Economical Design of Insulating Concrete Form (ICF) Walls

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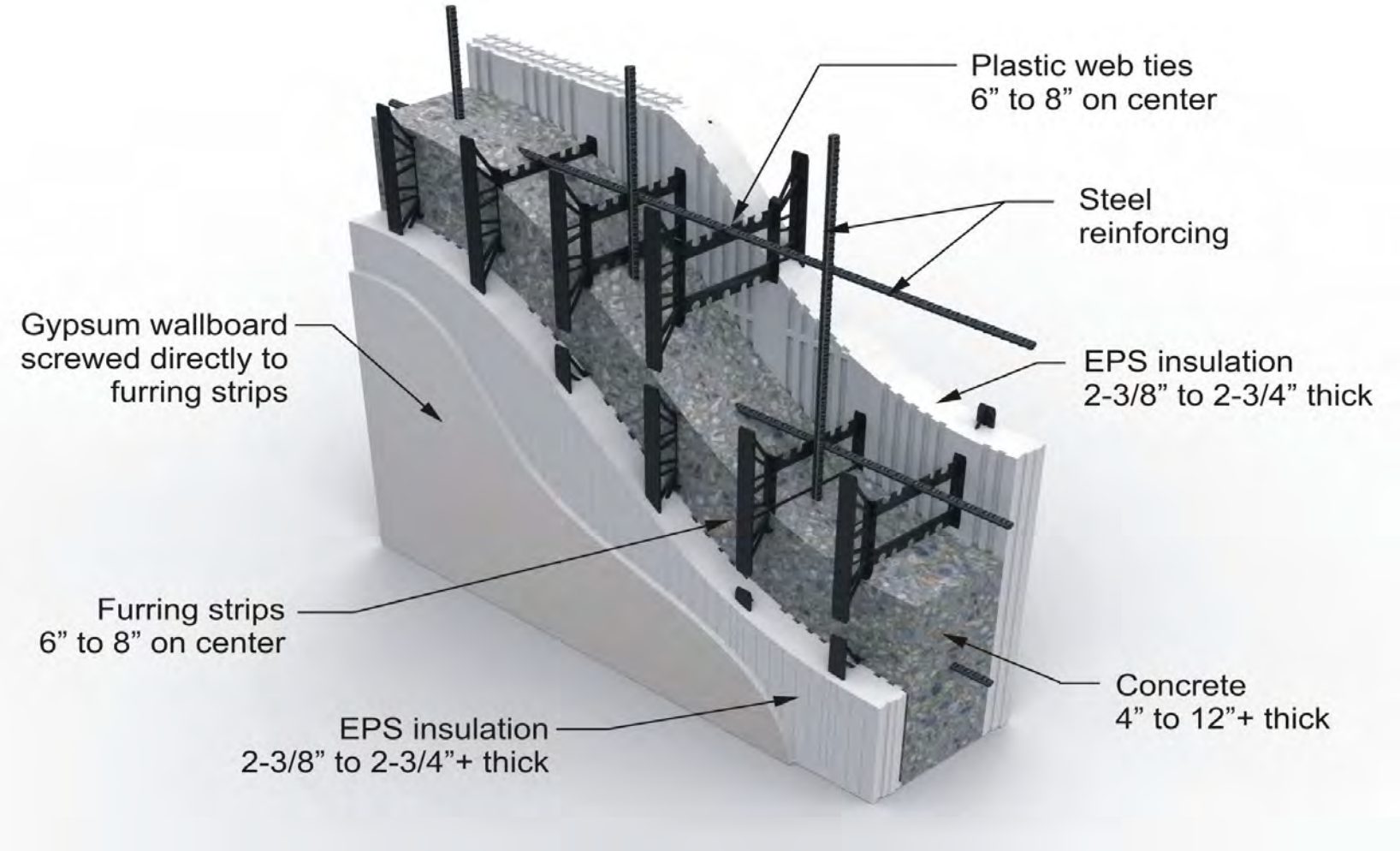
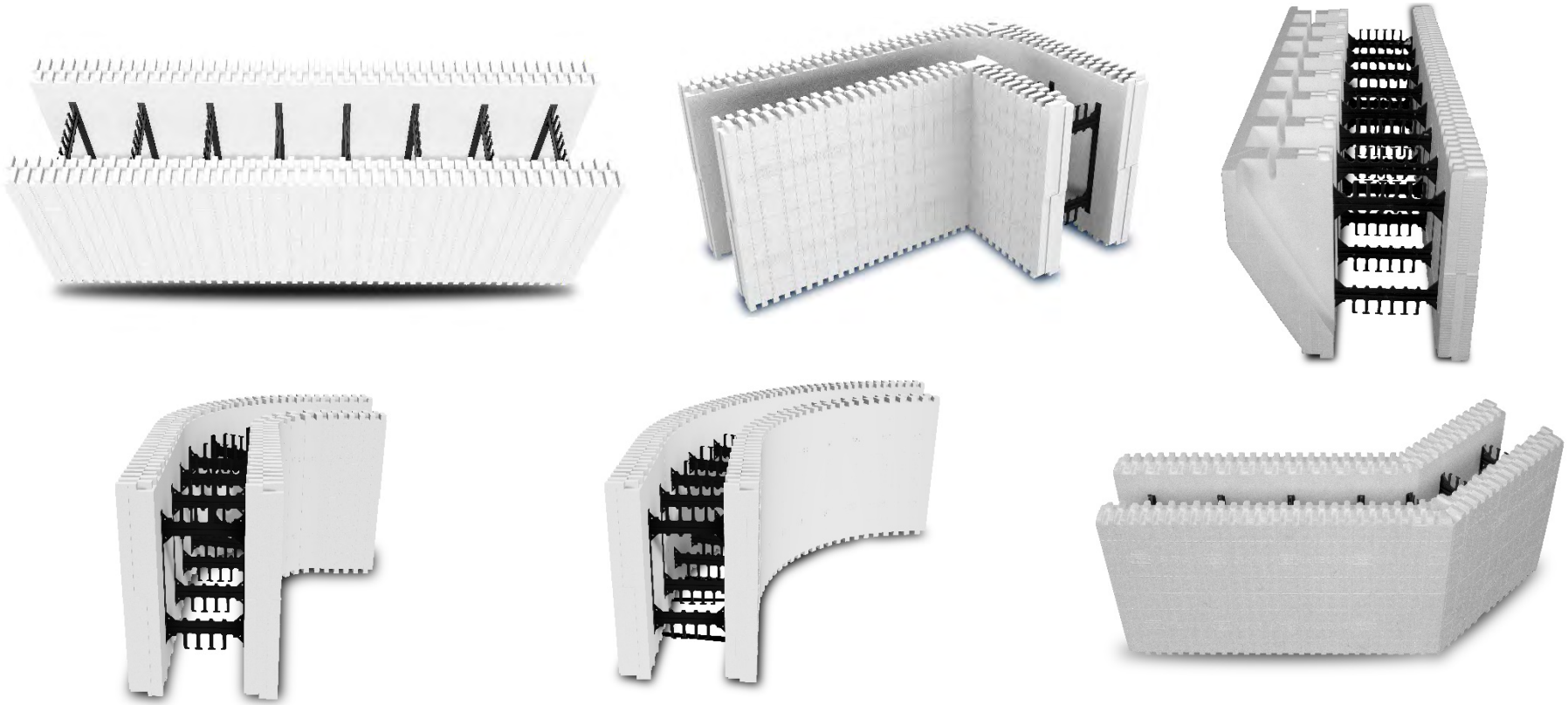
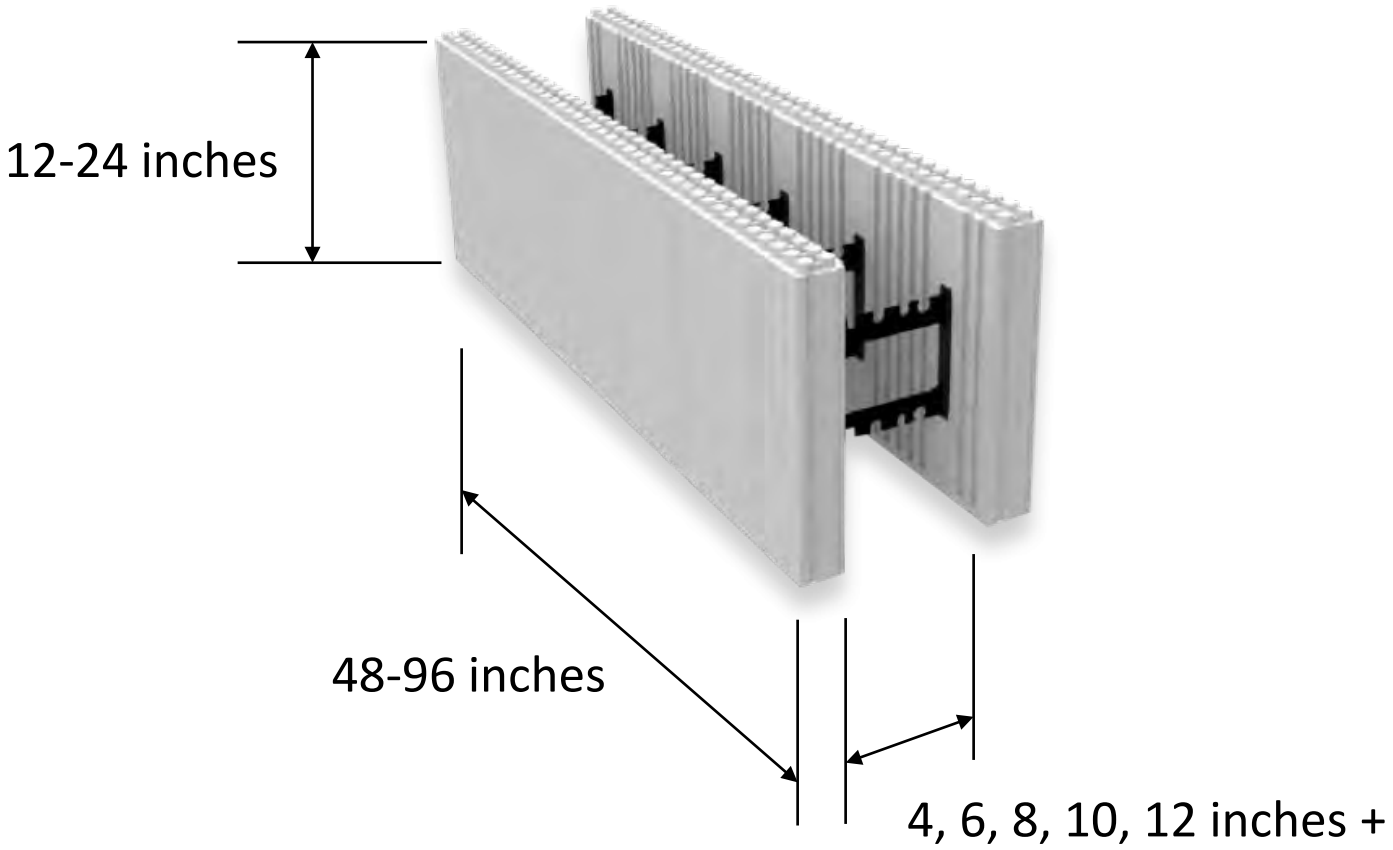
What are ICFs?



Form Types



Form Dimensions



History

- 1967 (first patent in U.S.)
- 1980s (basements)
- 1990s (single family)
- 2000s (commercial)
- 2010s (nearly unlimited)

Form Manufacturers

ICFMA
INSULATING CONCRETE FORMS MANUFACTURERS ASSOCIATION

QUAD-LOCK®

NUDURA® INTEGRATED BUILDING TECHNOLOGY

LOGIX® INSULATED CONCRETE FORMS

SuperForm

BB BuildBlock® INSULATING CONCRETE FORMS

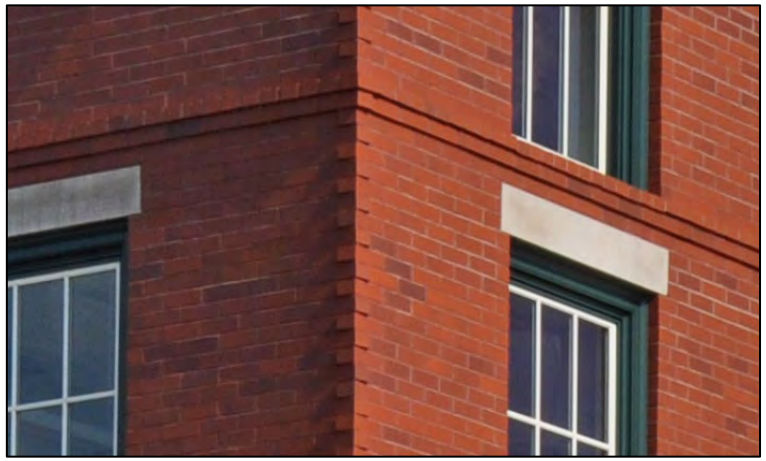
Be Clever... FOX BLOCKS®

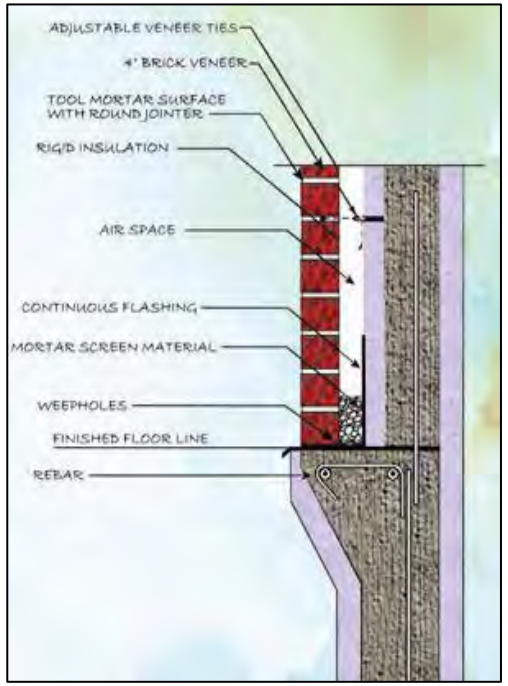
amvic building system

Integra SPEC®

Construction Steps

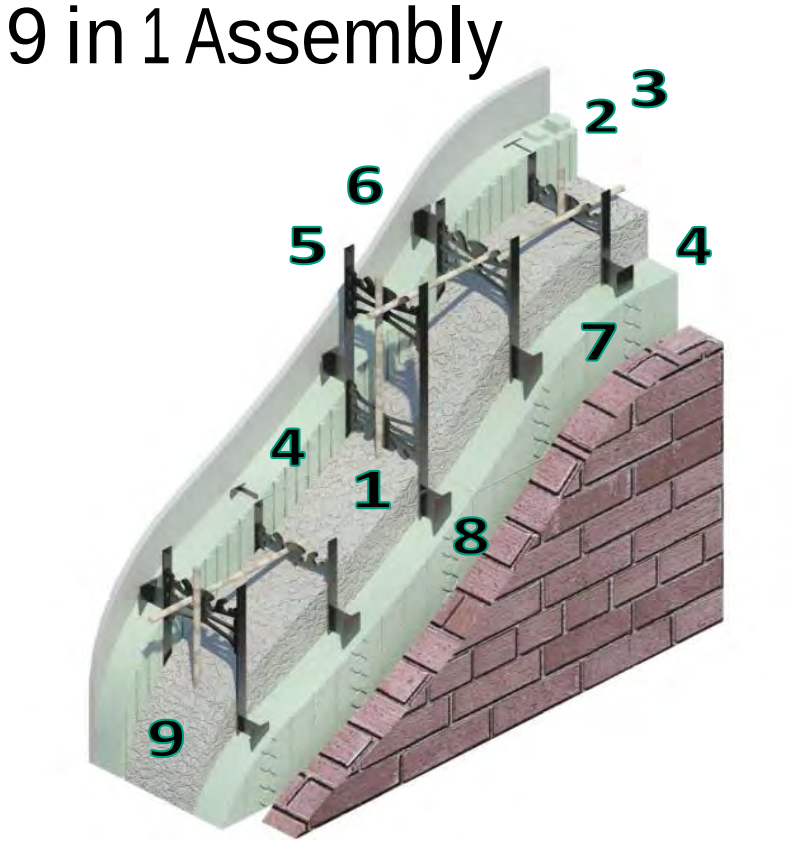
Electrical, Plumbing and Finishes





Combined Functions

1. Concrete form
2. Thermal barrier
3. Air barrier
4. Moisture retarder
5. Fire barrier
6. Sound barrier
7. Substrate for running utilities
8. Furring for attaching finishes
9. Reinforced concrete structure



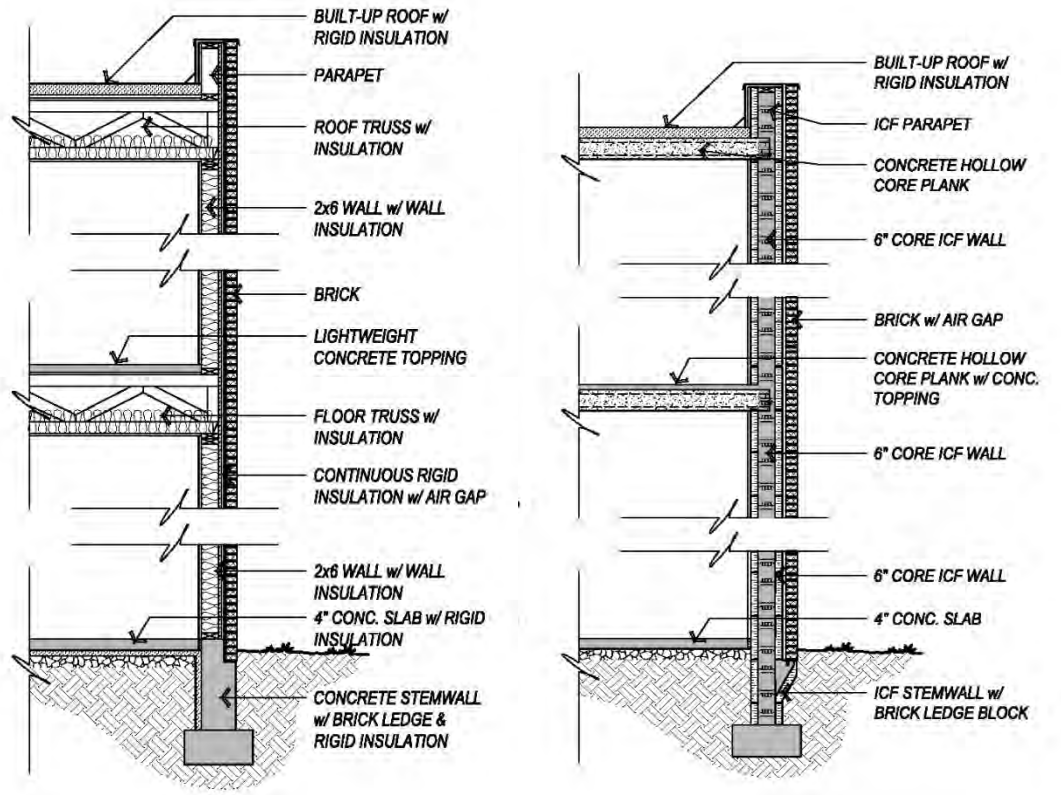
Floor Systems Used with ICFs

- Hollow Core
- Insulating Concrete Floors
- Cast-in-place floors
- Composite Steel
- Steel Joist
- Cold Formed Steel
- Wood Trusses

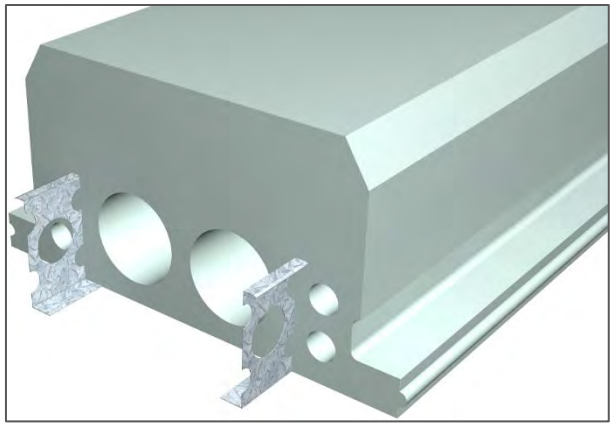
Floors - Hollow Core

Why Hollow-Core?

- Reduced floor heights
  - Reduce exterior finish
- Noise reduction
  - No sound insulation
- Exposed underside
  - Reduce ceiling finish
- Speed of construction
  - No formwork



Insulating Concrete Form Floors

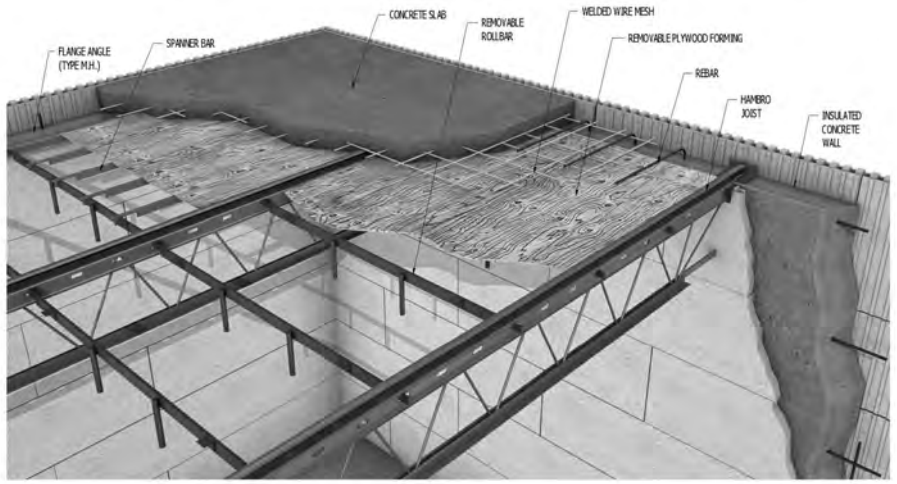


Cast-in-place Systems

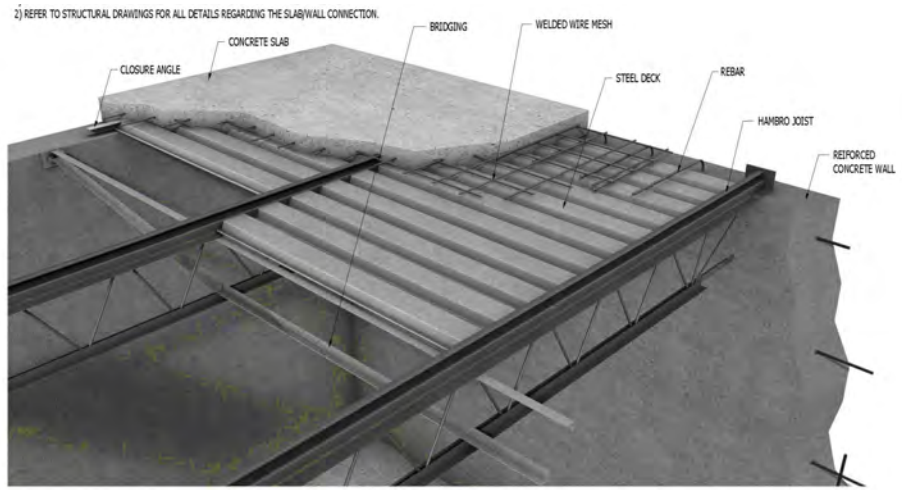
Wide-module Joist

Flat Plate System.

Steel Joists



Wood Forms



Metal Deck

Cold Formed Steel

Unlimited Possibilities

ICF Projects Today

Residential




Commercial




Schools




Low-, Mid- and High-rise

Most Typical Use of ICFs

- Bearing Wall Building
  - Walls carry vertical loads (and lateral loads)
  - Floors span between walls

Considerations For Selecting ICFs

Best Fit:

Long term owner
  - Build and hold/government

- Building Performance is Important
- Punched openings
- Resilience (fire, wind, seismic, flood)

Less Likely:

- Short term owner
  - Build and sell
- Ownership costs/Long term performance not a concern
- Curtain wall

Single Family / Townhomes

Single-family, Bluffdale, UT

Single-family, Possum Kingdom, TX

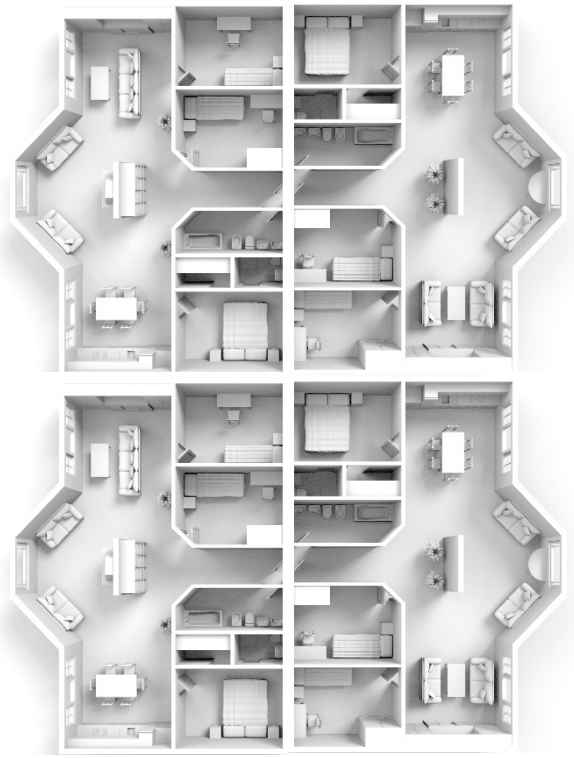
Townhomes, Orlando, FL

Single-family dev., New Paltz, NY

Townhomes, Boone, NC

Single-family home, Fort Worth, TX

One- and Two-Family Dwelling Form



Multifamily Residential

Beach Green North, Rockaway, NY

Walker's Landing, Milwaukee, WI

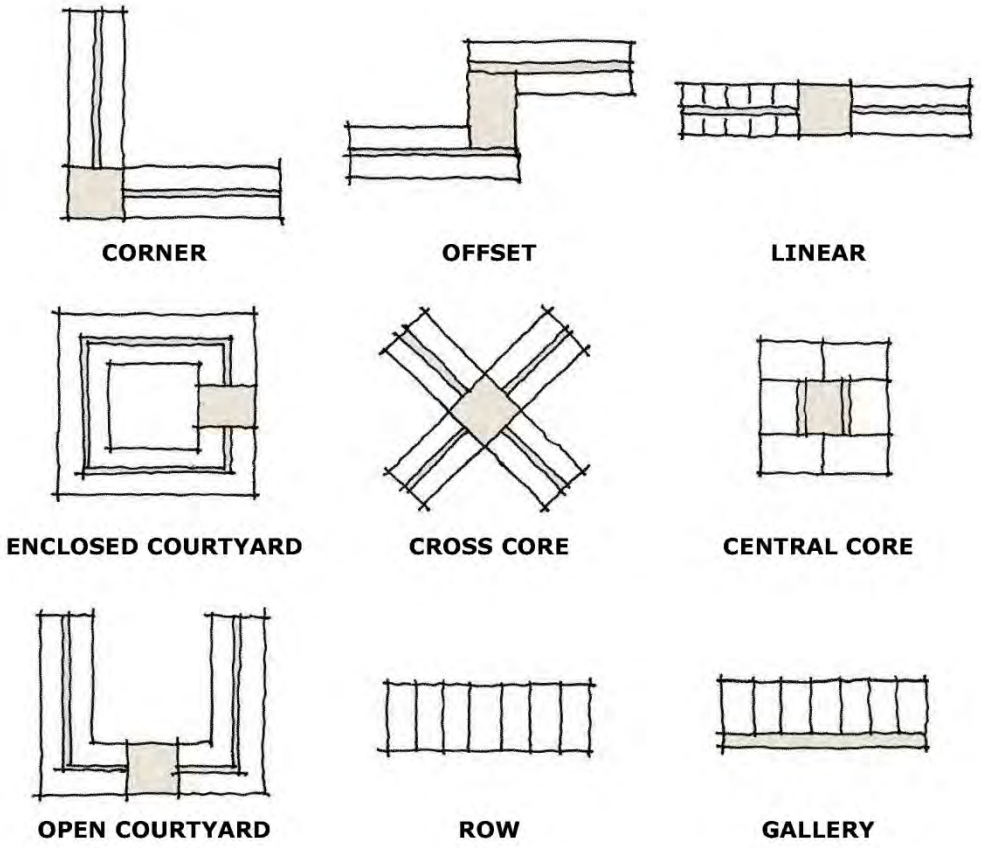
Central Ave Villas, Oklahoma City, OK

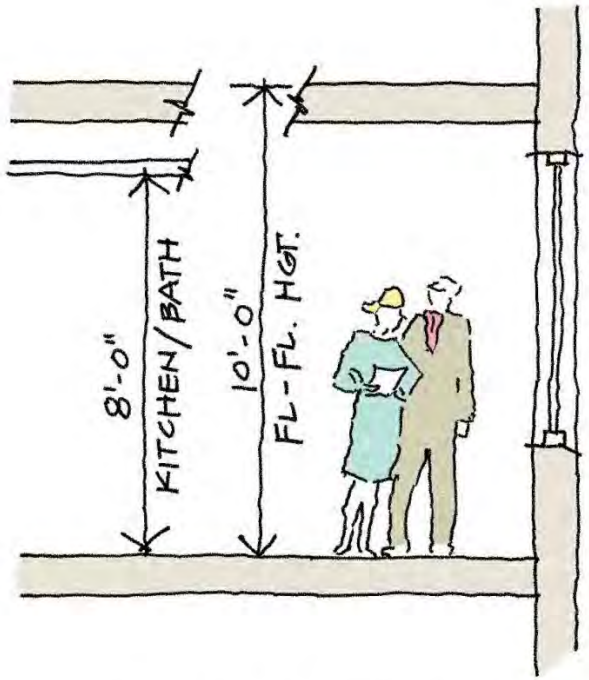
Hilton Garden Inn, Lewisville, TX

Holiday Inn Express, Louisville, KY

Dormitory, Texas Tech, Lubbock, TX

Multifamily Residential Forms





Typical Section

Commercial

Fire Station, Las Vegas, NV

Community Building, Greensburg, KS

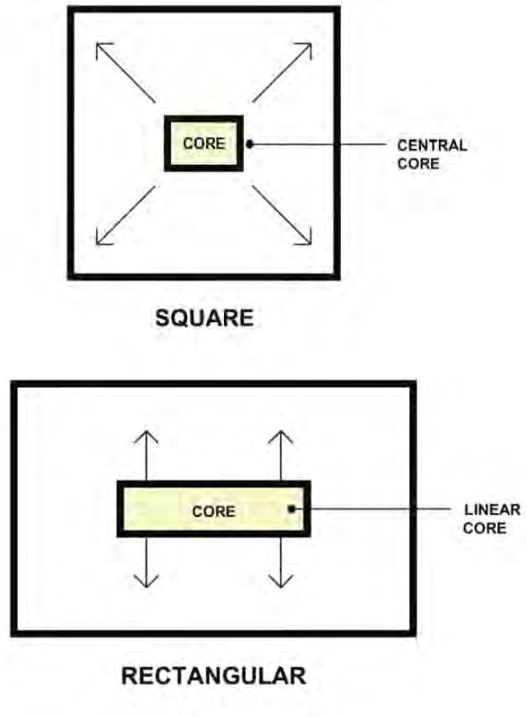
Office Building, Kitchener, Ontario

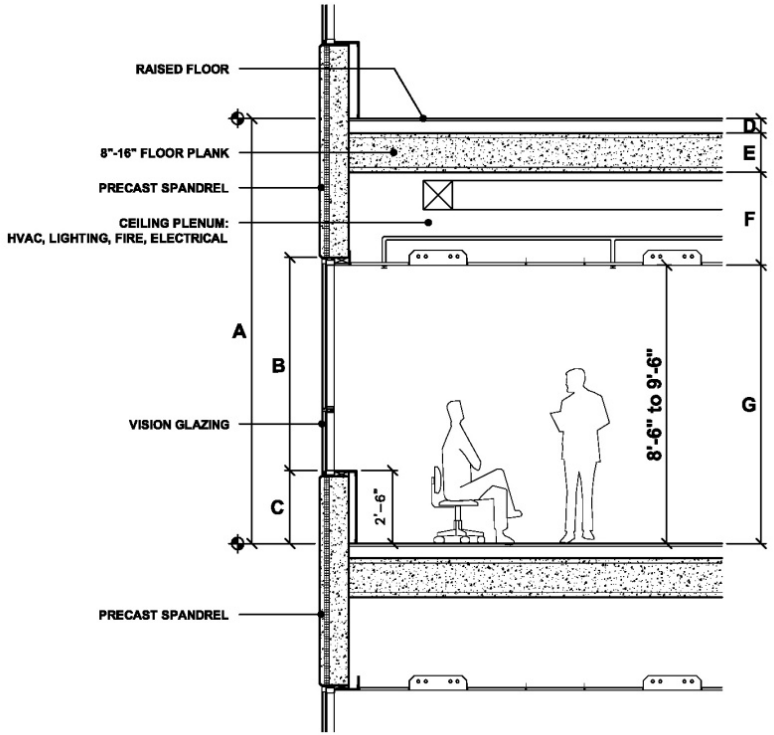
Office Building, Louisville, KY

Winery, Lompoc, CA

Movie Theater, West Valley City, UT

Commercial Forms





Schools

Alamosa Elementary, Alamosa, CO

Discovery Elementary, Arlington, VA

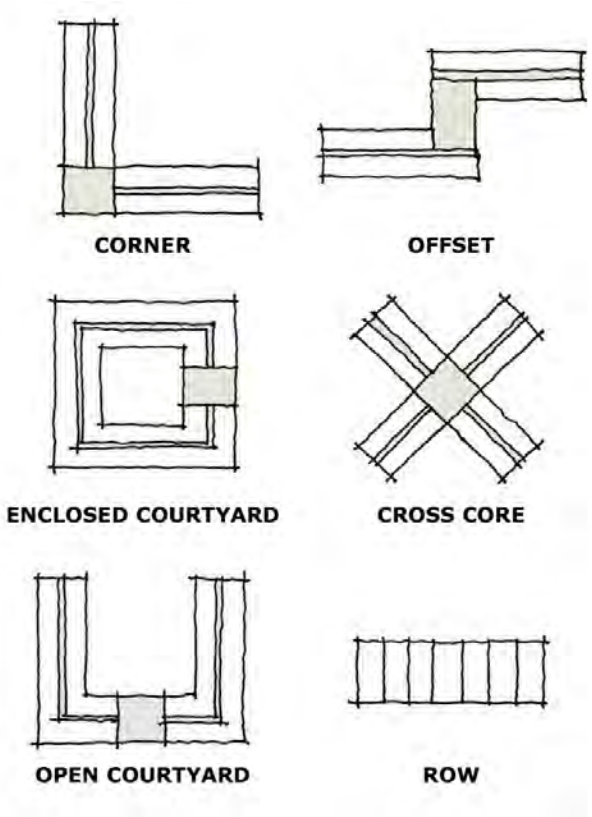
Glasgow HS, Glasgow, KY

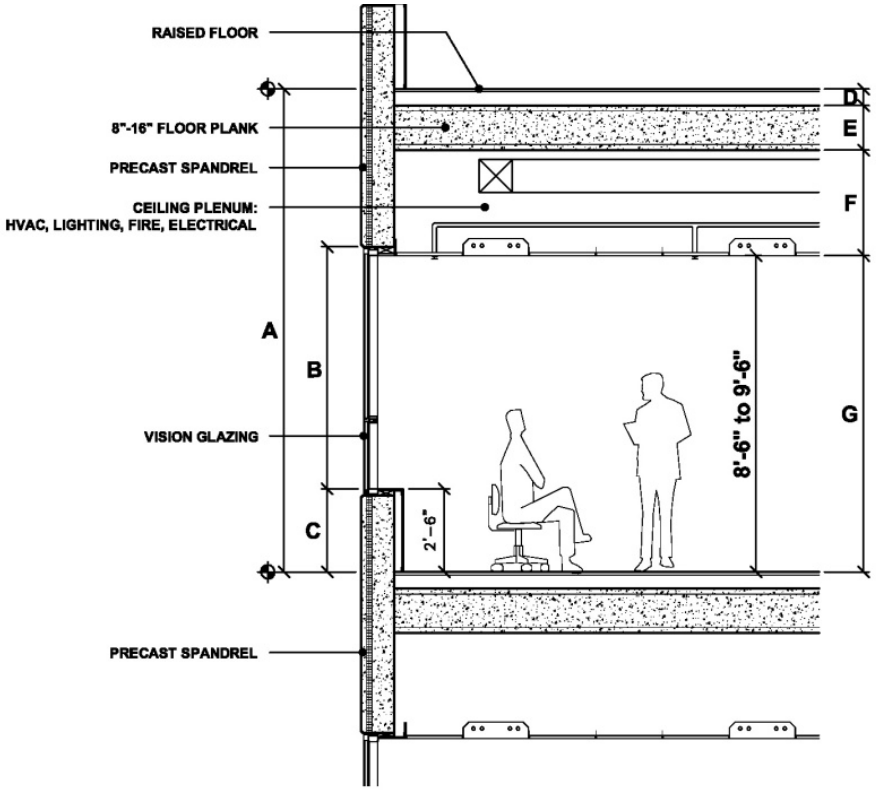
South Warren HS, Bowling Green, KY

Dearing Elementary, Round Rock, TX

Nola Dunn Academy, Burleson, TX

Educational Forms

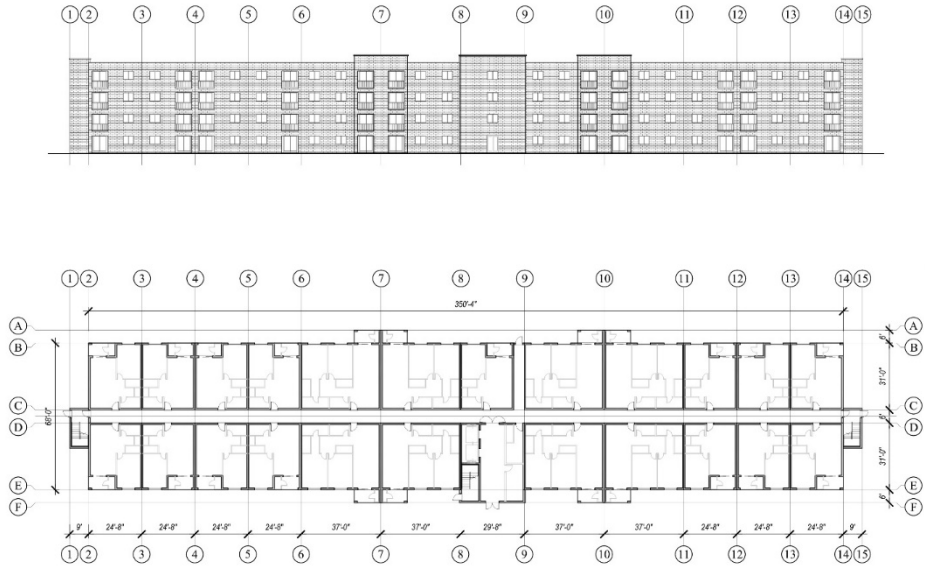


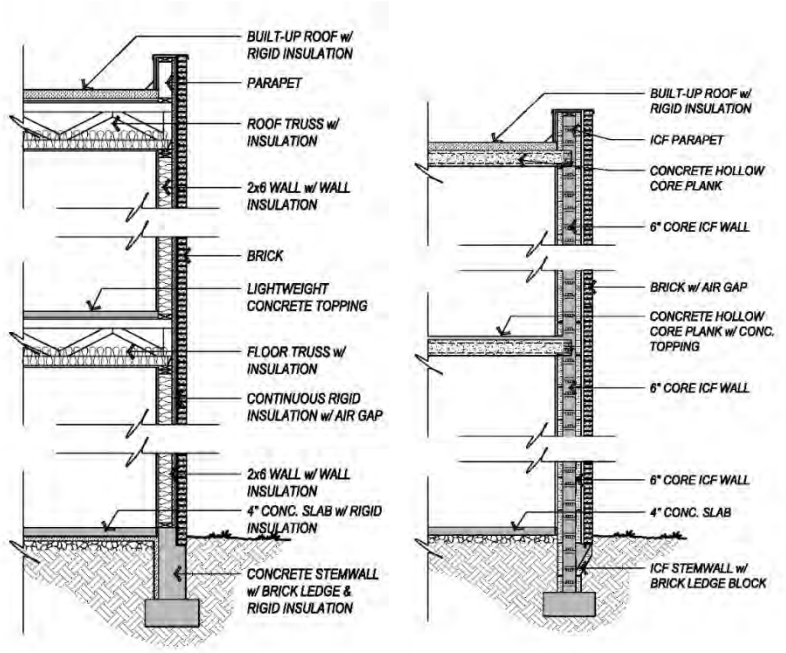


Why Select ICFs?
Low Cost

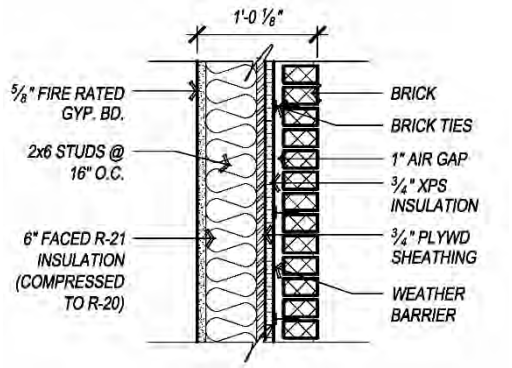
Combustible: **$14,812,194**

Non-Combustible: **$14,818,984**





ICF Energy Savings Vs. Wood



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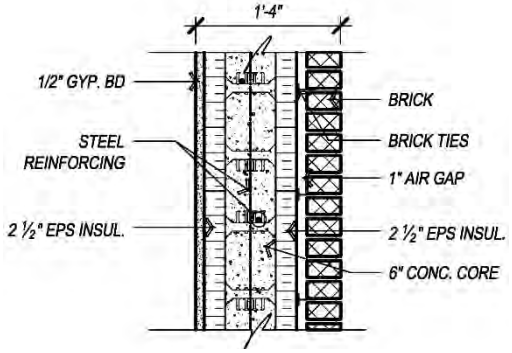

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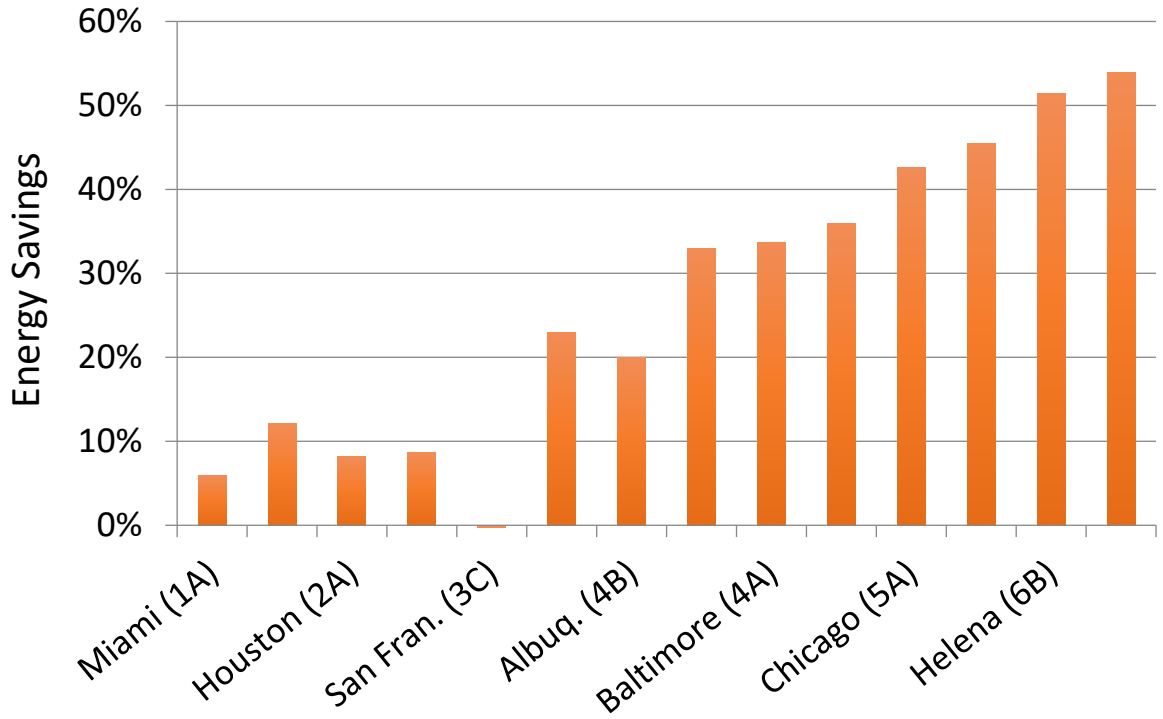
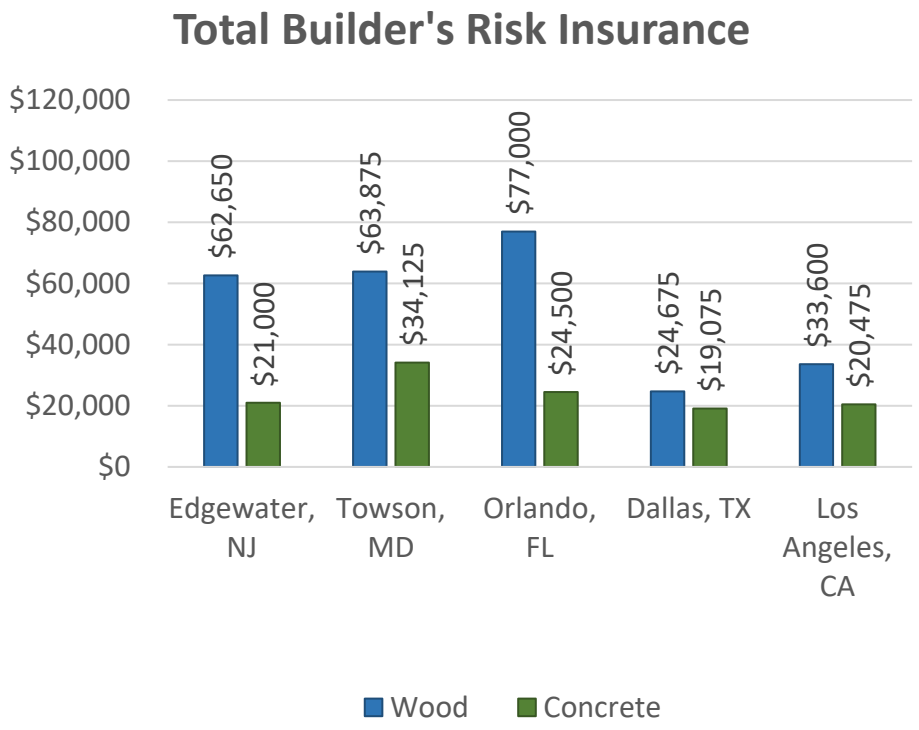
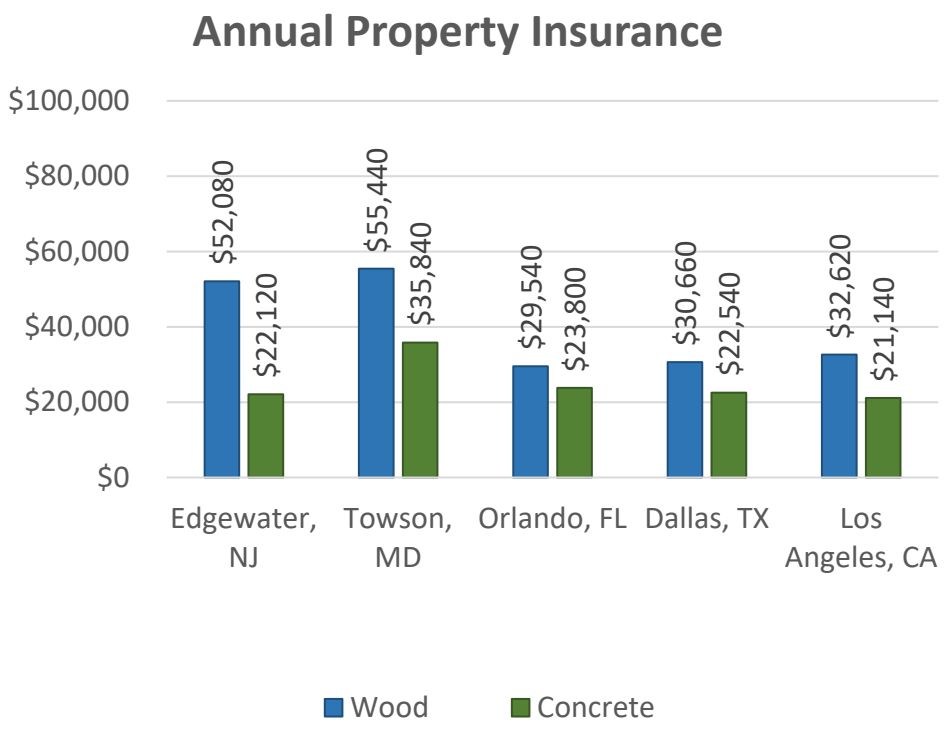


Thermal Mass Energy Savings

Source: Mapping Thermal Mass Benefit, MIT Concrete Sustainability Hub

ICFs Reduce Insurance Costs





ICFs Reduce Insurance Costs

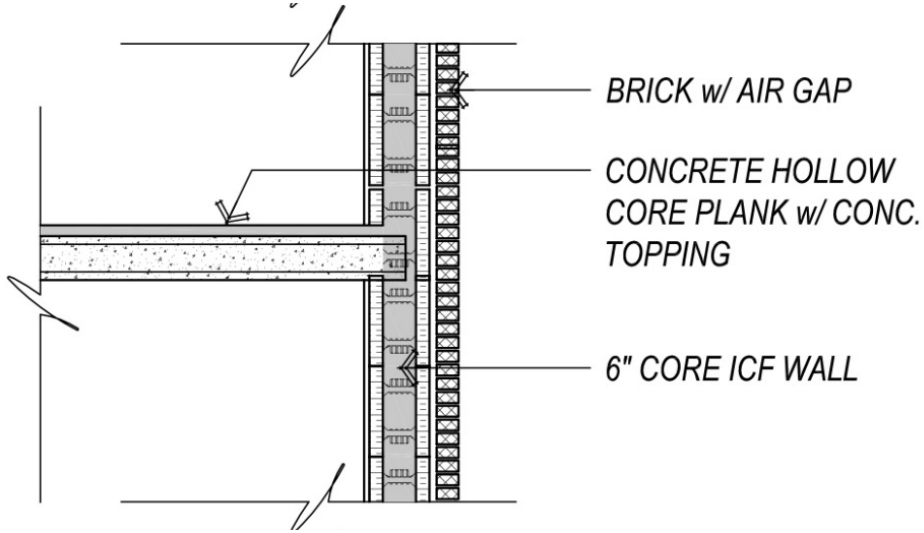
10-YEAR COST ANALYSIS

	2-YEAR TOTAL PREMIUM	COMPLETED BUILDING PREMIUM								TOTAL 10-YEAR COST
$40M PROJECT	**BUILDERS RISK**	**YEAR 1**	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	**YEAR 6**	**YEAR 7**	**YEAR 8**	**TOTAL**
Frame Construction	***$ 240,000*** *(0.30-0.35 cents)*	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	**$840,000**
Concrete Construction	***$ 40,000*** *(0.05-0.07 cents)*	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	**$440,000**

BKS PARTNERS | ROSENTHAL BROTHERS REthinking insurance

ICFs are Quiet = Reduce Losses on Vacancy

- Walls
  - STC: 55-70
- Floor
  - STC: 50+
  - IIC: 50+



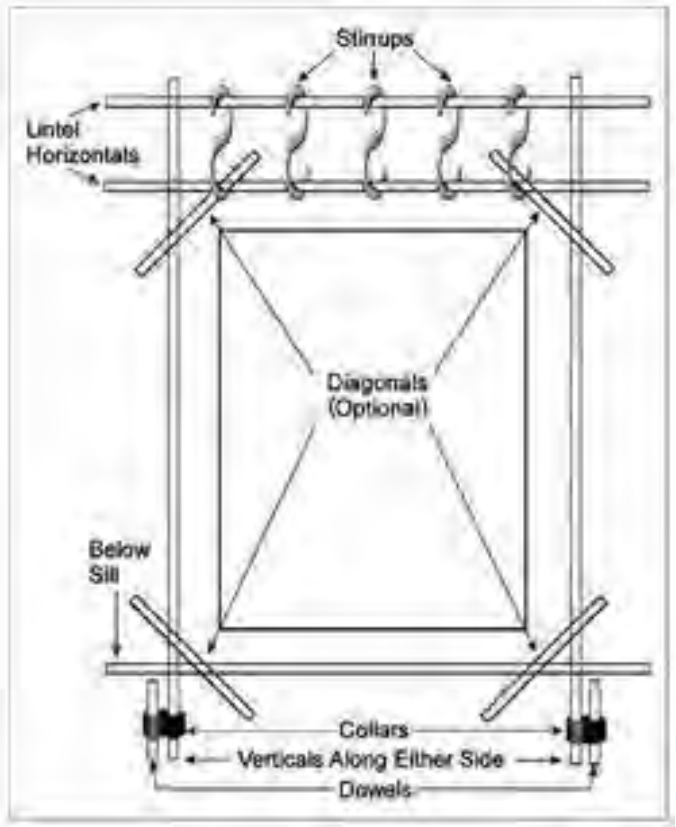
Increased Revenues for Owner

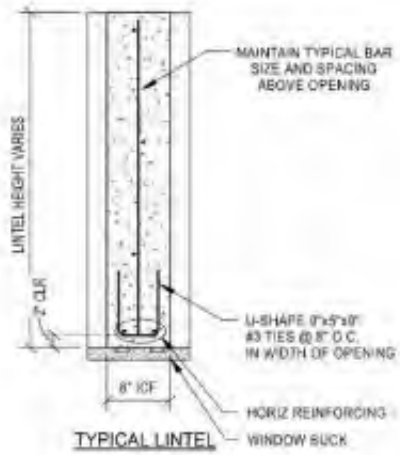
	Individual Metered		Master Metered	
	Wood	Concrete	Wood	Concrete
Revenues				
Gross Potential Rent	1447000	1447000	1740000	1740000
Losses to Vacancy	78000	54600	78000	54600
Collection Losses	9000	9000	7000	7000
Losses to Concessions	15000	15000	15000	15000
Other Revenue	84000	84000	90000	90000
Total Revenue	**1429000**	**1452400**	**1730000**	**1753400**
Operating Expenses				
Salaries and Personnel	137000	137000	173000	173000
Insurance	28000	16800	31000	18600
Taxes	169000	169000	158000	158000
Utilities	35000	28000	104000	83200
Management Fees	39000	39000	59000	59000
Administration	28000	28000	38000	38000
Marketing	19000	19000	18000	18000
Contract Services	38000	38000	52000	52000
Repair and Maintenance	52000	52000	81000	81000
Total Operating Expenses	**545000**	**526800**	**714000**	**680800**
Net Operating Income	**884000**	**925600**	**1016000**	**1072600**

Speed – Fewer Delays

- Build through winter.
- Place floor slabs 3-7 days after a wall pour.
- Finishes can be attached to interior and exterior forms.
- Install windows while superstructure is being built

Details for Openings



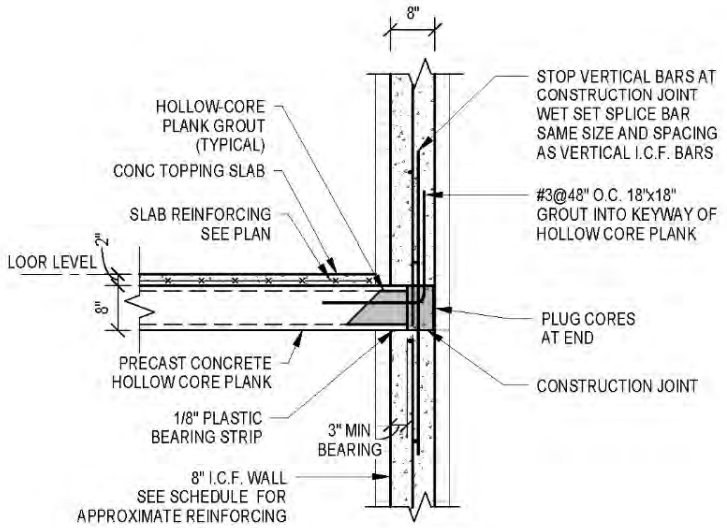


LINTEL SCHEDULE			
OPENING SPAN LIMIT	HORIZ REINFORCING	JAMB REINFORCING EACH SIDE OF OPENING	STIRRUPS
0" TO 8'-0"	(2) #5	(2) #5 @ 4" O.C.	—
8'-1" TO 16'-0"	(2) #5 TOP (2) #7 BOT	(3) #5 @ 4" O.C.	#3 1@2", R@12" AT EACH END

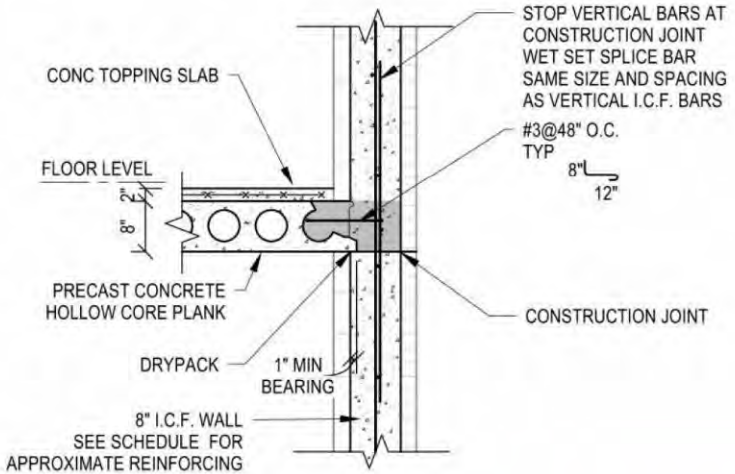
TYPICAL I.C.F.WALL LINTEL SCHEDULE

Courtesy of Brown + Kubican

Concrete Plank-Wall Intersection



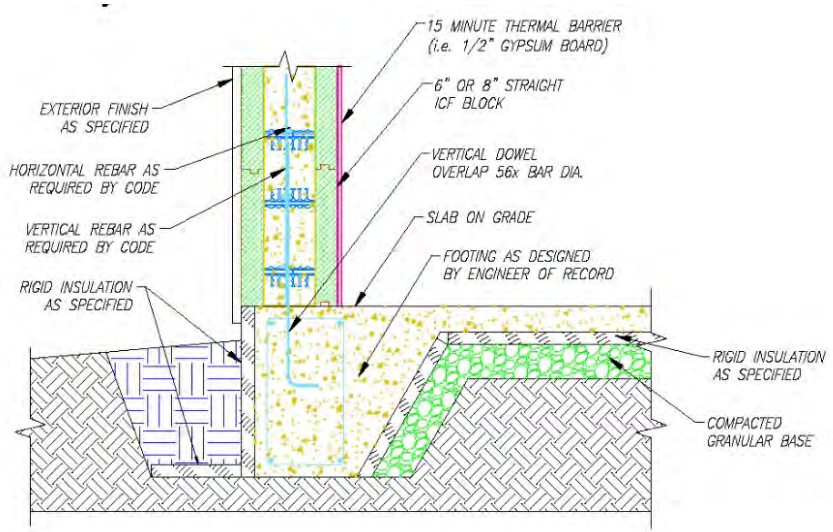
TYPICAL PRECAST PLANK BEARING ON I.C.F.WALL

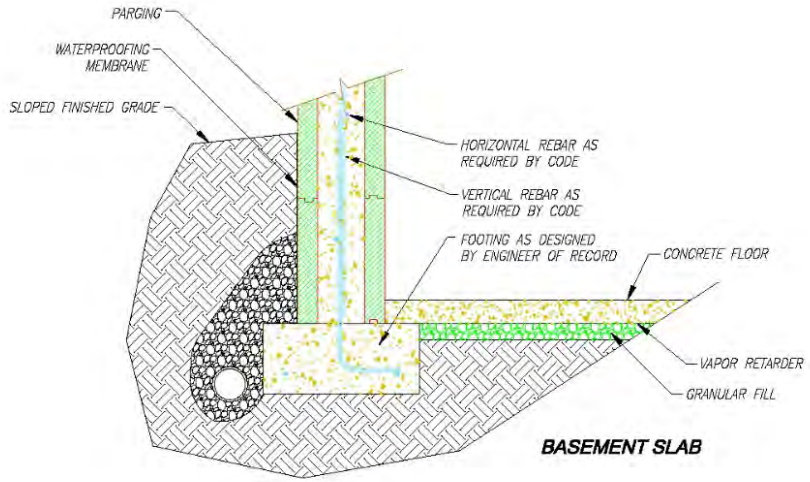


TYPICAL PRECAST PLANK PARALLEL TO I.C.F.WALL

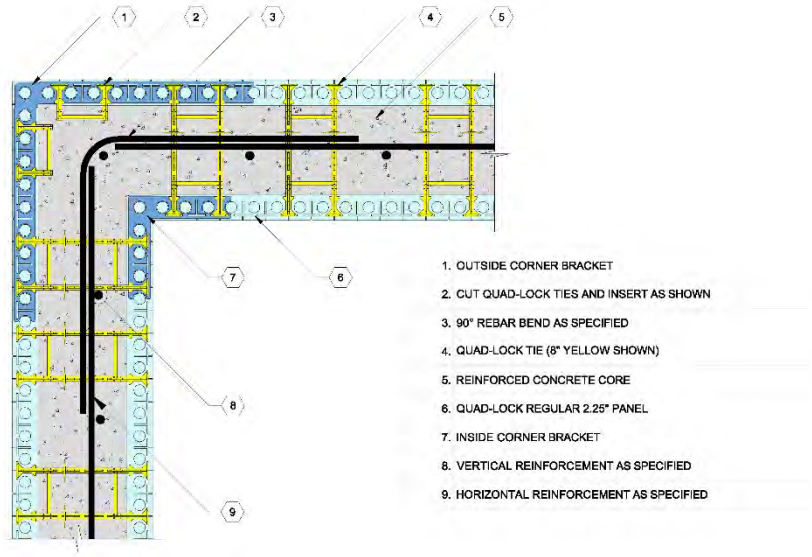
Courtesy of Brown + Kubican

Foundation Details

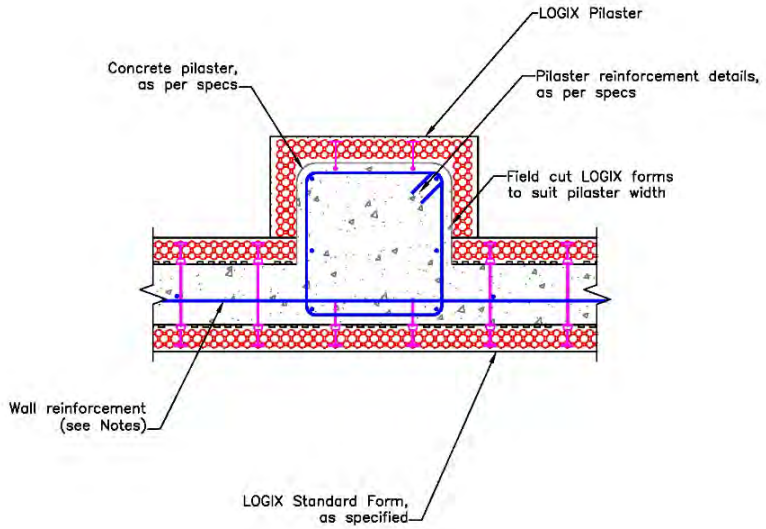




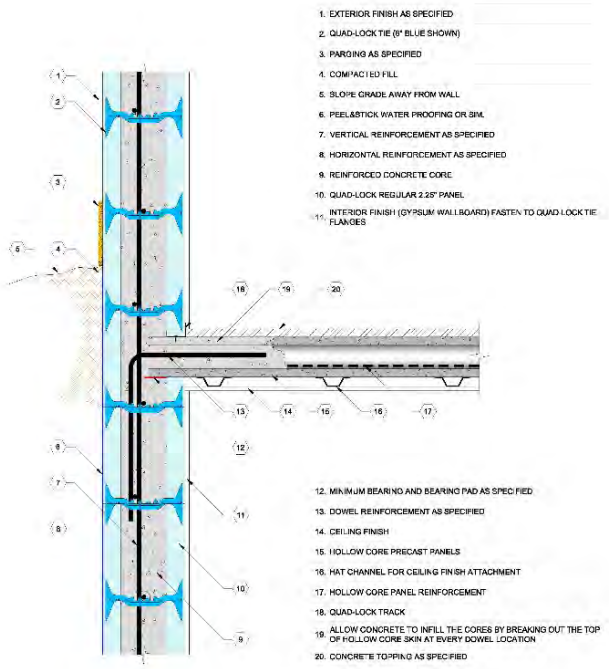
Corner/Pilaster Details

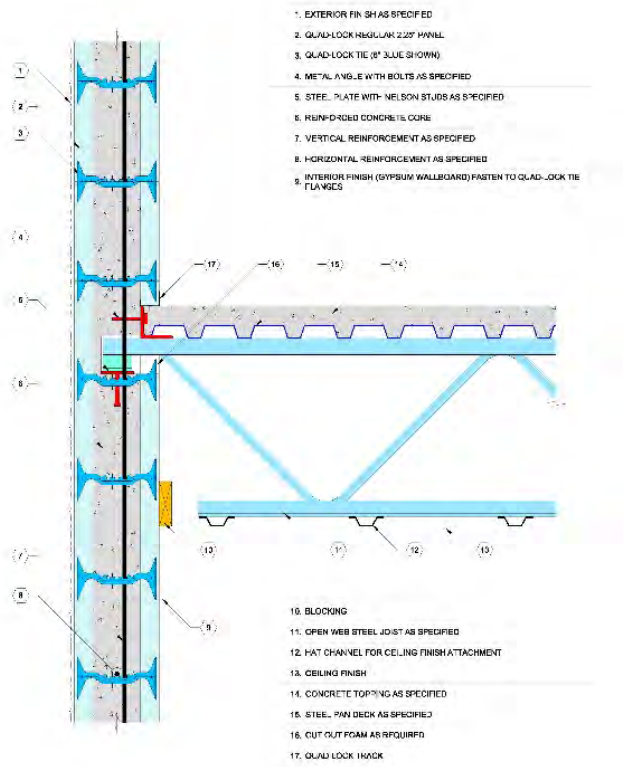


1. OUTSIDE CORNER BRACKET
2. CUT QUAD-LOCK TIES AND INSERT AS SHOWN
3. 90° REBAR BEND AS SPECIFIED
4. QUAD-LOCK TIE (8" YELLOW SHOWN)
5. REINFORCED CONCRETE CORE
6. QUAD-LOCK REGULAR 2.25" PANEL
7. INSIDE CORNER BRACKET
8. VERTICAL REINFORCEMENT AS SPECIFIED
9. HORIZONTAL REINFORCEMENT AS SPECIFIED

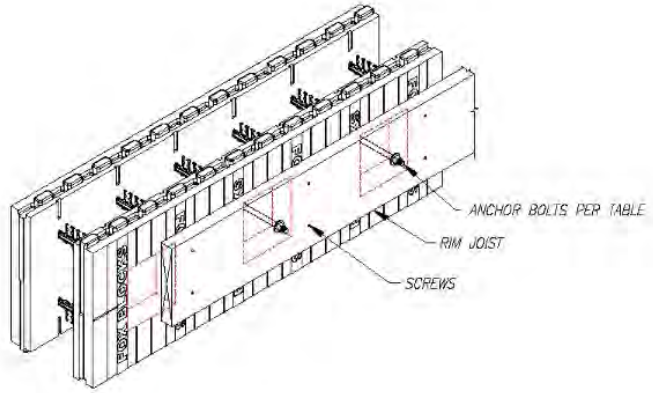


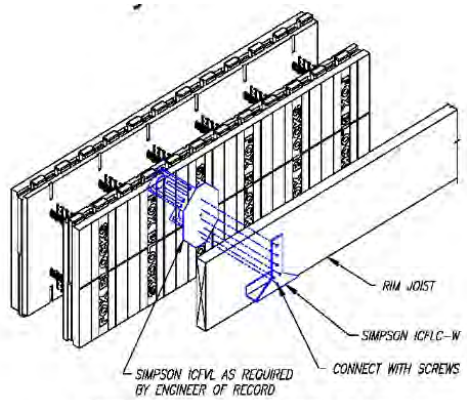
Joist and Composite Slab Details



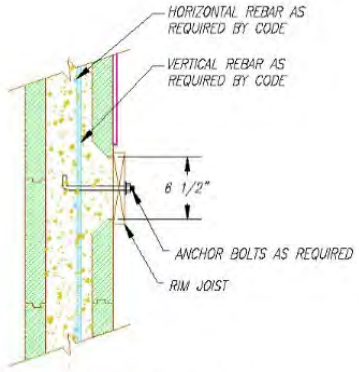


Ledger Details

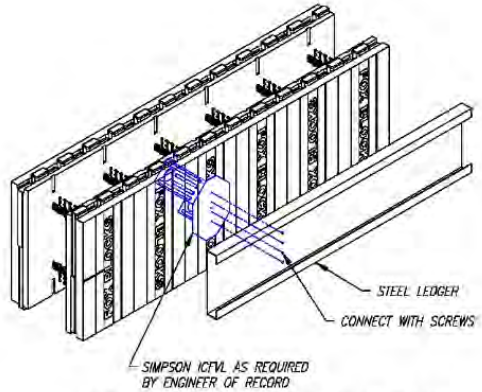




WOOD LEDGER INSTALLATION



WALL SECTION



STEEL LEDGER INSTALLATION

LEDGER DETAIL

Sustainability

How can ICF’s facilitate sustainable concrete?

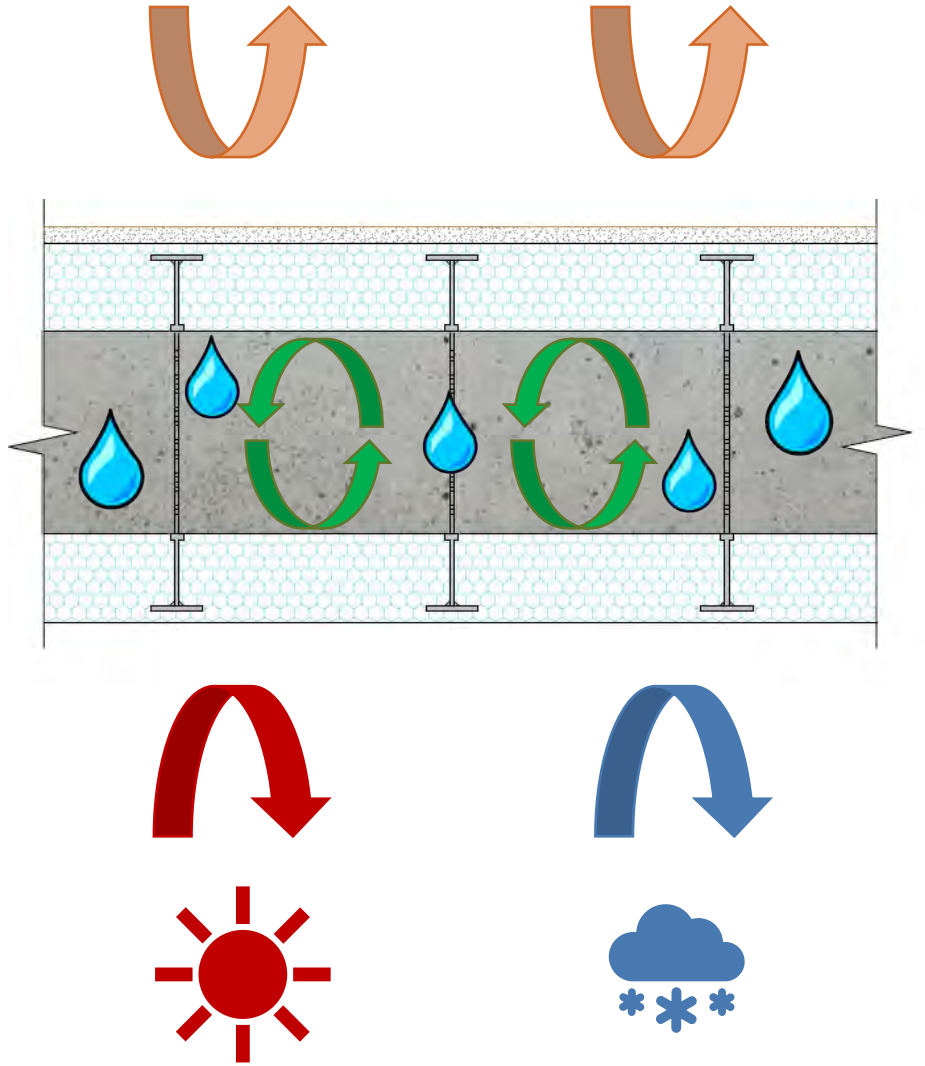
ICF and Sustainable Concrete

Curing of Concrete 101:

- Prevent moisture loss
- Maintain/elevate internal temperature

Inherent ICF Benefits:

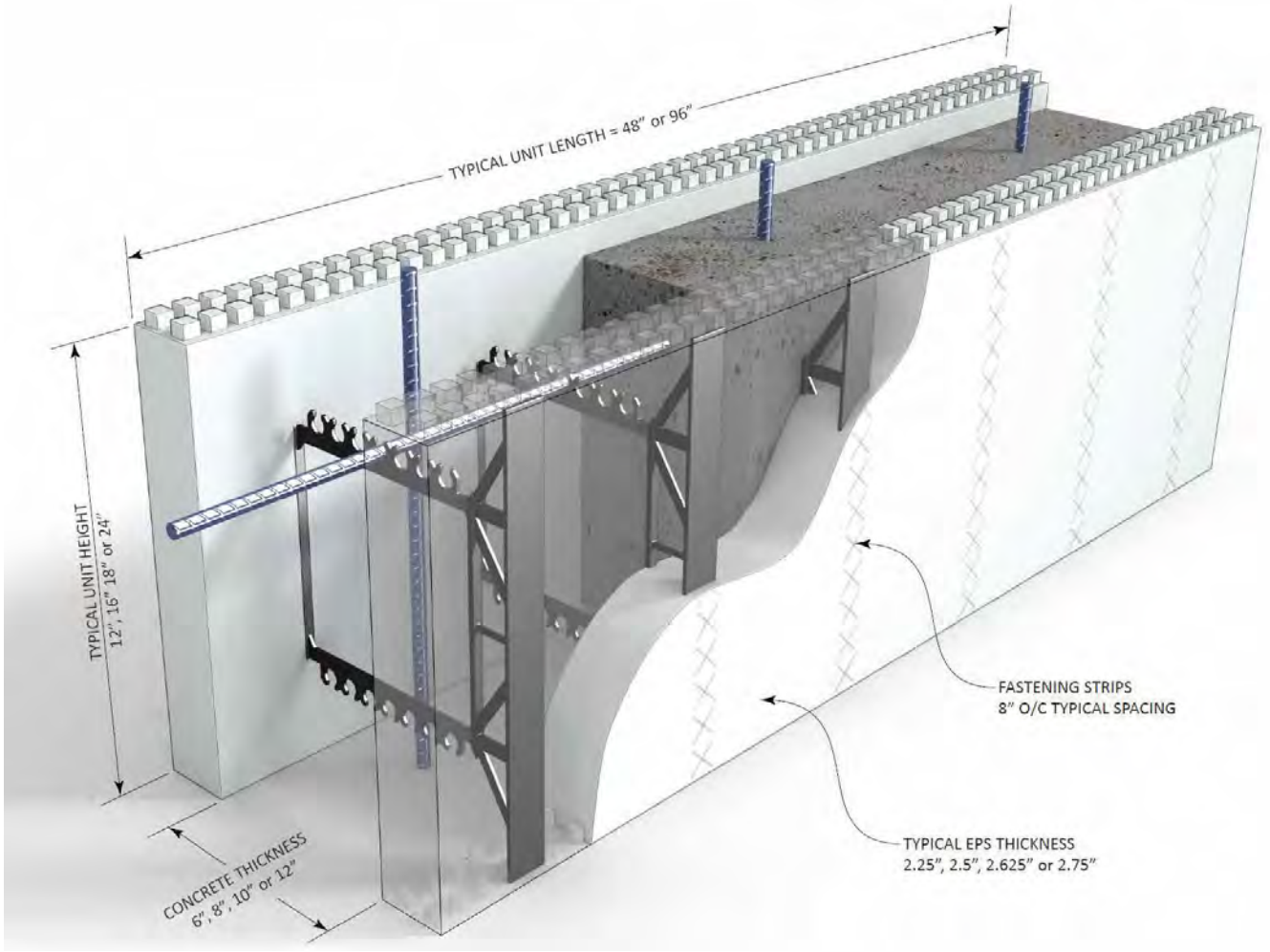
- Moisture vapor retarder
- Insulating



ICF and Sustainable Concrete

Result:

- Optimal curing environment
- Improved cementitious efficiency
  - psi/lb increase
- Opportunity for reducing cementitious demand
  - Lower cementitious content
  - Improve sustainability



Embodied Carbon of Concrete Constituents

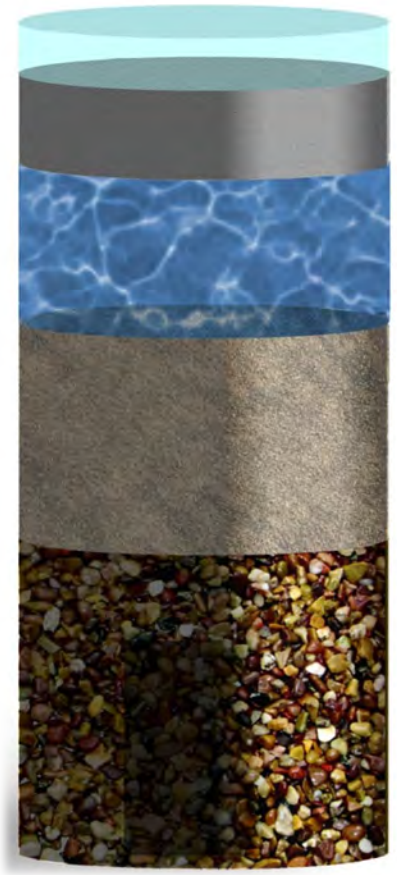
Volume (%)

Air: 2%

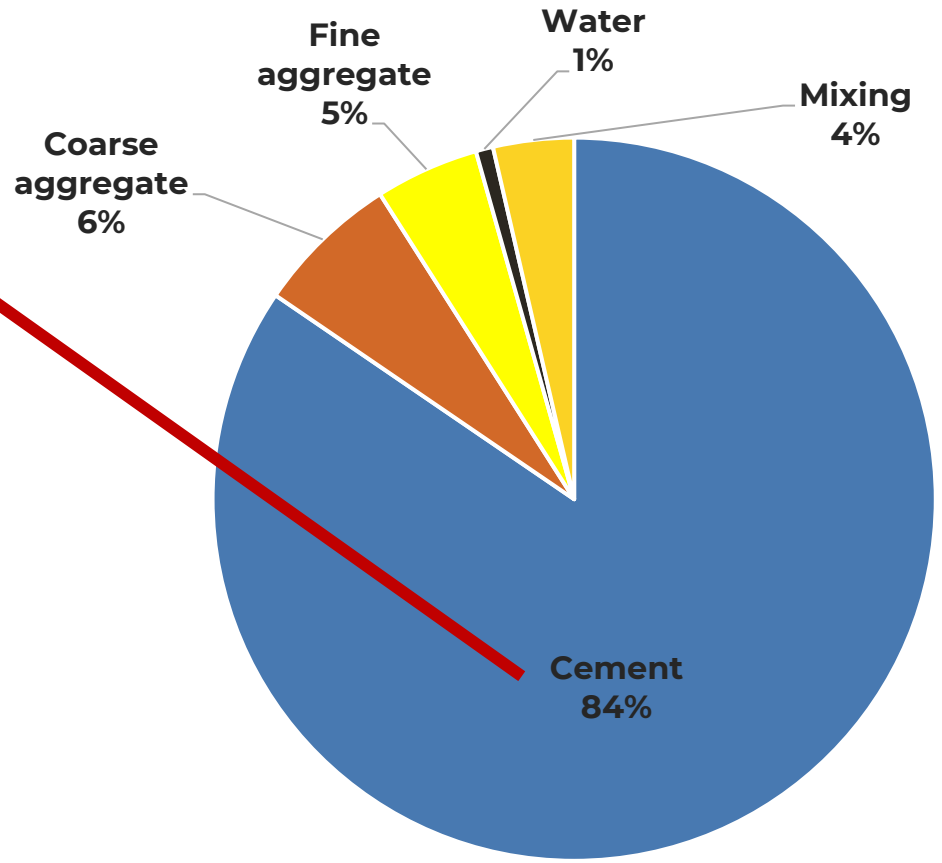
Cement: 10%

Water: 18%

Aggregate: 70%



Carbon Impact (%)

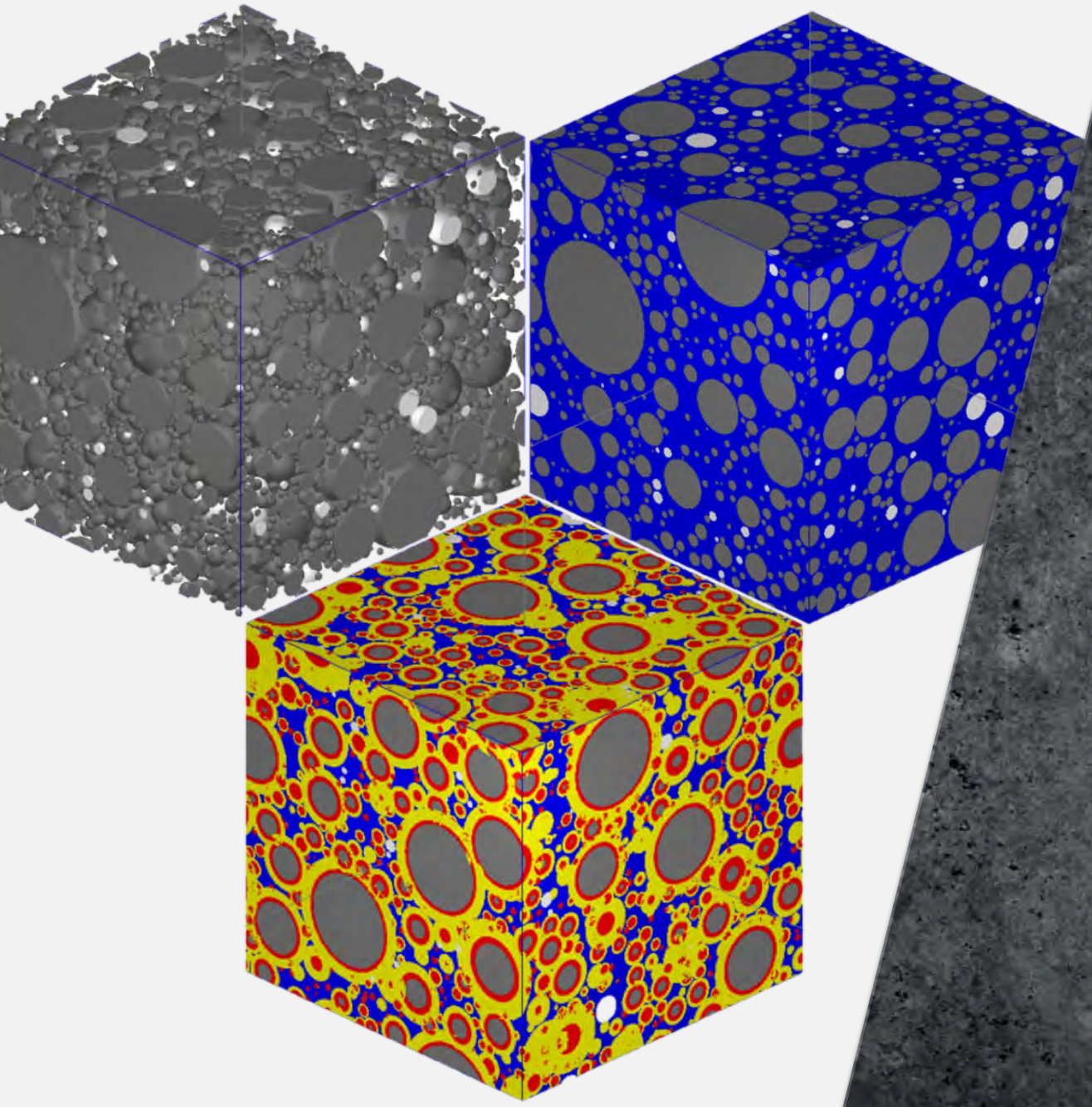


4000 psi mixture with no SCMs

The Top 10 Ways
To Reduce Concrete's Carbon Footprint

1. Communicate Carbon Reduction Goals
2. Ensure Good Quality Control and Assurance
3. Optimize Concrete Design
4. Specify Innovative Cements
5. Specify Supplementary Cementitious Materials
6. Specify Admixtures
7. Don't Limit Ingredients
8. Set Targets for Carbon Footprint
9. Sequester Carbon Dioxide in Concrete
10. Encourage Innovation

www.structuremag.org/?p=20310
www.BuildWithStrength.com



Strategy:

Specify Innovative Cements

- ASTM C595 Blended Cements
- ASTM C1157 Performance Based Cements

Strategy:

Specify Supplementary Cementitious Materials

ICF and Supplemental Cementitious Materials

SCM Usage:

- Reduce cement = improved sustainability
- Common limitations:
  - Environmental Conditions
  - Fast-paced schedules

Solution: ICF!

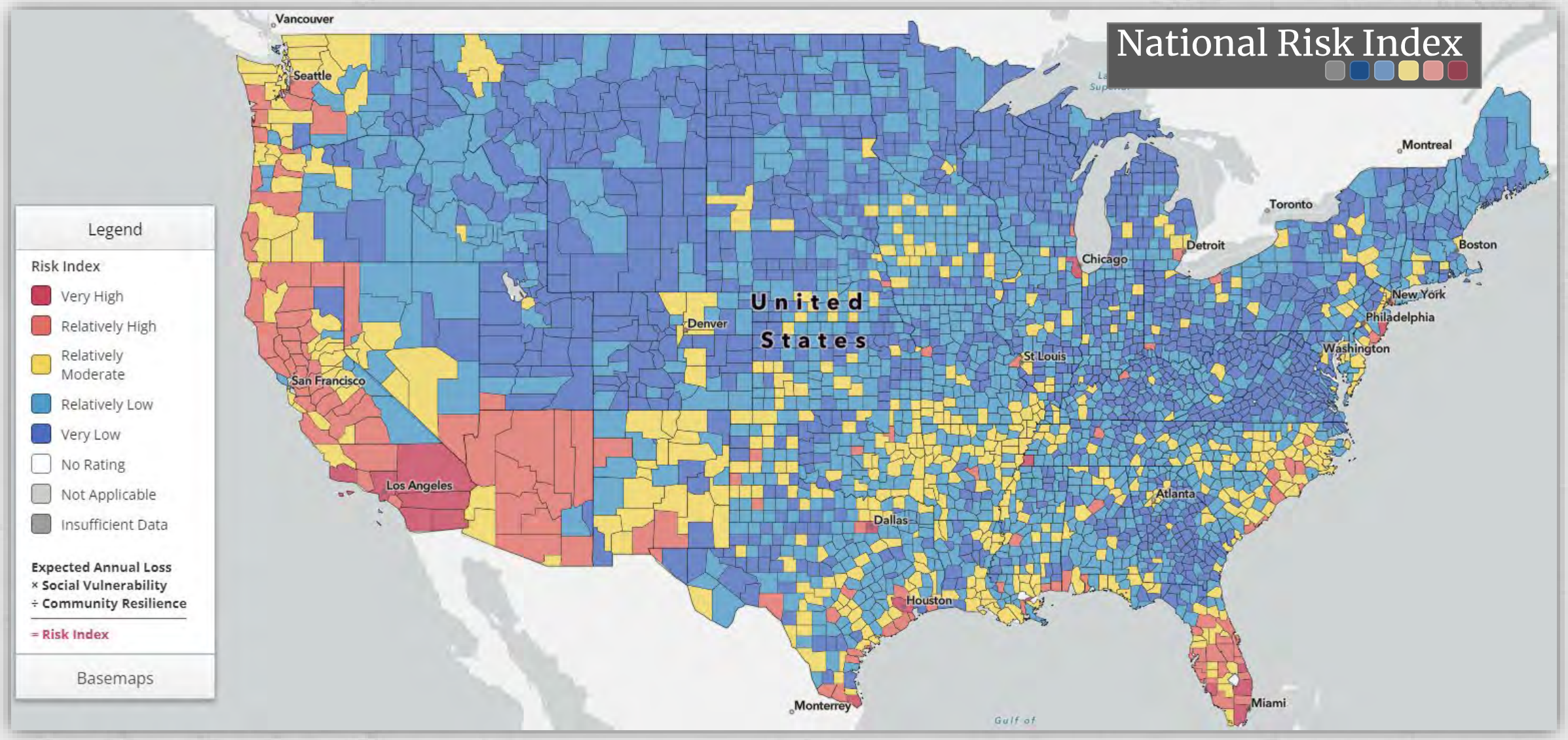
Overdesign:
Closer to 8,000 psi @ 56 days

Resiliency:

Performance Assessment of Structural Materials

National Risk Index

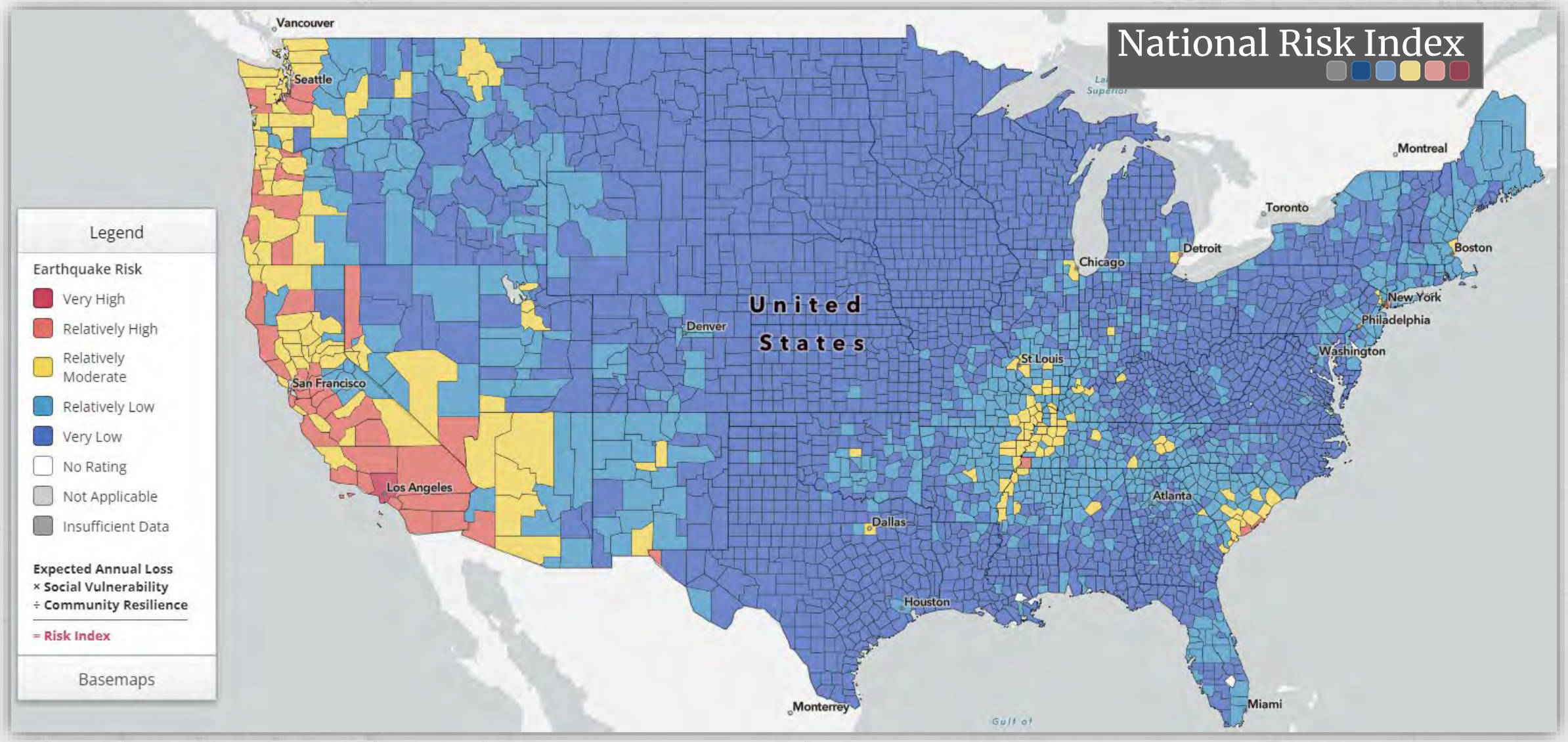
FEMA



Source: FEMA National Risk Index Map - https://hazards.fema.gov/nri/

NRI – Earthquake

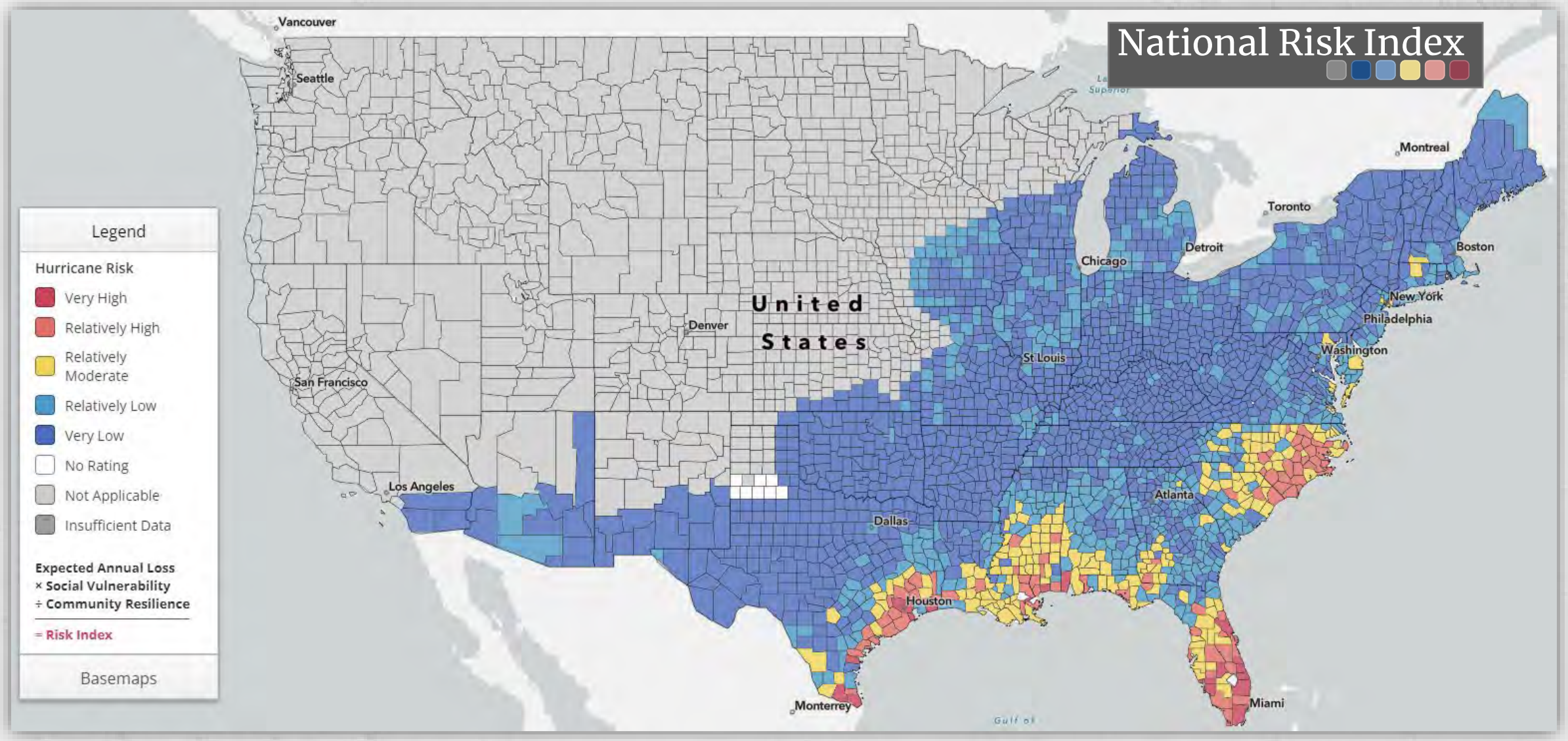
FEMA



Source: FEMA National Risk Index Map - https://hazards.fema.gov/nri/

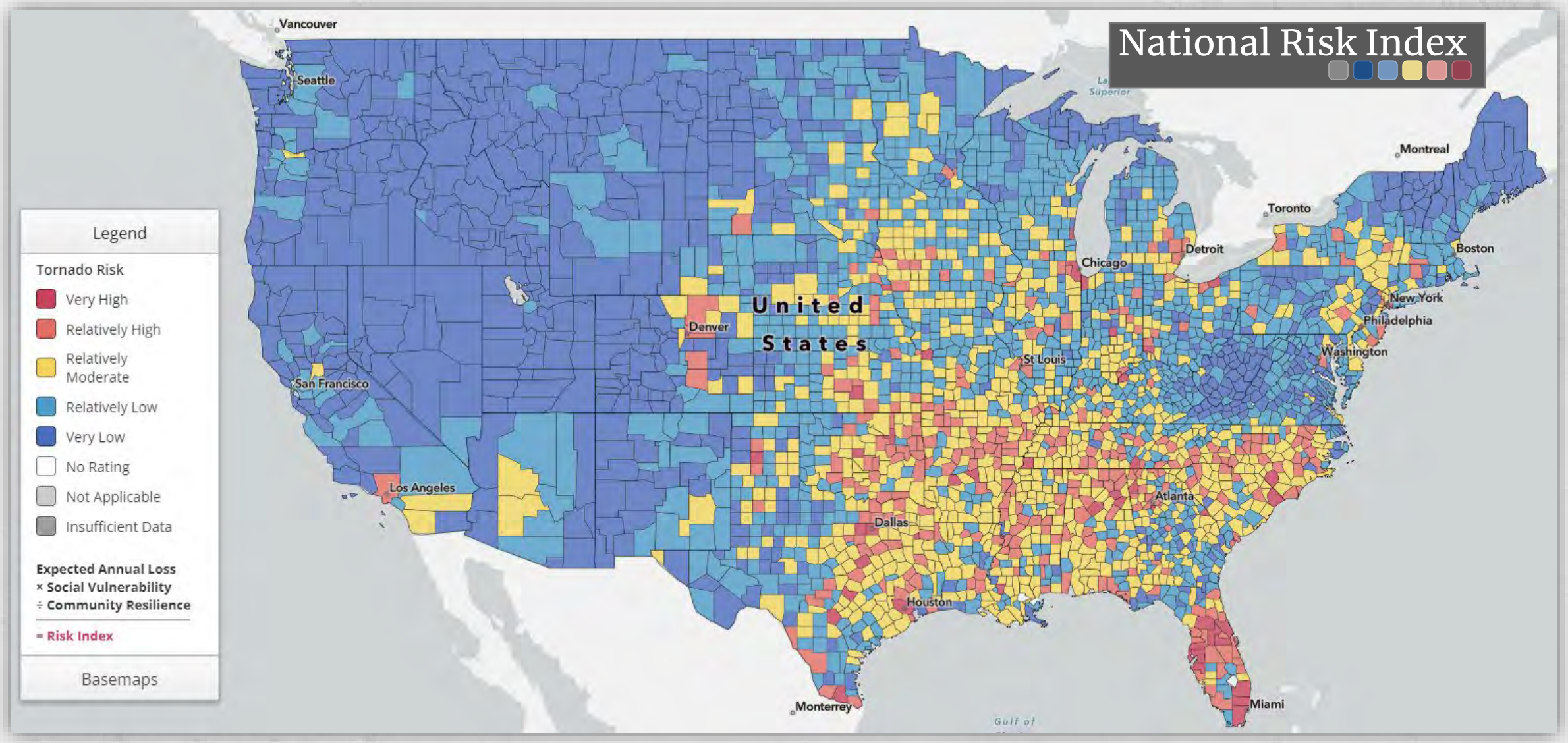
NRI – Hurricane

FEMA



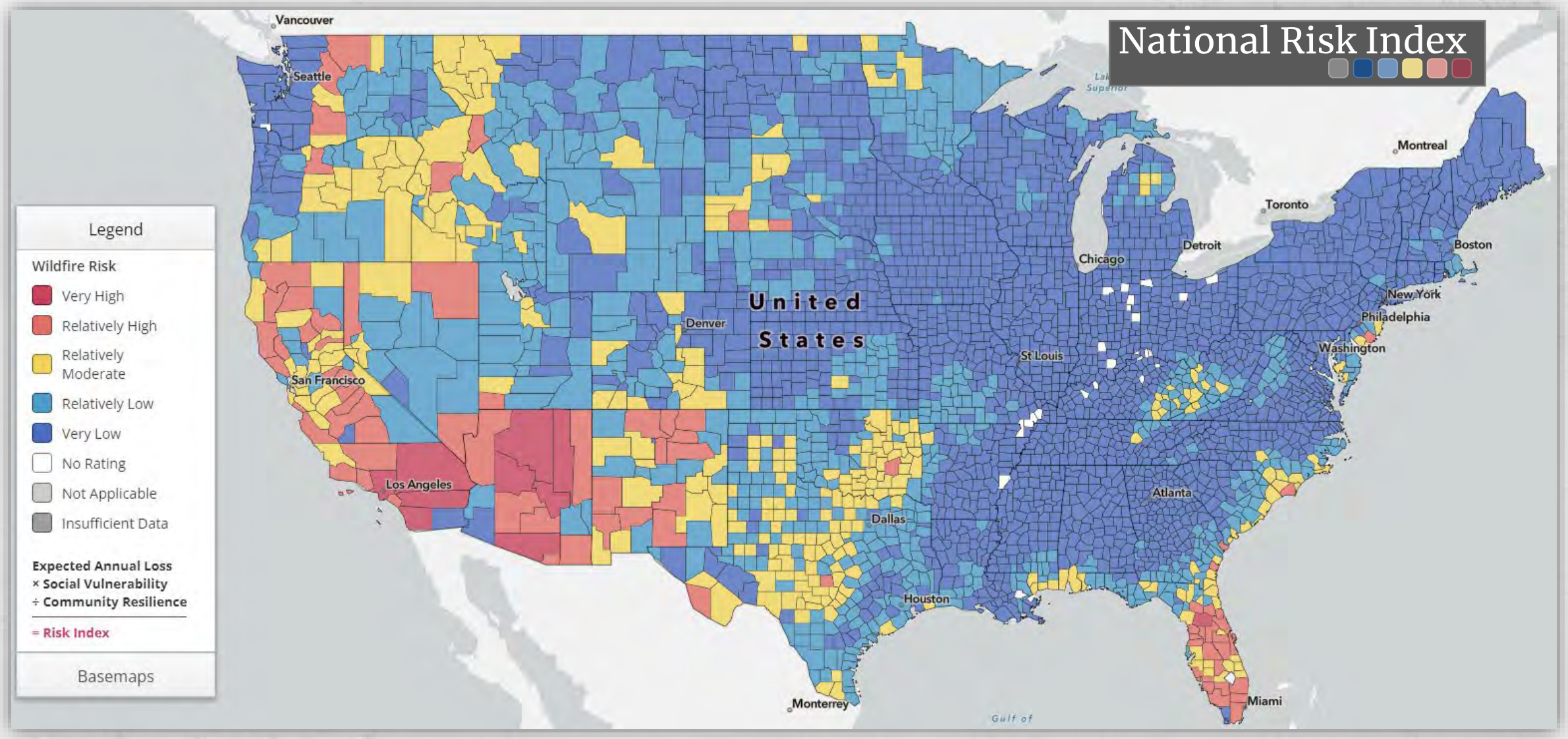
Source: FEMA National Risk Index Map - https://hazards.fema.gov/nri/

NRI – Tornado



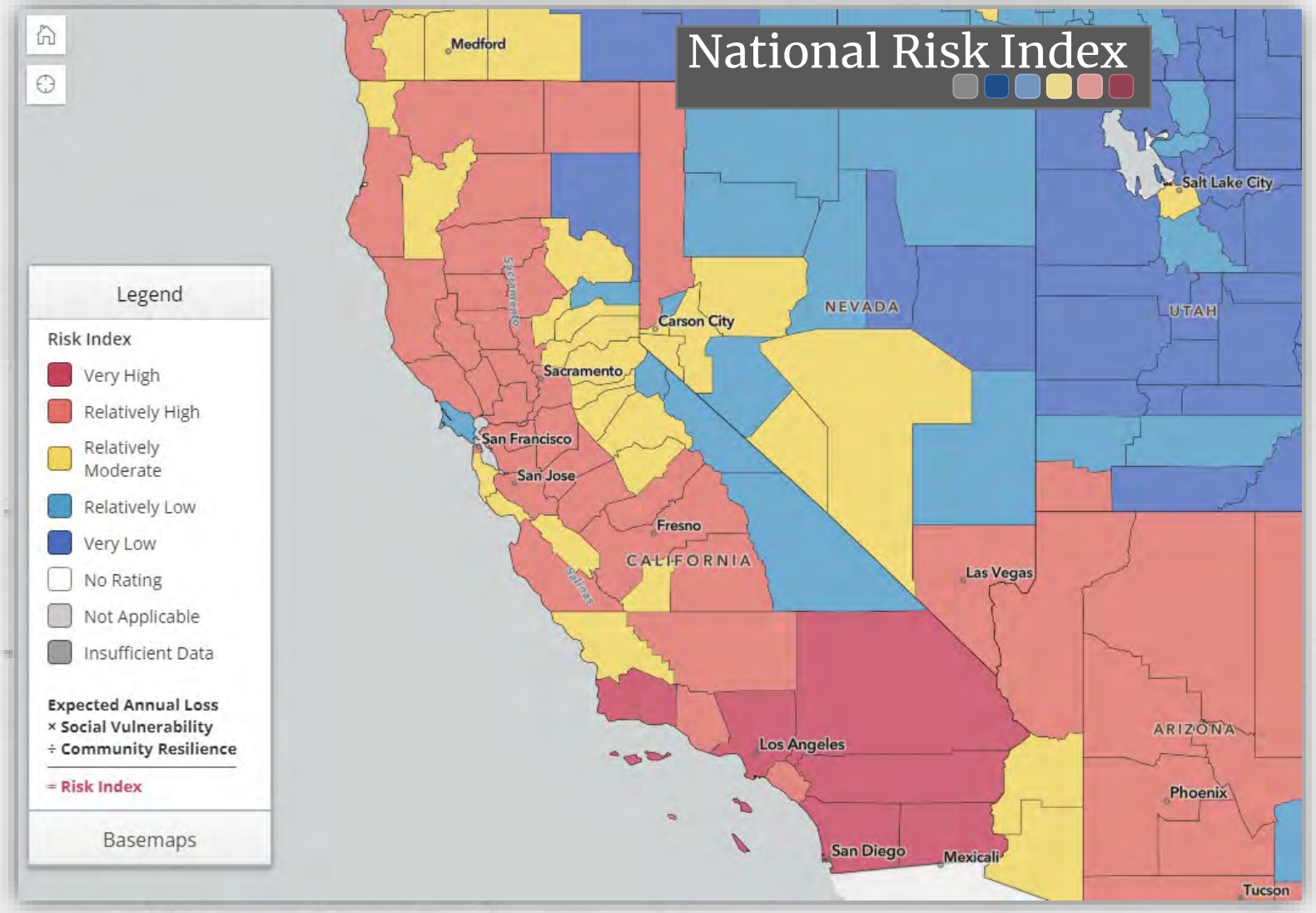
Source: FEMA National Risk Index Map - https://hazards.fema.gov/nri/

NRI – Wildfire



Source: FEMA National Risk Index Map - https://hazards.fema.gov/nri/

Why Resiliency?



California
LA County:

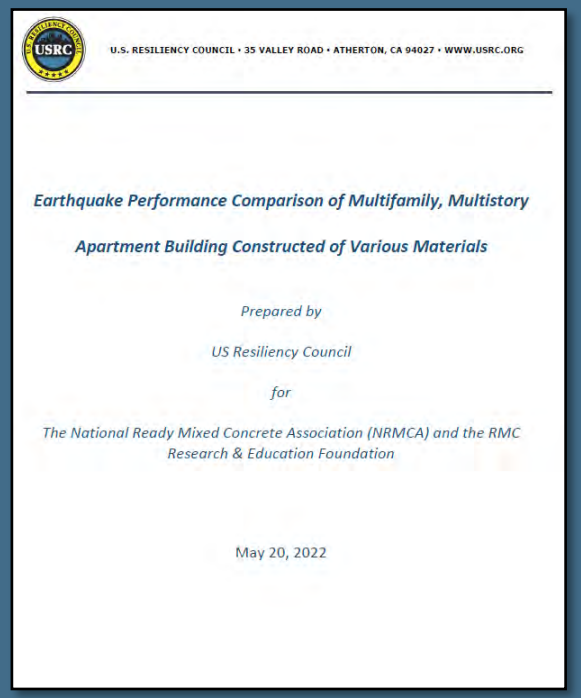
- 2.5% of land area
- 30% of state's property value ~$1.9 Trillion
- Risk Index = 100 VERY HIGH

Source: FEMA National Risk Index Map - https://hazards.fema.gov/nri/

National Institute of Building Sciences

National Benefit-Cost Ratio per Peril for Designing Beyond Code Requirements (Adapted from NIBS)	
Riverine flood	5:1
Hurricane surge	7:1
Wind	5:1
Earthquake	4:1
Wildland-urban interface fire	4:1
Overall benefit-cost ratio	4:1

Multifamily Apartment Performance Comparison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Earthquake Performance Comparison of Multifamily, Multistory Apartment Building Constructed of Various Materials

Prepared by

US Resiliency Council

for

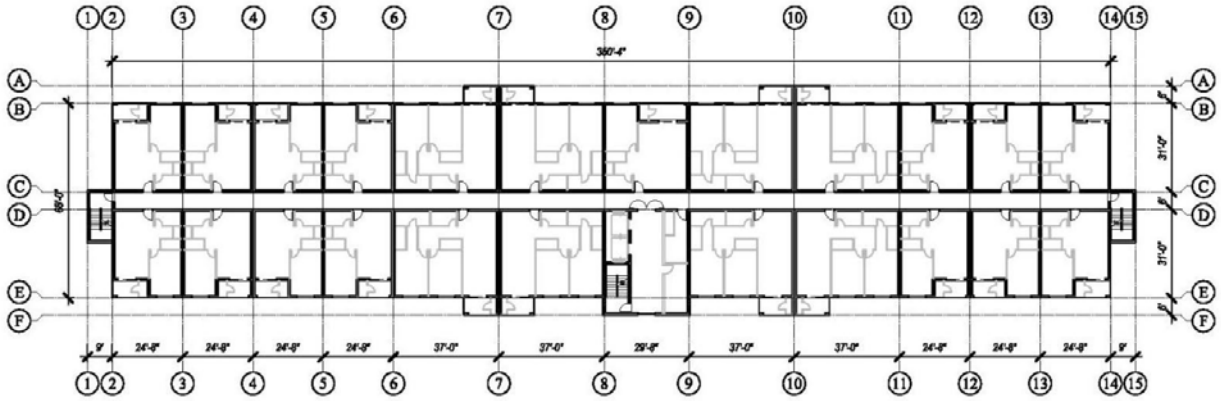
The National Ready Mixed Concrete Association (NRMCA) and the RMC Research & Education Foundation

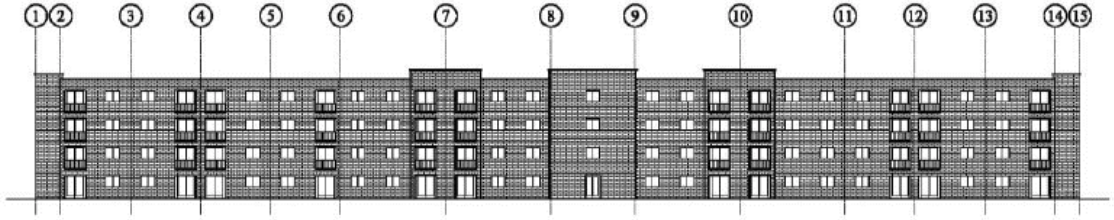
May 20, 2022

www.BuildWithStrength.com

- Consider a four-story multifamily apartment style building built to the current building code, ASCE 7-16.
- Evaluate seismic performance for four structural configurations: **Insulated Concrete Forms, traditional wood framing, Cross Laminated Timber and steel framing.**
- Consider performance in three cities: Los Angeles, Seattle and Memphis.
- Estimate cost of construction for each configuration.
- Evaluate net benefits among the four configurations in terms of reduced earthquake damage.
- Determine the expected USRC performance rating for each configuration.

Typical Building Plan

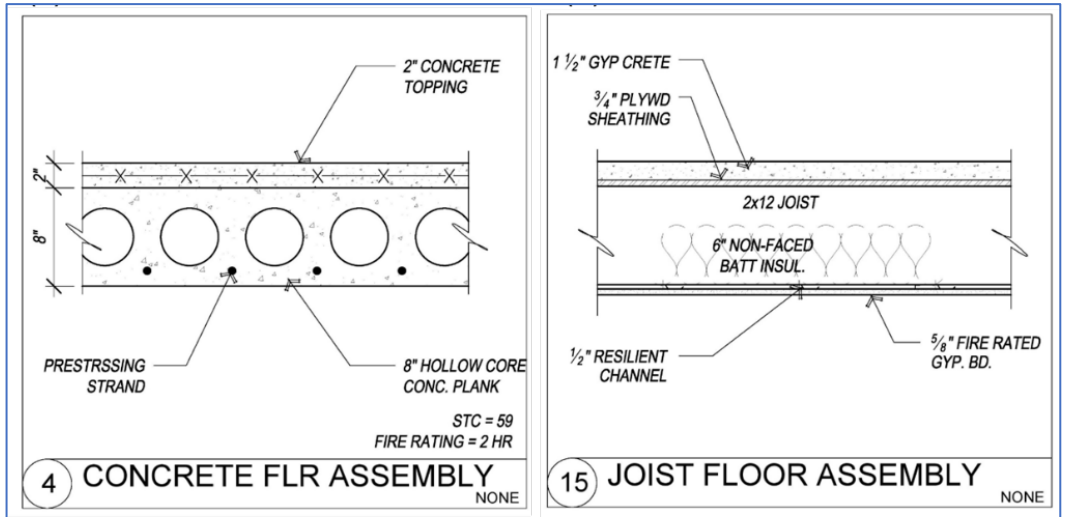




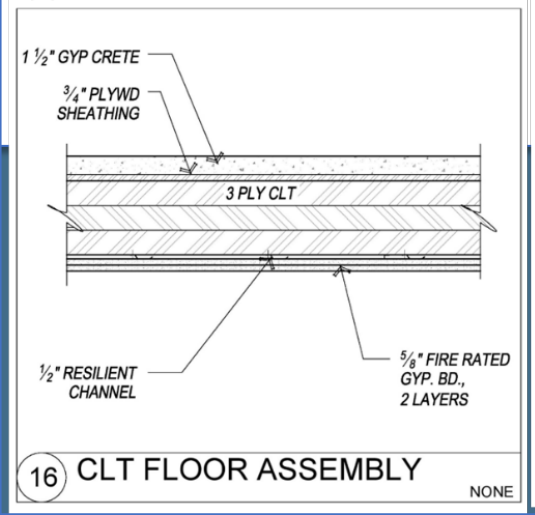
Credit: NRMCA

- Four stories, 9’ to 10.5’ tall
- 360’ x 68’ in plan over height
- Founded on slab and strip footing foundation
- Stucco exterior

Typical Building Details



(c)



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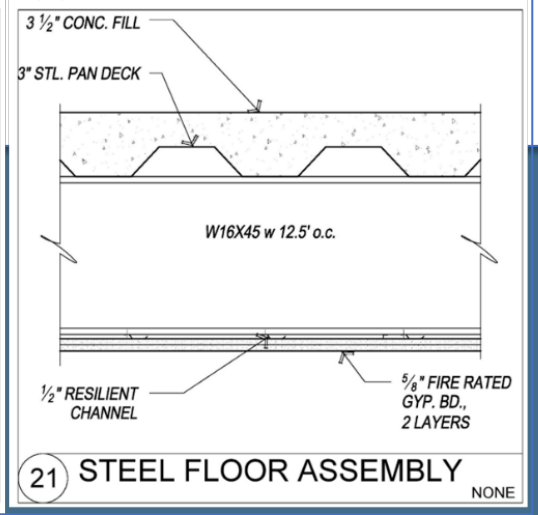
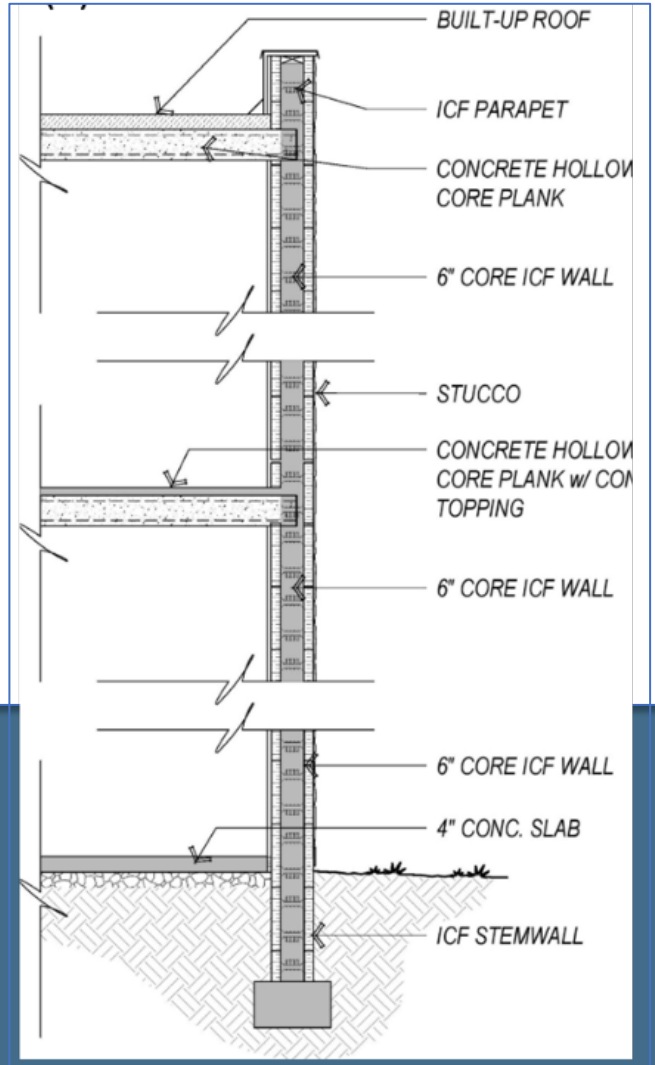
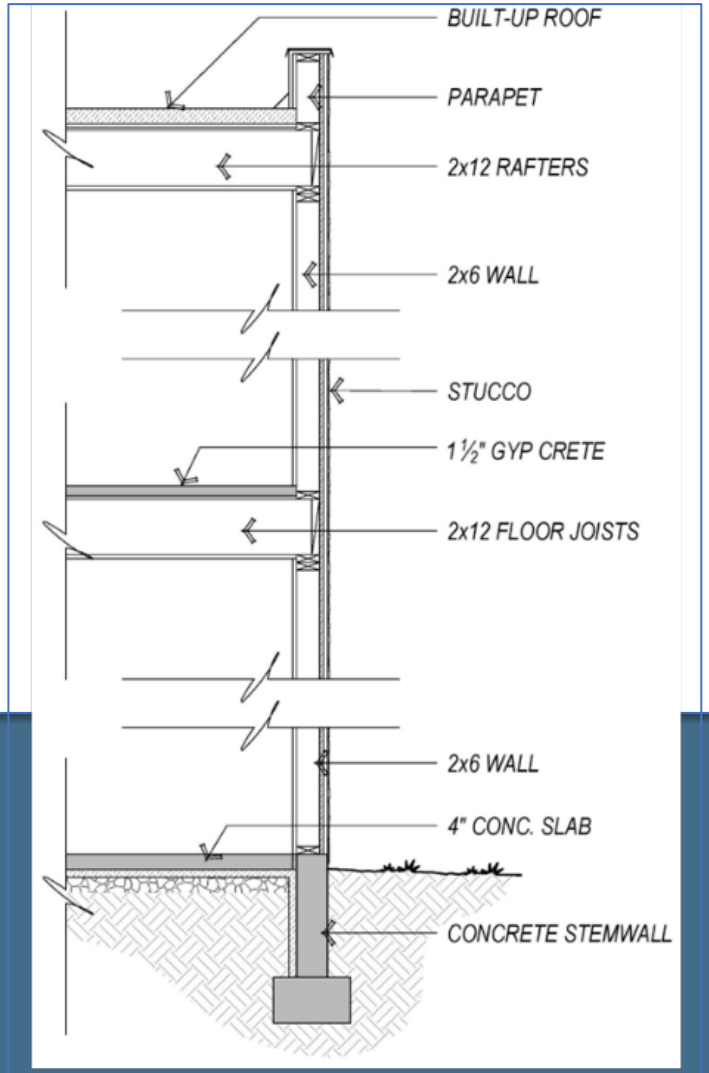




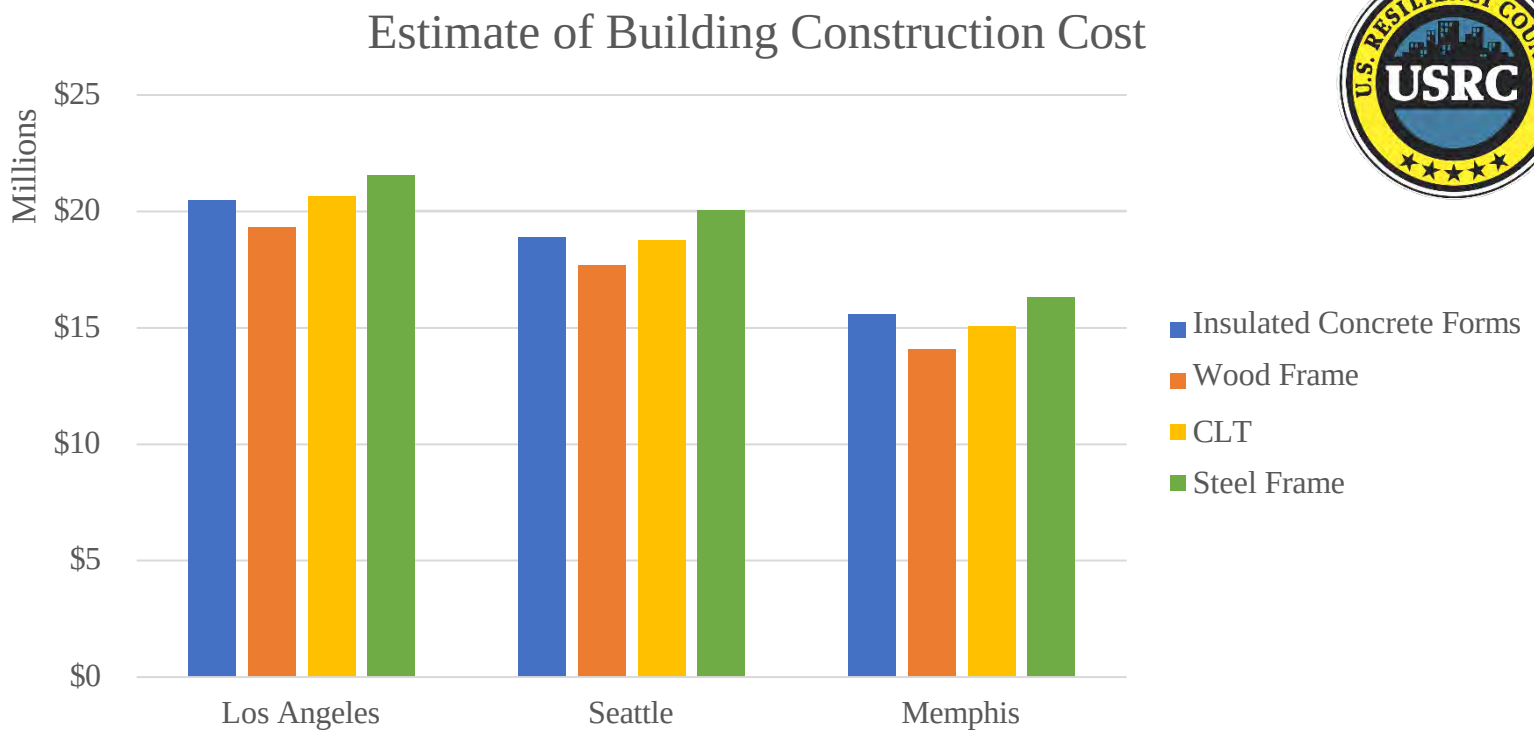


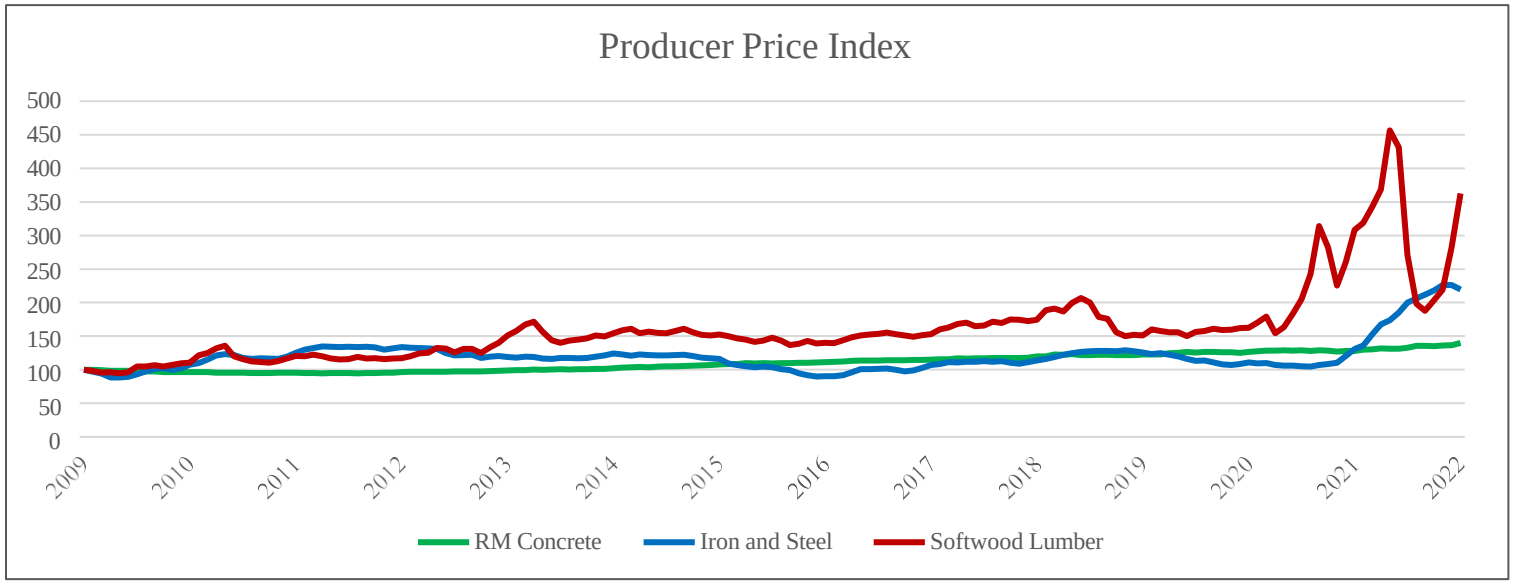
Multifamily housing construction costs

Based on estimates from NRMCA using **RS Means**

Based on high variability of lumber costs, evaluated **100%** and **125%** of current lumber pricing

Costs are typically within **6%** of each other





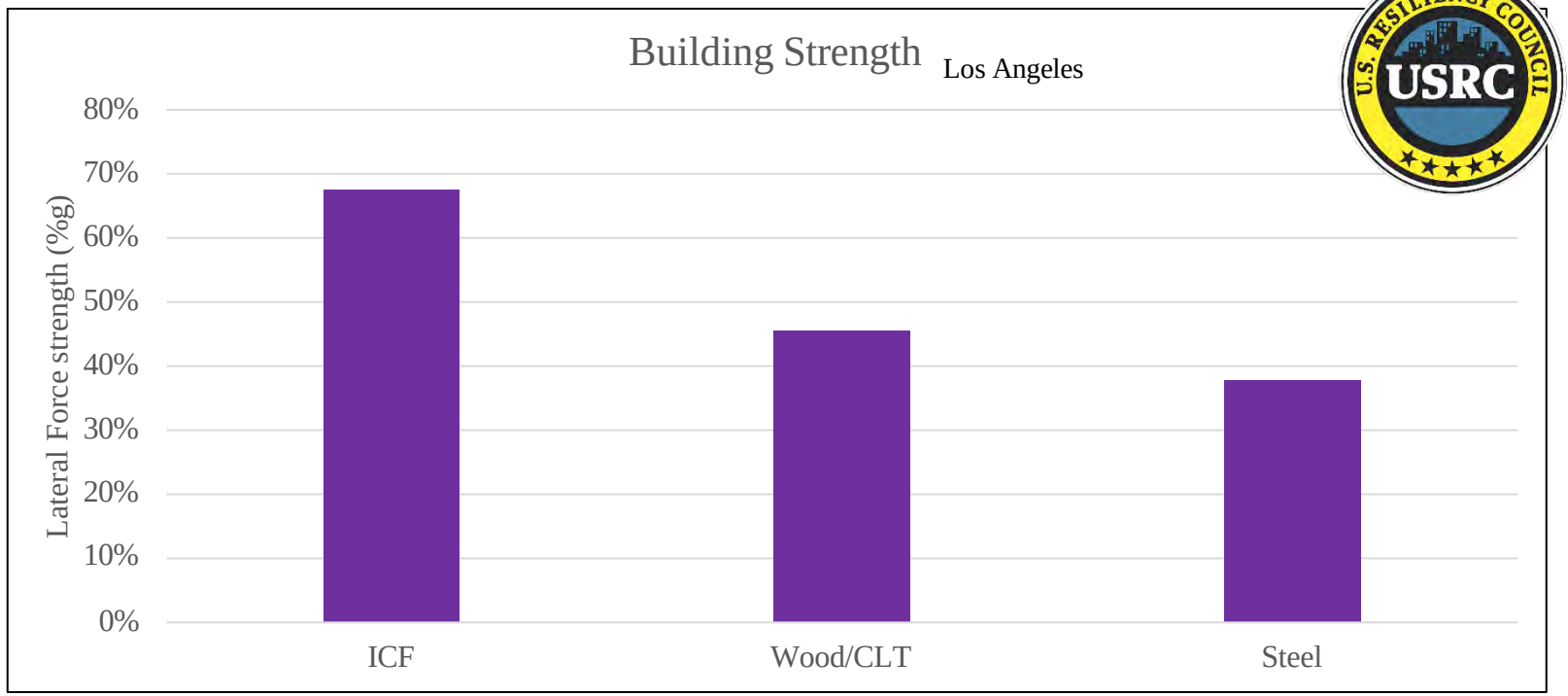
Strength and stiffness of building configurations

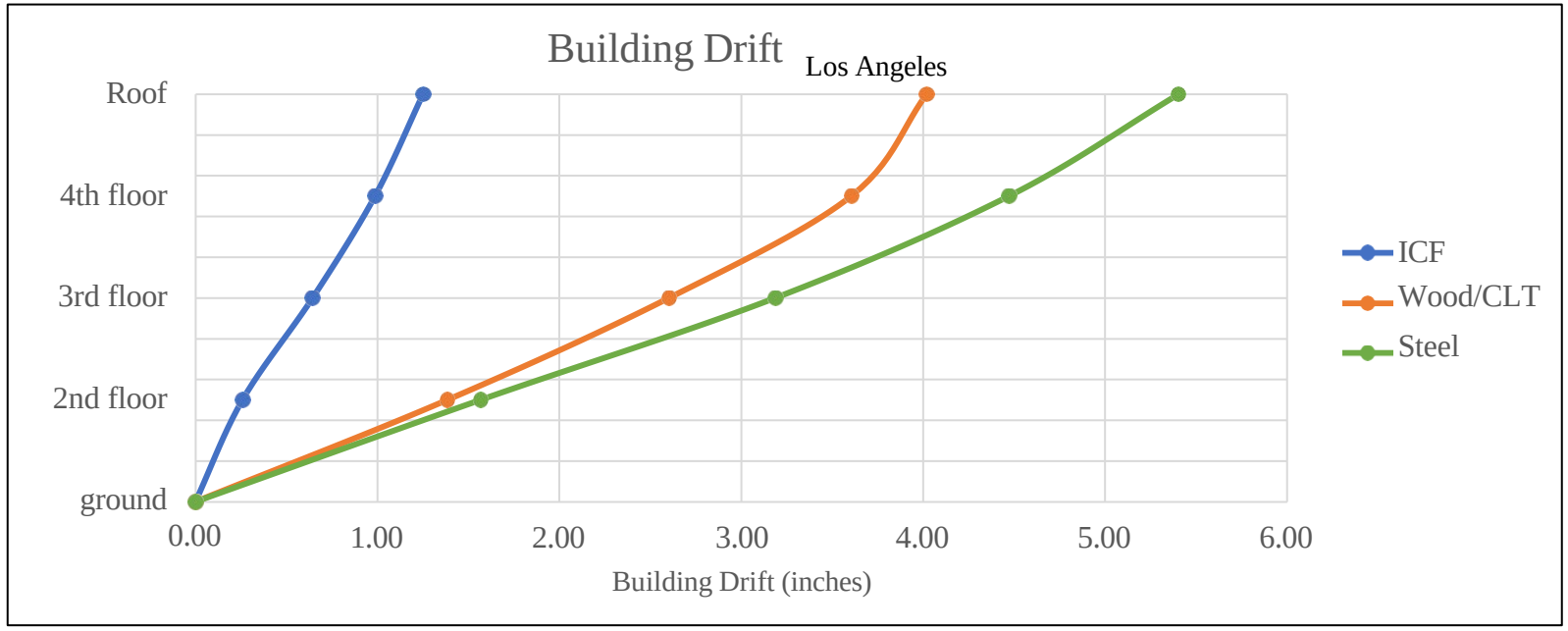
All buildings are designed to basic requirements of ASCE 7-16

Certain materials are inherently stiffer and stronger than others

Higher strength reduces structural damage

Higher stiffness reduces building drift and certain nonstructural damage



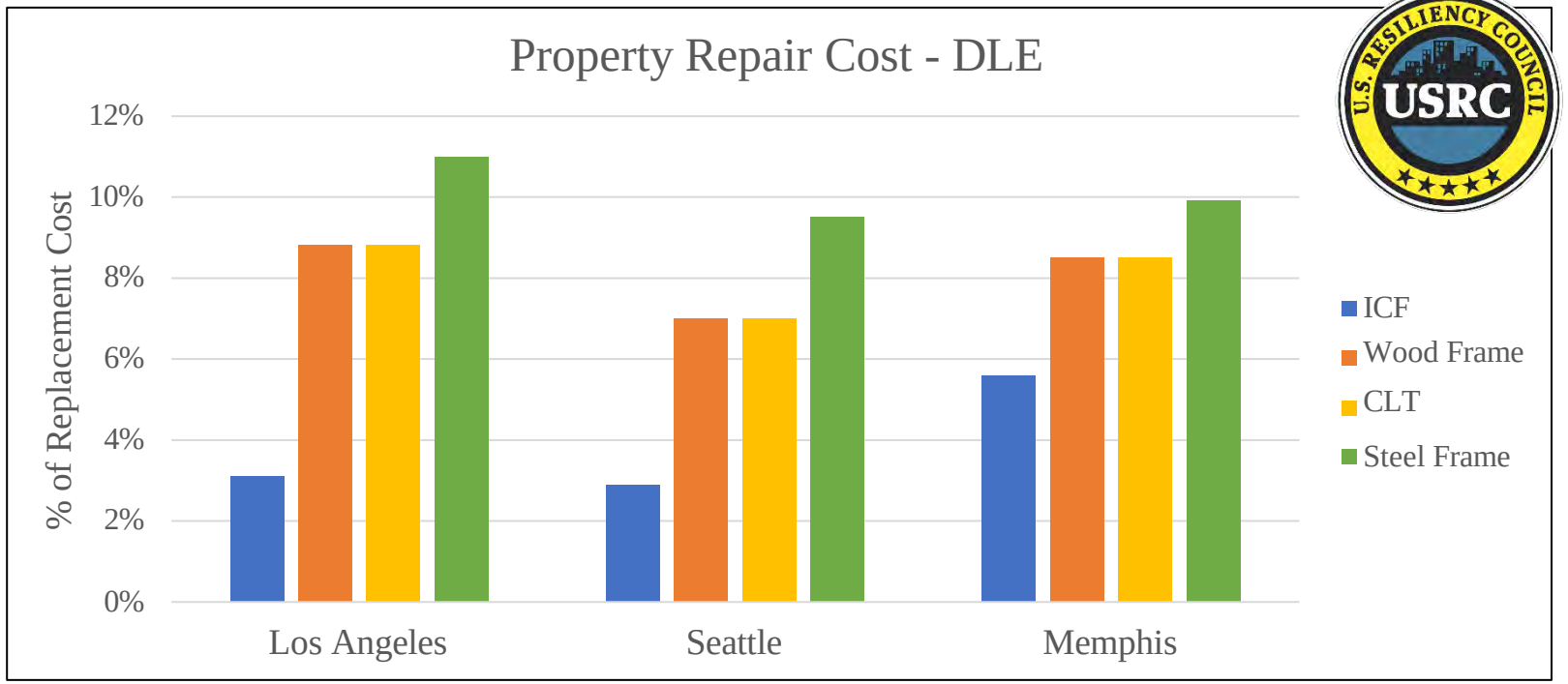


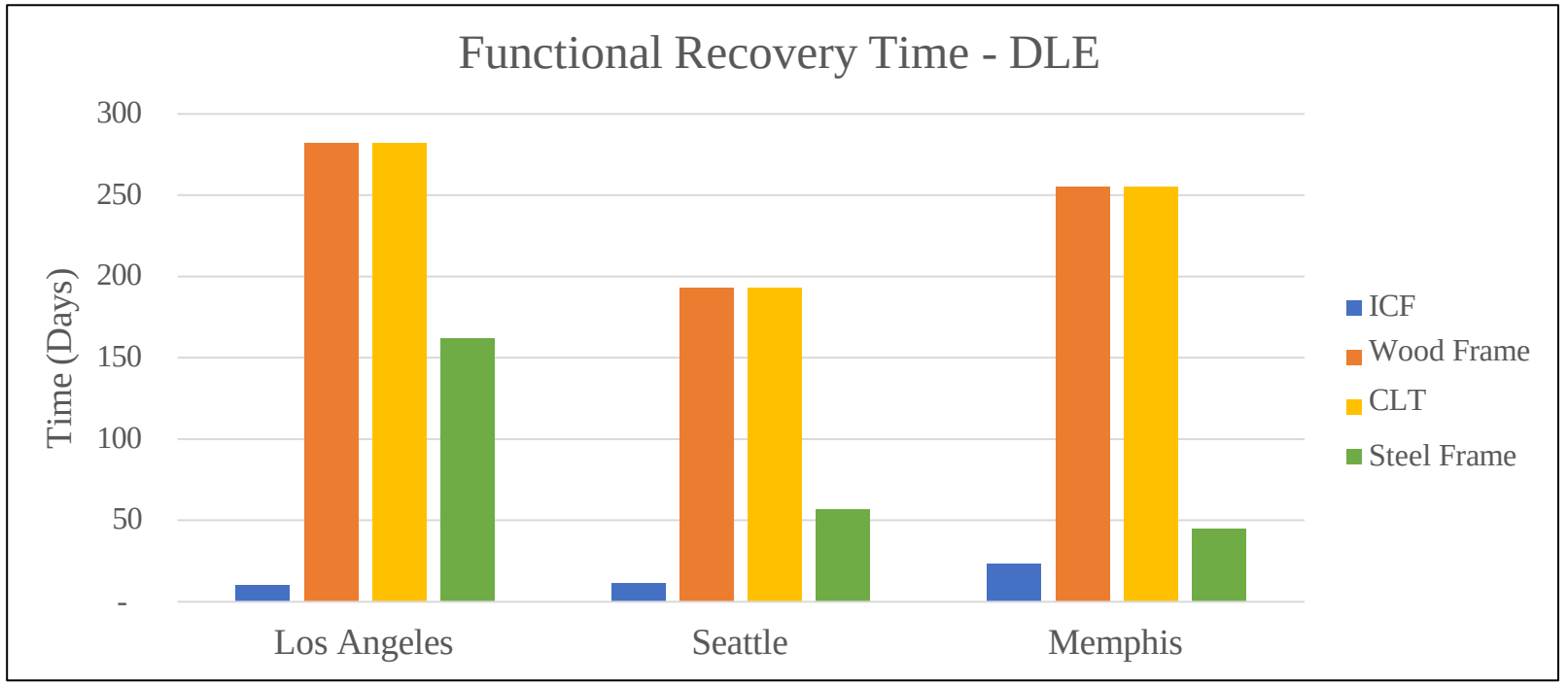
Property damage and recovery time

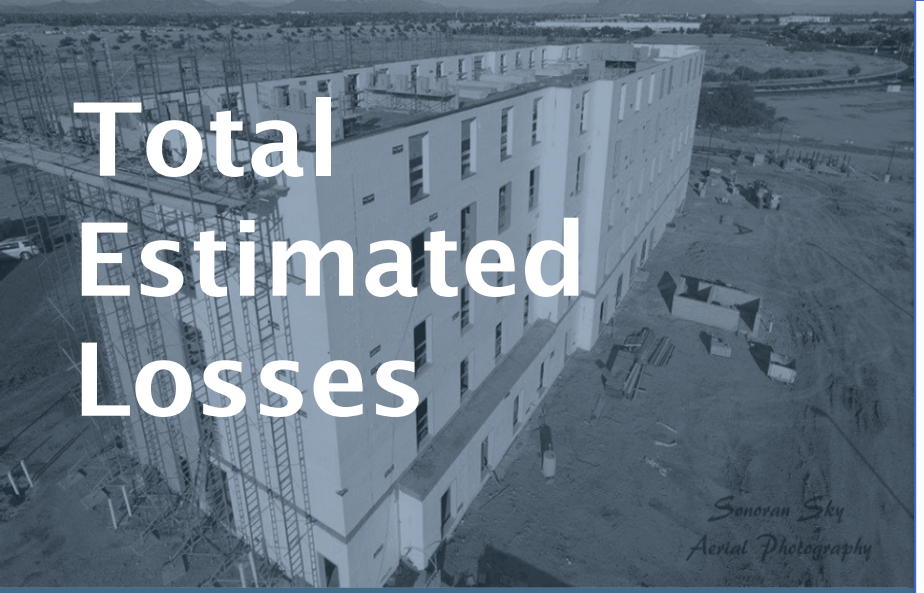
Design Level Event (DLE) is building code design level

Property damage represents damage to structure and nonstructural systems.

Functional recovery time is time to restore basic function of building.







Total Estimated Losses

Total losses include **Property damage** and **rental losses**

Net benefit for Design Level Event includes reduced losses accounting for construction cost of ICF relative to other configurations

High Wind

Both Built with ICF

Wildfires

Both Built with ICF

Debris Hazard

Projectiles

vs. Concrete

vs. Wood


PREPARING TODAY REDUCES THE CONSEQUENCES OF A DISASTER TOMOROW. VISIT READY.GOV
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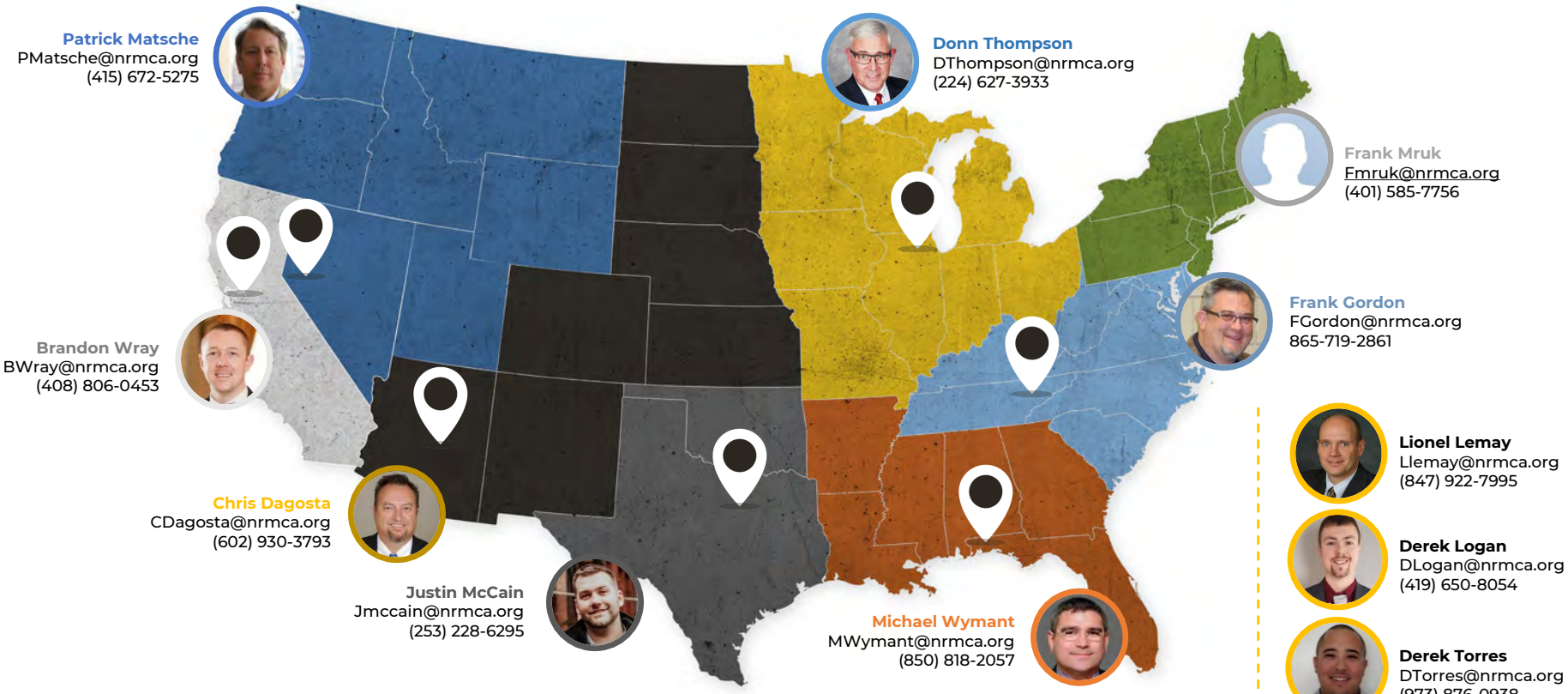
The Sky’s the Limit

Build With Strength: Concrete Design Center



Questions?

Website: www.buildwithstrength.com

Example: https://structurepoint.org/publication/case-studies.asp

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Brandon Wray: Bwray@nrmca.org 408-806-0453