and 12”
- Engineering available in IRC code or ACI 318
- ICFs are covered in the IRC building code
- Continuously insulated **mass wall** assembly
- One block equals 5.33 sq.ft. of wall area
- Full line of block products and accessories
- Meets or exceeds current energy codes for all climate zones
Simple Design Strategy

6 in 1 product attributes for high-performance:

- Easy constructability for below and above grade walls
- Minimize materials and sub-contractors
- Business advantages – faster, cheaper, better
- No call backs, over satisfy your customers
- Step into High-Performance and NZR home construction

Progress away from conventional ‘Multiple Component Wall Assemblies’ to a simpler more effective wall assembly with ICFs.
Fox Blocks Experience

- 22+ years experience manufacturing and building with Fox Blocks
- Over 11 million +, ICF blocks produced to date
- Over 60 million plastic webs/ties
- Over 55 million square feet of ICF walls successfully installed to date
- Fox Blocks Technical Team with over 300 Years ICF experience
- Multiple manufacturing locations throughout North America
Thank You

Feel free to ask us any questions.

info@foxblocks.com

www.FoxBlocks.com

Connect with Us
RESOURCES

The experience of the Fox Blocks team has created an extensive and expanding library from building codes to educational videos to technical bulletins, you'll find a huge collection of resources here, for engineers, developers, architects and homeowners. And if you don't find what you need, feel free to contact us. We want to be your go-to people for anything ICF.

Contact us for:

Distributor Locations
Training – classroom, on-line
Trade shows
Technical Information
Any questions? 877-369-2562
Fox Blocks Specialty Products

Fox Buck, 4” Riser, Energy Stick and Reveal One-side Block
HV Clips, Tie Key Masonry Anchor, xLerator Reinforcing
Material and Labor Estimating

Fox Blocks Estimator Pro for accurate project quotes:

- Blocks
- Accessories
- Concrete
- Reinforcement
- Labor Rates
- Ordering

Available for download on Fox Blocks website