BUILDING INNOVATION
Conference

Designing and Building Resilient Communities with ICF Wall Systems

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About the Speaker

Dr. Mills-Beale has a combined 20 years of experience in academia, materials research, engineering consulting, civil/structural code advocacy, and field engineering work.

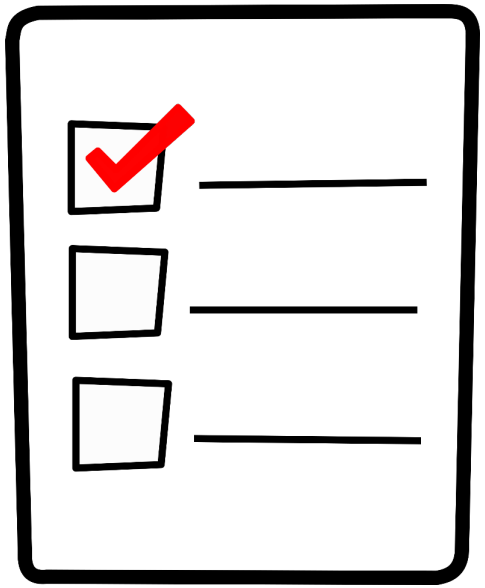
He is a member of ACI-560 committee on ICF technology, ACI-332 committee on Above Grade Walls, ASHRAE 90.1 committee on Energy Standards for Sites and Buildings except Low-rise Buildings, ICC Performance Code committee Subgroup 3 (Functional Recovery), SG-5 (Structural and Geotechnical).

Specialties:

Construction materials' performance modeling, concrete technology, nanomaterials, geostructural analysis, innovative materials, green design, pavements and transportation systems.

PRESENTATION OUTLINE

- Introduction - history and background of ICFs
- Components of the ICF wall system
- Construction methodology
- Structural and non-structural benefits of ICFs
- Code and standards' requirements
- Project cases and examples of ICF construction
- Q & A Time



History of ICF Construction

- 1937 (Belgium) – DURISOL, the first ICF
- Post-WWII Europe – Build Quickly & Efficiently
- 1959 – Intro in 13 Countries, Reducing Costs by 20% – 30%
- 1966 – Gregori files patent in Canada
- 1970's to 1980's – Substantial Industry Growth
- 1990's – Over 30 manufacturers within the ICF industry
- 2009 – Market down-turn…>20 manufacturers
- 2021 – Unprecedented Market Growth = INSTALLERS

Background on ICF Wall Systems

Walker's Landing, Milwaukee, WI

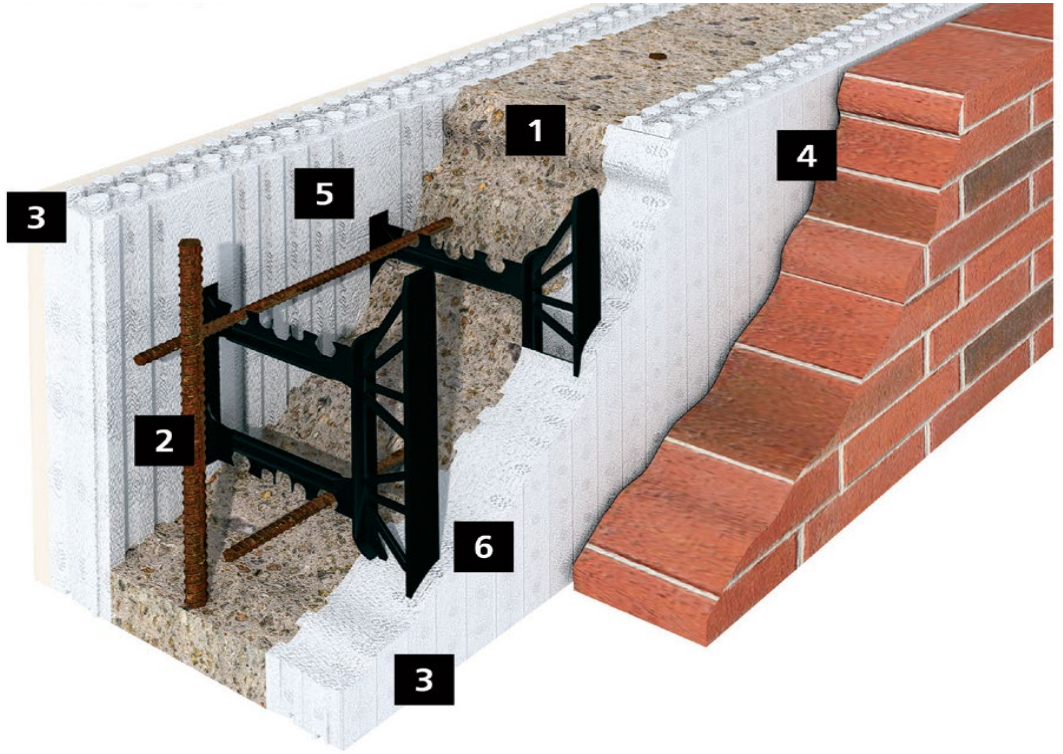
Dormitory, Texas Tech, Lubbock, TX

- What are ICF wall systems?
- What is the history of ICF wall construction?
- What are some of the known benefits?

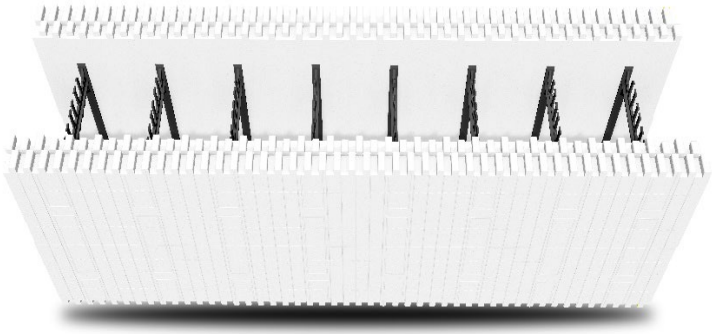
Background on ICF Wall Systems

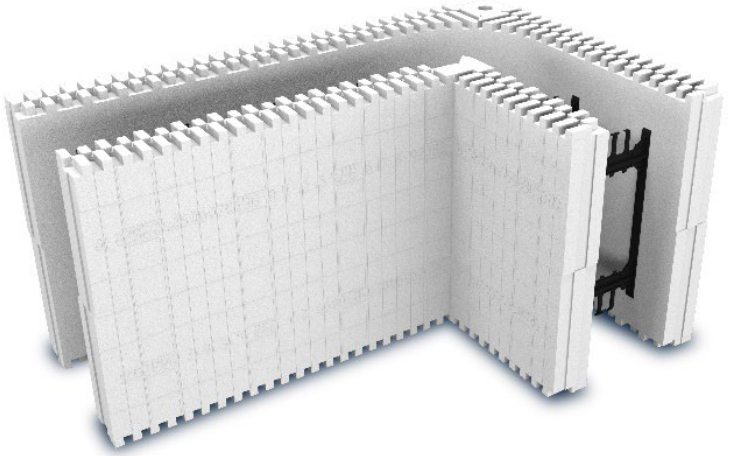
A **composite wall system** designed consisting of concrete, steel reinforcement, insulation, air barrier, vapor barrier and furring strips for: **structural performance**, **thermal efficiency** and **faster construction**.

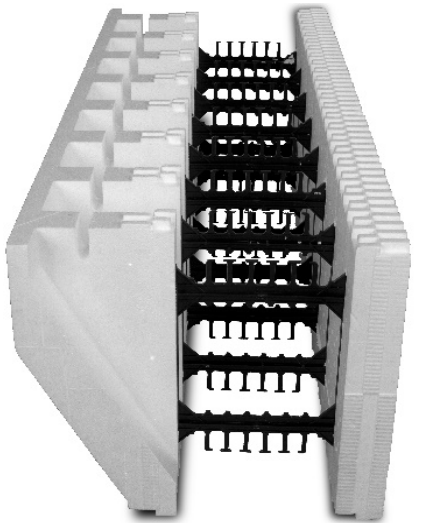
1. concrete
2. steel reinforcement
3. insulation
4. air barrier
5. vapor barrier
6. furring strips

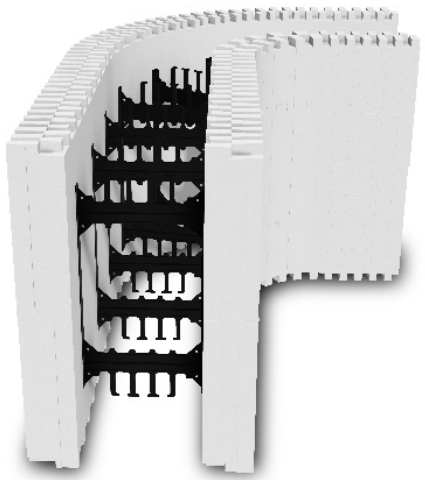


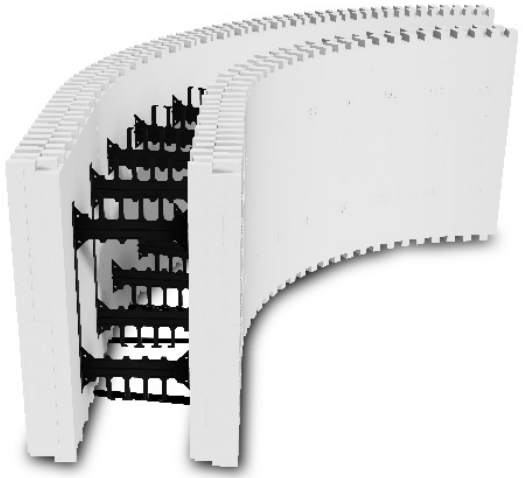
Block/ Form Types and Shapes

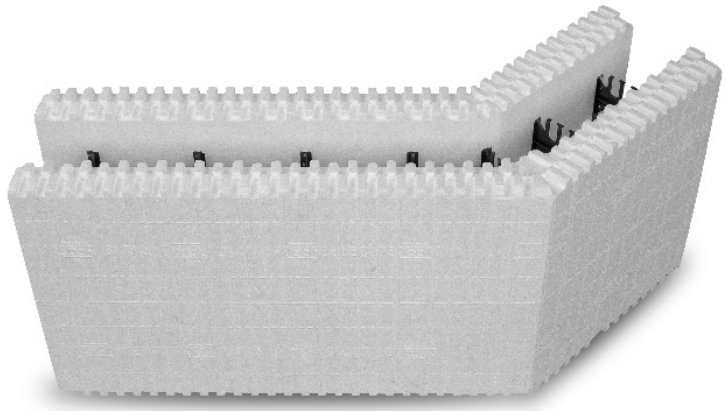












Components of the ICF Wall System

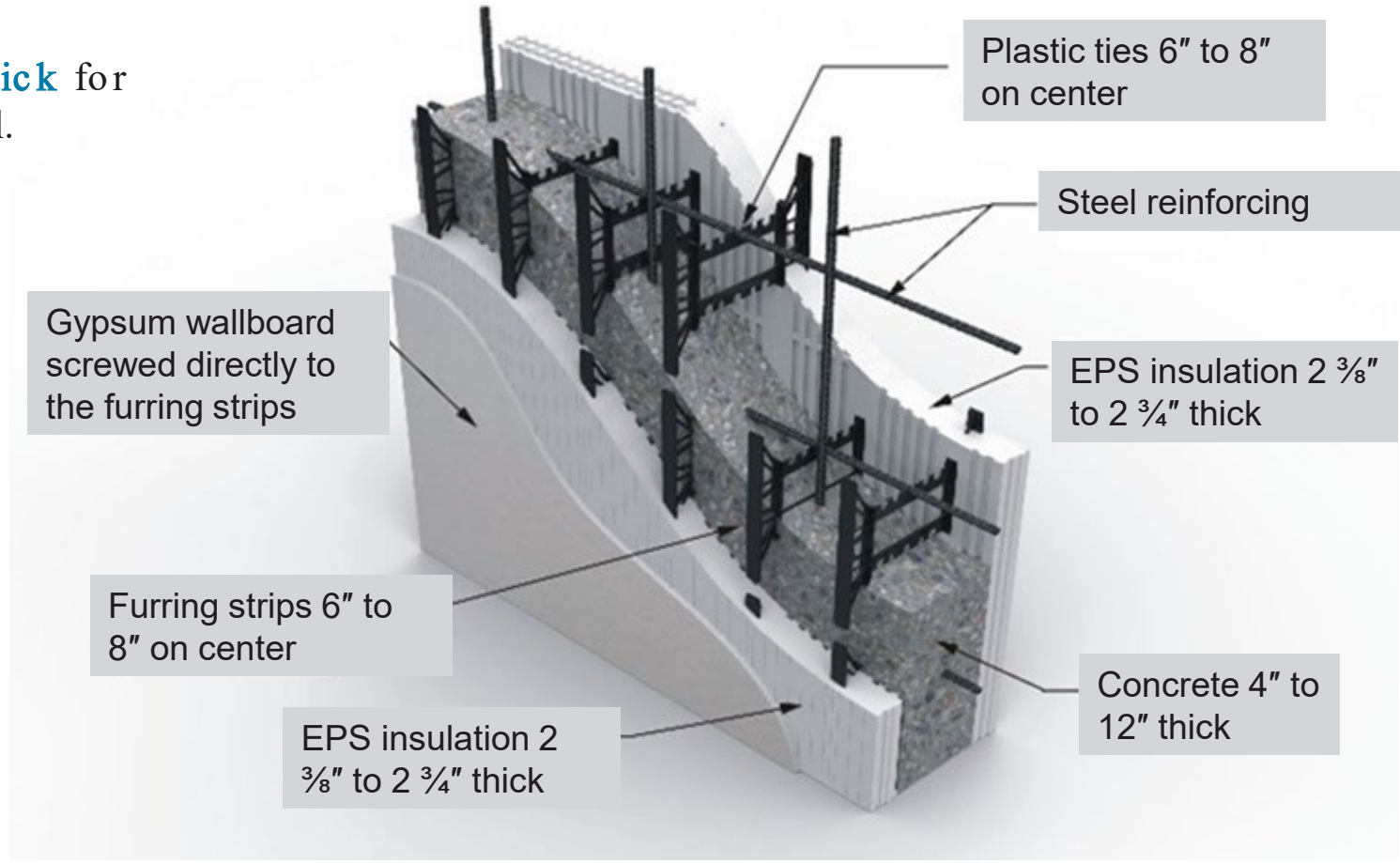
Outer edges = EPS insulation 2 ⅜" to 2 ¾" thick for continuous insulation on both sides of the wall.

Interior of the wall = concrete 4" to 12" thick.

Plastic ties = placed 6" to 8" on center.

The **ties determine the thickness of the total wall as per specs.**

Ties offer form support during concrete placement, and help to eliminate thermal bridging.

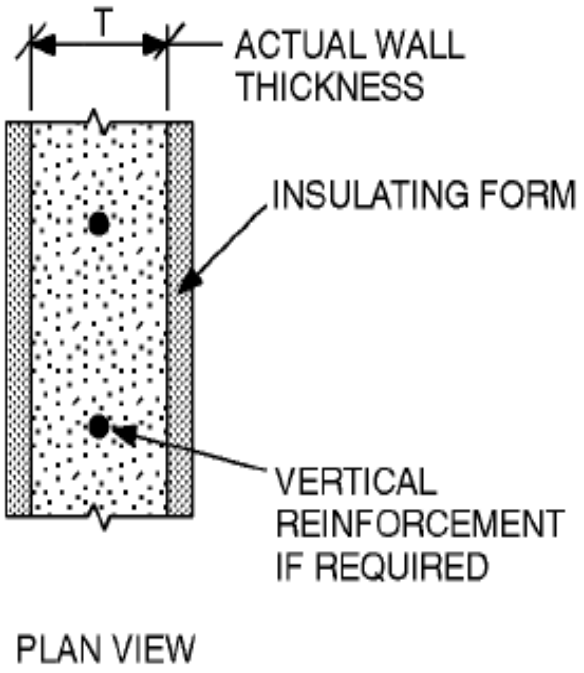


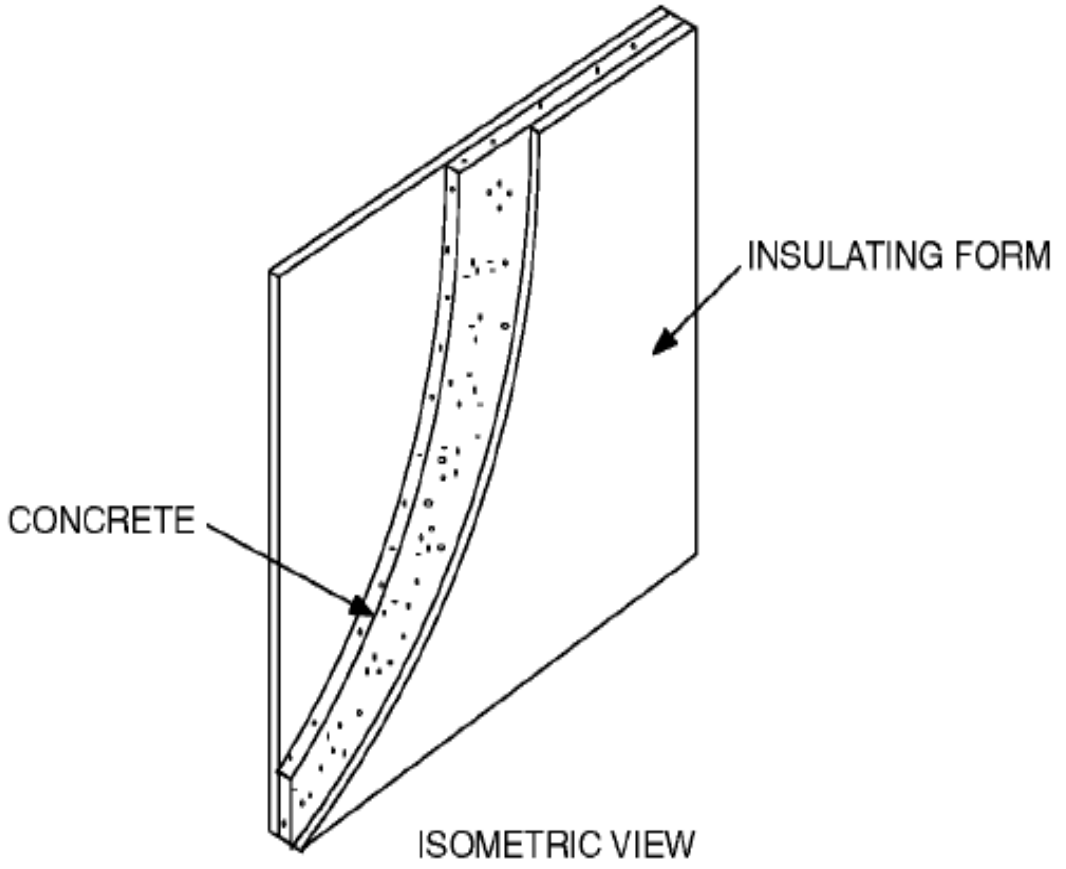
Types of ICF wall systems

3 types of wall systems are designed and constructed:

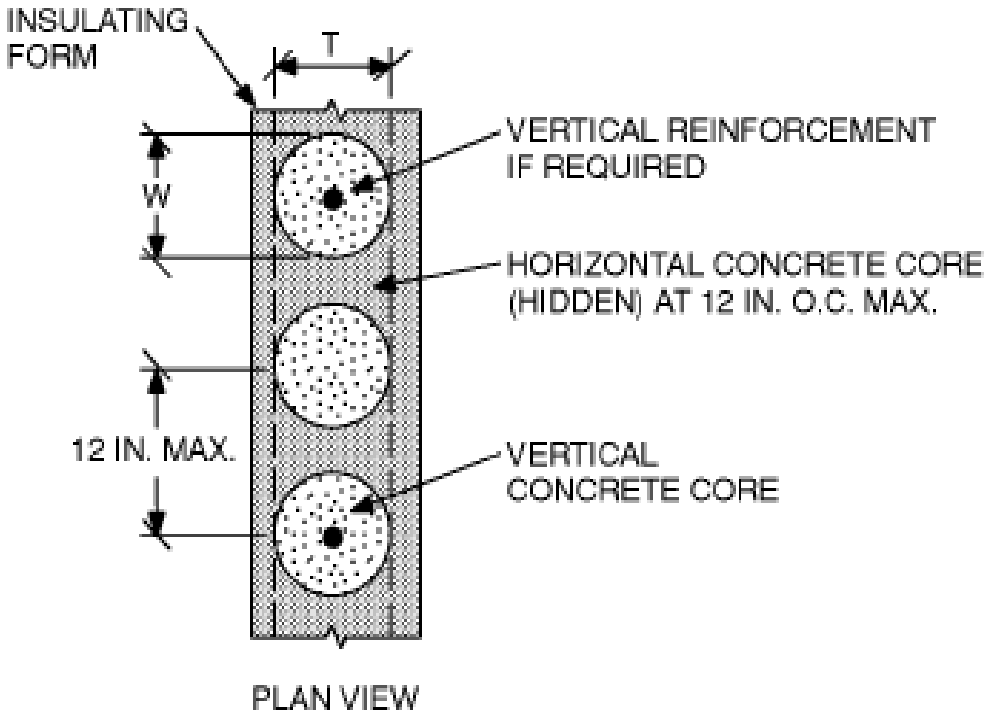
- Flat wall systems
- Screen-grid wall systems
- Waffle-grid wall systems

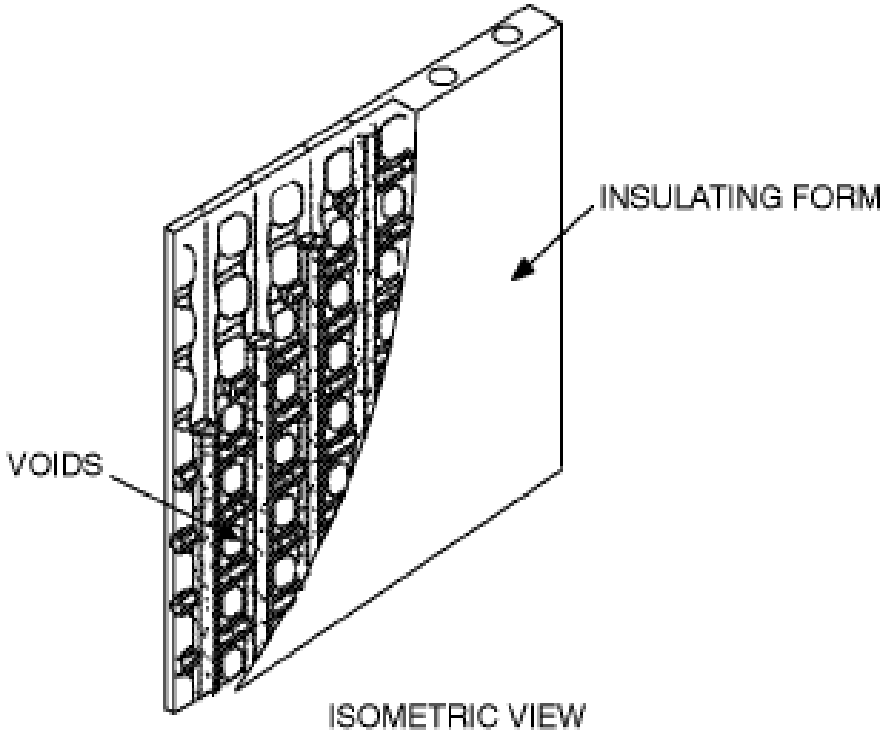
The flat ICF wall





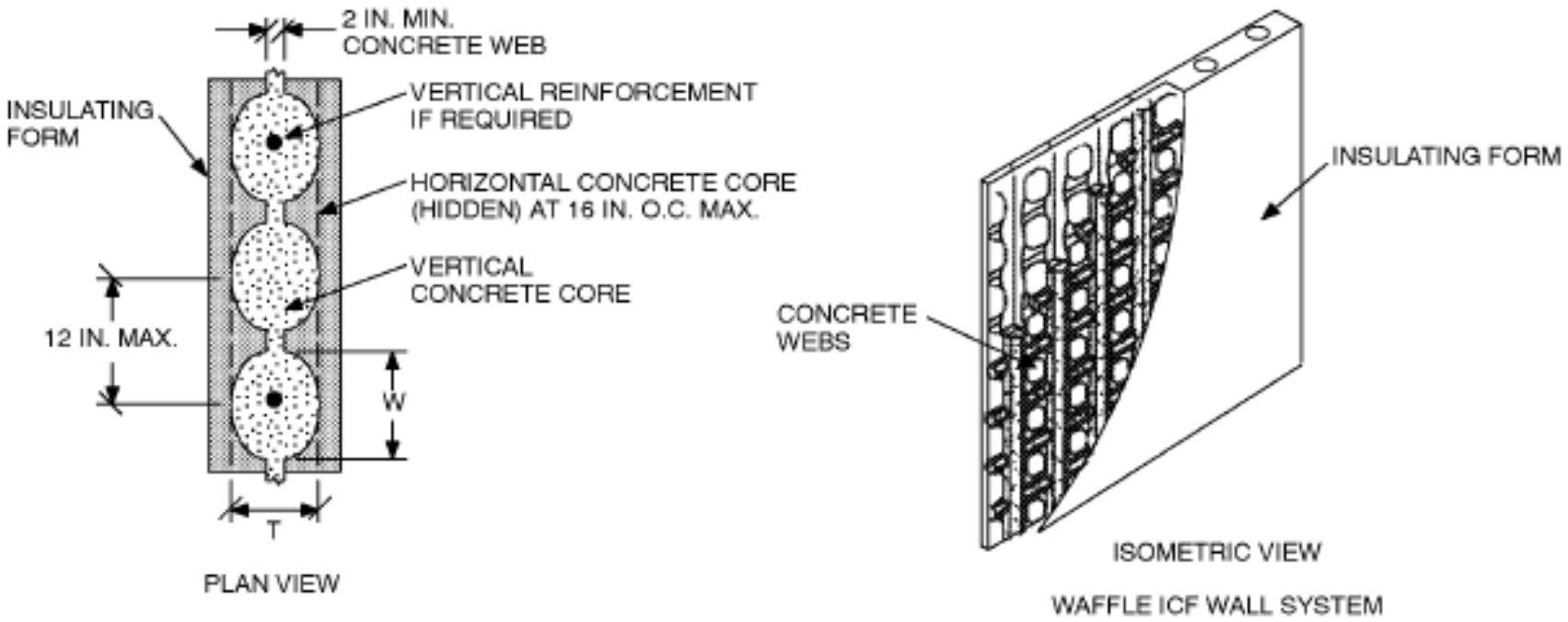
The screen-grid ICF wall



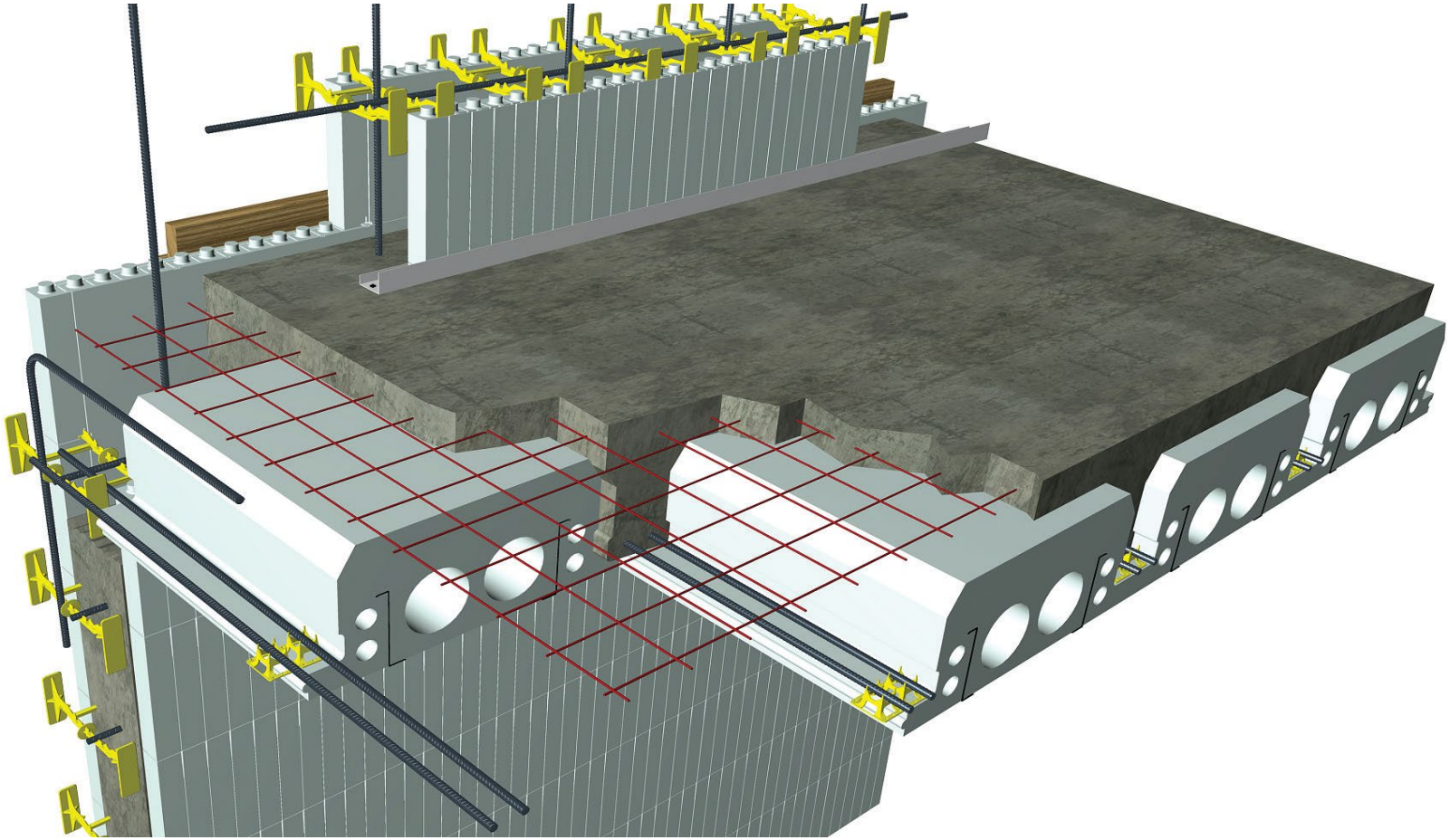


SCREEN—GRID IFC WALL SYSTEM

The screen-grid ICF wall



Typical ICF wall-to-floor connection



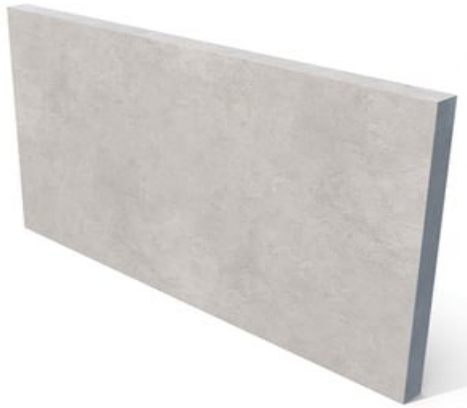
ICF Construction Methodology

Construction Step	Installation Procedure
Step 1	ICFs are stacked in the shape of the wall, and openings for windows and doors are formed using treated wood or plastic.
Step 2	Steel reinforcing is placed into the forms and secured in place.
Step 3	Bracing and scaffolding are installed to keep the wall straight, plumb, and secure and to provide a working platform.
Step 4	Concrete is pumped into the forms.
Step 5	Electrical and plumbing lines are installed into the EPS by cutting channels with a hot knife or other tool.
Step 6	Interior and exterior finish is installed directly to the ICFs by screwing into the embedded furring strips.

Construction procedure

Structural and Non-structural Benefits

- Resilient performance against extreme weather events.
- Thermal and energy-efficient performance.
- Fire-resistant performance.
- Sound-attenuation performance.



Hello - Can I hear you ?

Resilient performance of ICF Wall Systems

Some reported structural benefits include, but not limited to:

- Large inelastic, stable deformations.
- High energy dissipating capacity of the wall systems.
- Flexural resistance models for solid cross-section reinforced concrete (RC) members are applicable for ICF walls.

Reference:
Lopez et al. (2021). Experimental study of in-plane flexural behavior of screen-grid insulated concrete form rectangular and T-shaped walls, Engineering Structures, Volume 247.

Resilient Performance in High-Risk Seismic Zones

- Using **Concrete Damage Plasticity Constitutive Models (CDP)**, Asadi et. al. (2017) showed that **a screen-grid wall structural system**, if used in high seismic risk zones, **has an acceptable ductility**.

- This performance ensures required dissipation of earthquake energy in the wall system.

Reference:

Asadi et al. Response Modification Factor due to Ductility of Screen-Grid ICF Wall System in High Seismic Risk Zones (2017). KSCE Journal of Civil Engineering 21(1):258-264.

Strength and Durability Requirements

High Impact Resistance

Shear wall systems to resist high winds.

Category 5 Hurricane

EF-4 / EF-5 Tornado

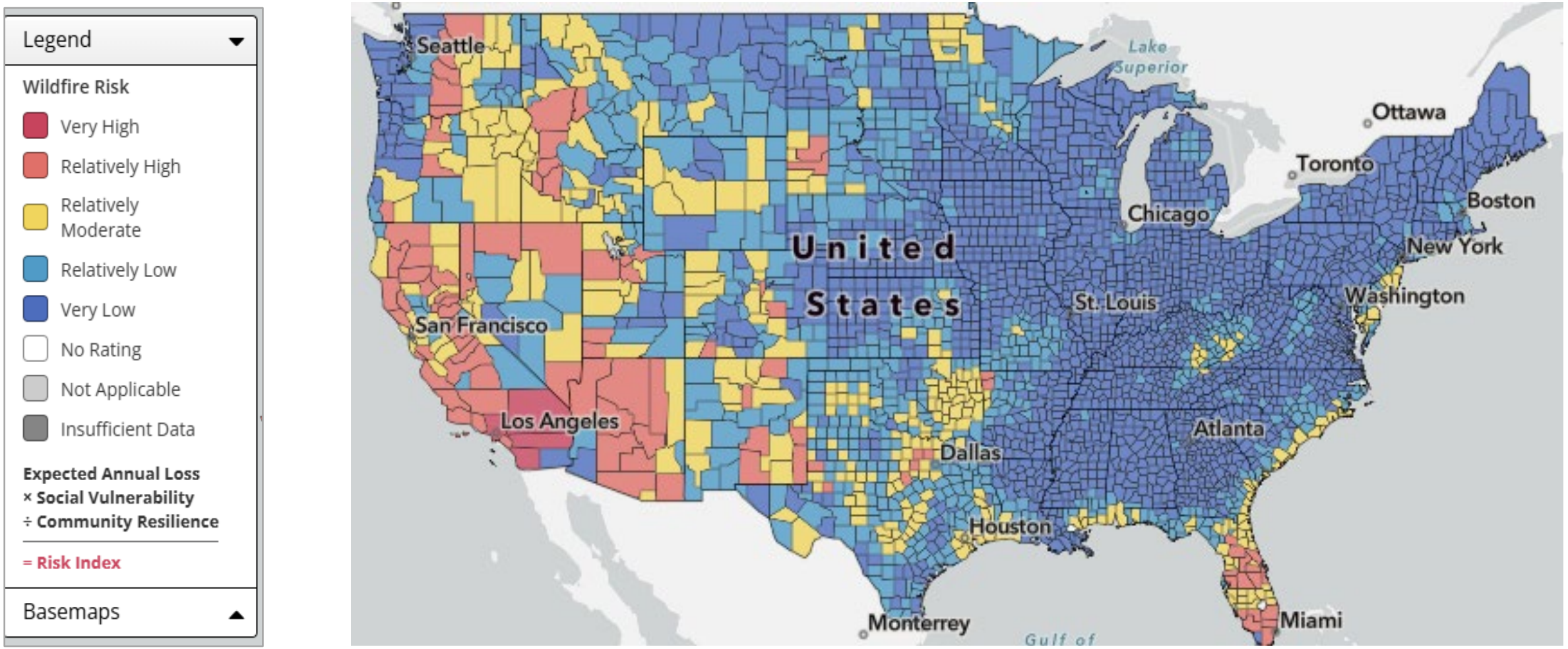
Flood-damage Resistance

Class 5 Building Materials – highest classification (FEMA).

Can be used below base flood elevation (BFE).

ICFs can help our communities mitigate risks and impact of fire occurrence.

The FEMA National Wildfire Risk Map



Fire-resistant performance of ICF walls

When tested according to the ANSI/UL 263 and ASTM E119-07, an ICF wall with reinforced concrete with a minimum compressive strength of 2,900 psi (20 MPa), and ½-in. (13-mm) gypsum wallboard on each side:

ICF wall thickness, inches (mm)	Fire Rating
4-in. (102-mm)	2-hours
6-in. (152-mm)	3- or 4-hour rating
8-in. (203-mm) and thicker	> 4-hour rating

Fire-resistant performance of ICF walls – Contd.

The EPS used for ICFs is manufactured with flame retardants that render the EPS insulation completely unable to support a flame without an outside flame source.

EPS used for ICFs is required to have:

- A flame spread index less than 25;
- A smoke developed rating less than 450 (ASTM E84-197 and ANSI/UL 723).

Flame Spread Rating Chart

Class	Flame Spread Index	Smoke Developed Index
Class A	0-25	0-450
Class B	26-75	0-450
Class C	76-200	0-450

Case Study – Blast Resistance Testing

Photo credits: Insulated Concrete Form Association

Force Protection Equipment Demonstration

- Quantico Marine Corps Base, 2003
- Demonstrate blast resistant properties of ICFs
- ICF reaction boxes with no exterior cladding were subjected to blasts from a 50-pound charge of military grade TNT at distances of 40 feet to 6 feet
- Acceptance criteria
  - Military personnel in the structure survive the blast
- Outcome
  - Limited damage observed to the concrete structure
  - EPS absorbs energy from the shock waves, dissipates energy over time, cushions concrete

Case Study – ICF Apartment Building Survives Explosion and Fire

Massive natural gas explosion in East Harlem, New York City (2014)

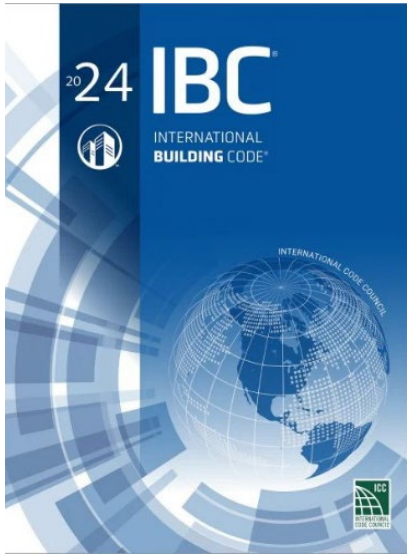
- Destroyed two apartment buildings, vacated four neighboring properties, and shattered windows blocks away
- Nearby, buildings and households affected by the blast
- Eight (8) deaths, 70 injuries and 100 displaced families
- > 250 firefighters, paramedics, and police officers responded
- Local utility was responsible for $153.3 million damages,
- Adjacent ICF concrete building survived a blast and subsequent fire and reopened after repairs.

Case Study – ICF Apartment Building Survives Explosion and Fire

Relevant Codes and Standards – 2024 IBC

IBC 1903.4 Flat wall insulating concrete form (ICF) systems. *Insulating concrete form material used for forming flat concrete walls shall conform to ASTM E2634.*

ASTM E2634 – Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems



Satisfying LEED v5 Requirements with ICF Walls

- LEED v5 was recently launched in April 2025.
- ICF wall systems has the potential to satisfy selected resilience prerequisites and credits under Sustainable Sites (SS) for example.

Sustainable Sites (SS)		11	11
SSp1	Minimized Site Disturbance	Required	Required
SSc1	Biodiverse Habitat	2	2
SSc2	Accessible Outdoor Space	1	1
SSc3	Rainwater Management	3	3
SSc4	Enhanced Resilient Site Design	2	2
SSc5	Heat Island Reduction	2	2
SSc6	Light Pollution Reduction	1	1

Source: LEED v5 Building and Construction Resilience Requirements, USGBC, April 2025.

QUESTIONS ?

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