# Build with Strength:
# Concrete Value & Innovation

# 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.

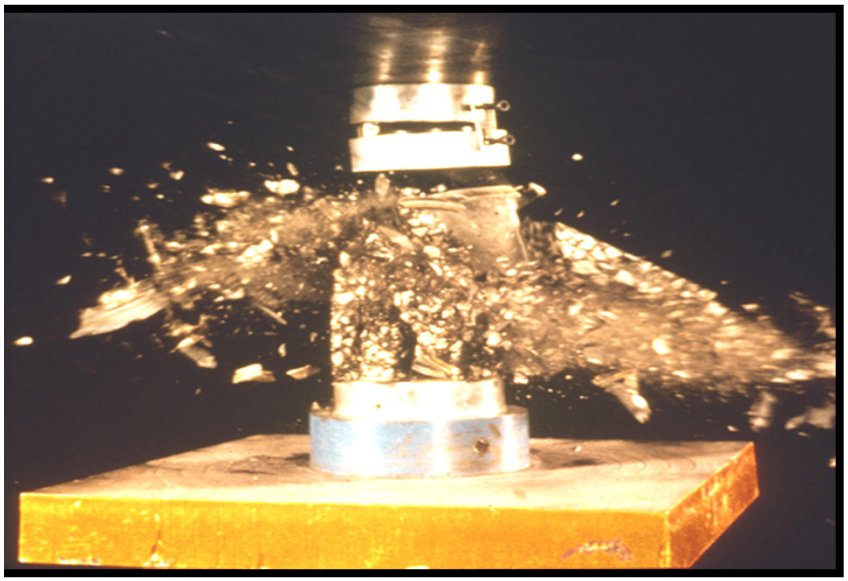
## Safe and strong

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—wh ich means the resources you invest now will last for decades to come.

# Ready Mixed Concrete



- **90% of ready-mixed concrete**

  20 MPa - 40 MPa (3000 – 6000 psi) @ 28-d
  (most 30 MPa – 35 MPa)

- **High-strength concrete**
  by definition —

  28 day – compr. strength

  ≥ 70 MPa (10,000 psi)

# Strength & Durability

**Building for the Information Age**

- Casual Office Environment
- Creative Space
- Column-Free Space
- Remodeling
- Hyper-Track Schedule
- Exposed Surfaces

# AOL Headquarters, Dulles, VA

# Adobe Headquarters, Seattle, WA

# Sprint World HQ, Overland Park, KS

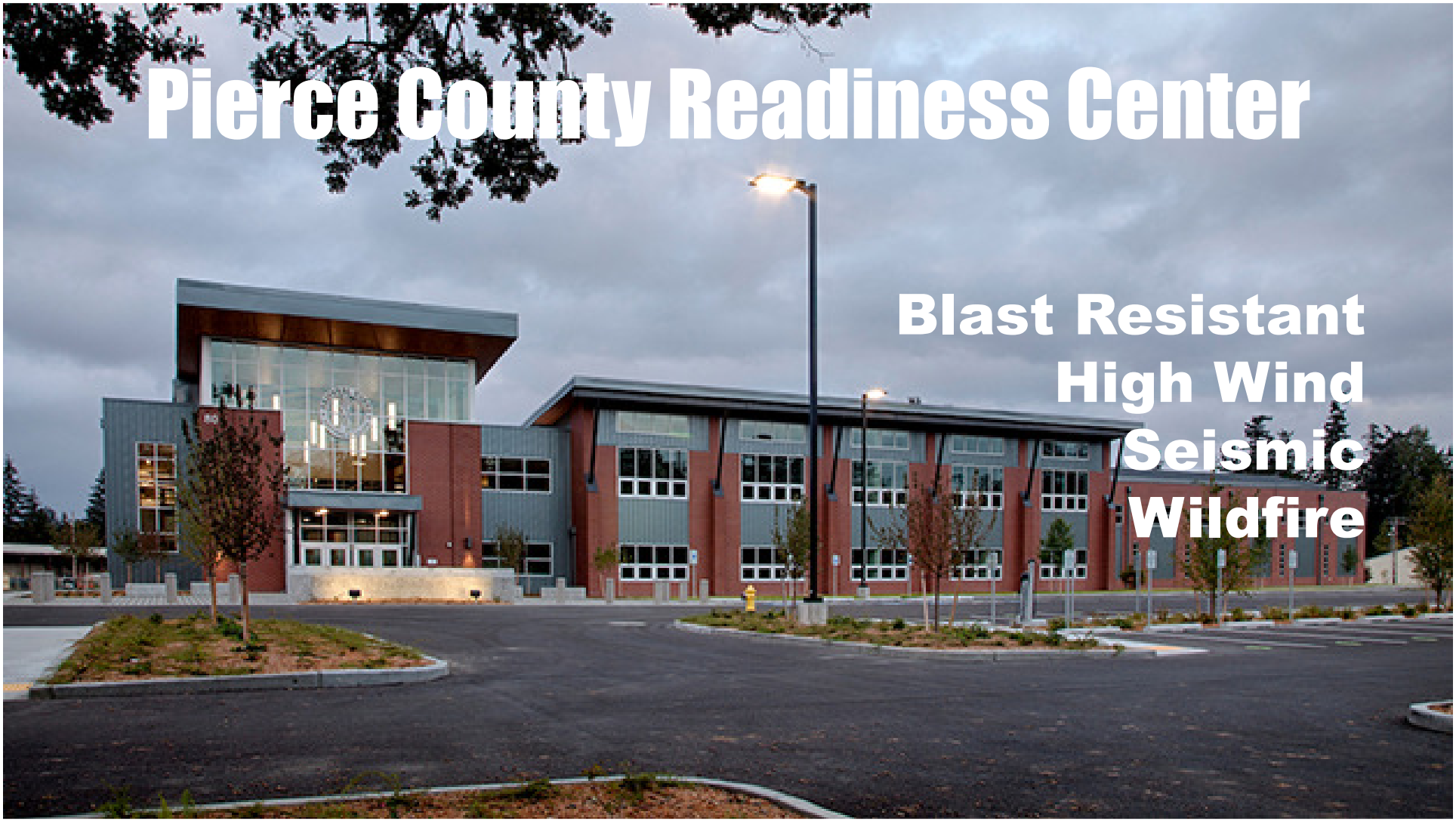
# Strength Case Study

**Pierce County Readiness Center**

- WJA Architects
- Completed 2016
- $29,000,000
- Washington National Guard
- Nudura ICF

# Pierce County Readiness Center


- Passive Survivability and Functionality During Emergencies
- Built for strength and durability


Pierce County Readiness Center
Blast Resistant
High Wind
Seismic
Wildfire

# Questions?

Strength & Durability

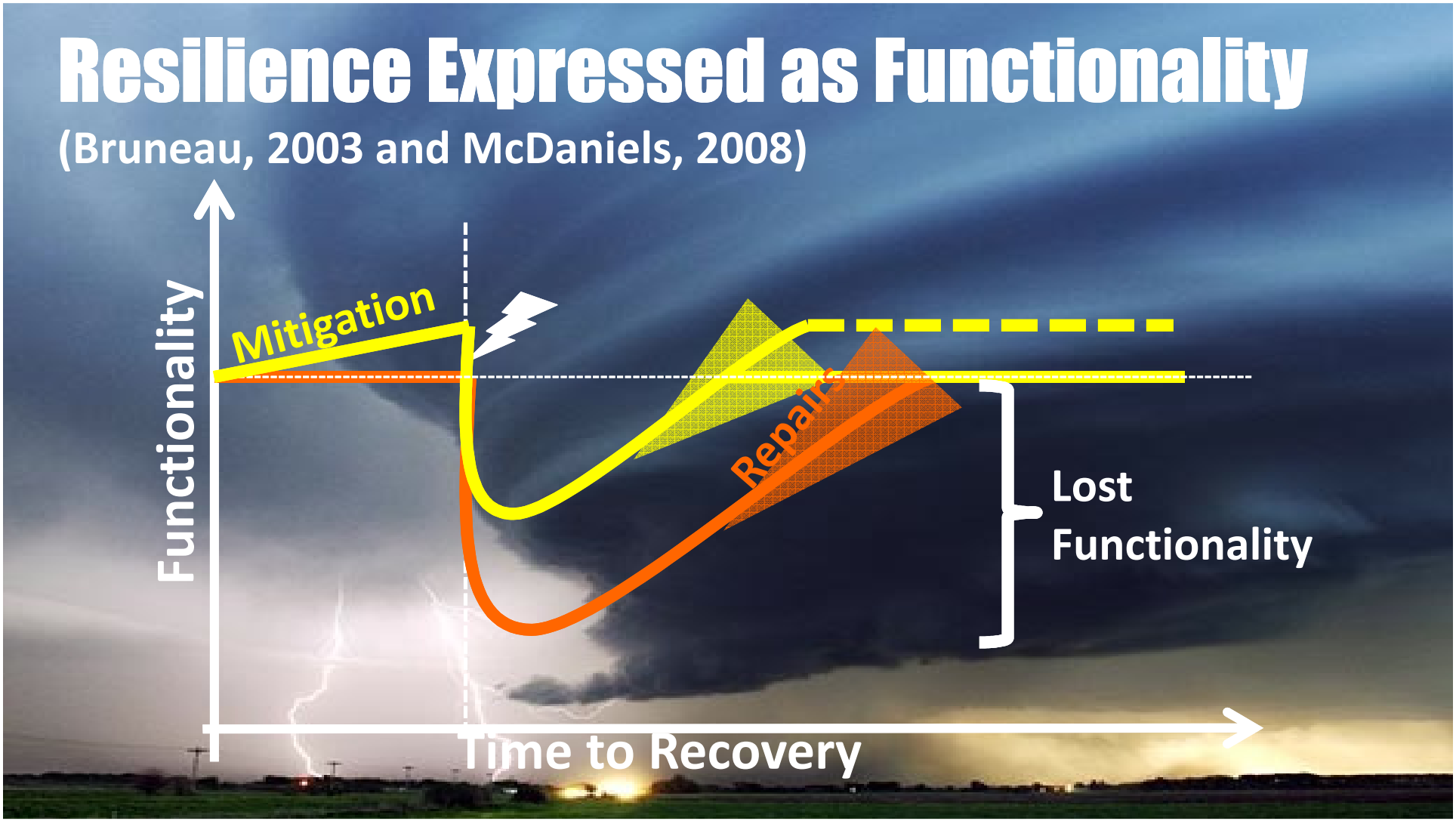

5 key benefits of concrete that protect lives and protect your interests:
Safety
Fire resistant
Unlike softwood lumber, concrete will not burn. It can take on temperatures over 1,000 degrees Fahrenheit.
Improved air quality
Concrete walls and floors are a healthier alternative that do not harbor toxic mold growth or emit harmful chemicals.
Stands up to Mother Nature
Concrete can outlast any natural disaster including hurricanes, tornadoes, high winds and floods.
Outlasts man-made disasters
Concrete can even withstand explosions and is resilient when other safety systems in the building fail.
Environmentally responsible
Over the life of the building, concrete has a lower environmental impact through reduced $CO_2$ emissions.

# Safety – Natural Hazards


FLASH: A Story of Survival
(https://youtu.be/xbCCwTlJdgU)

# Resilience Expressed as Functionality

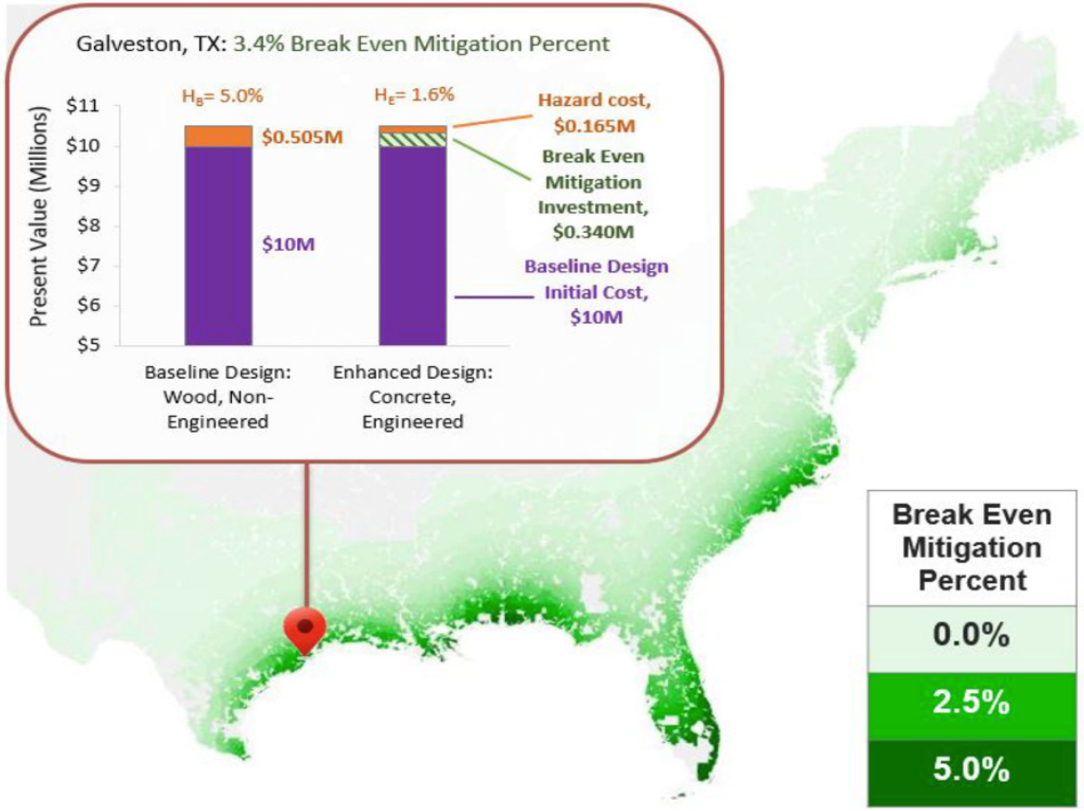
(Bruneau, 2003 and McDaniels, 2008)



# Safety - Resilience


# Safety – Research

A MIT study found a $10 million non-engineered wood building is expected to face more than half a million dollars in hazard related damages over 50 years, while a $10 million engineered concrete building is expected to face only $165,000 over the same period.



# Safety Case Study: Bluestone, NYC

2013

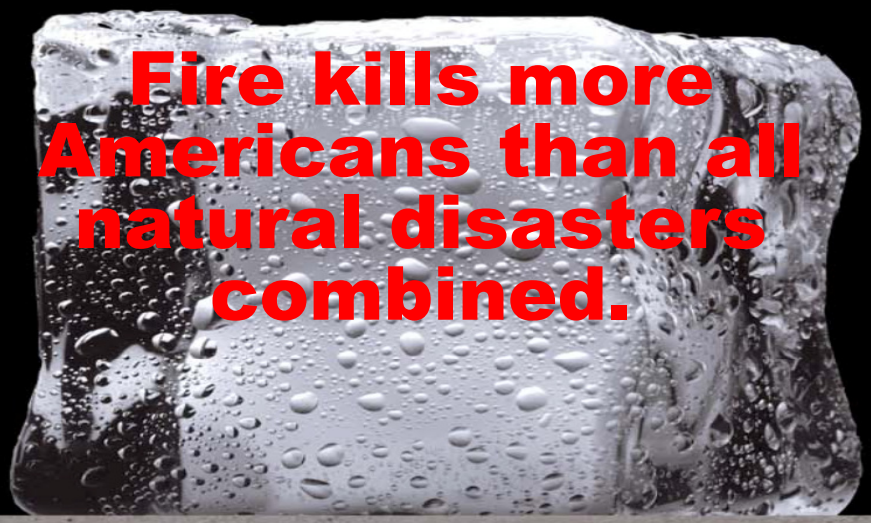
March 12, 2014
Natural Gas Explosion Next Building: 8 killed, 70 injured, 100 families displaced

# Safety Case Study: Bluestone, NYC



On March 25, 2014 a 5-alarm fire destroyed a $50 million apartment complex under construction in Houston, TX. The fire spread so quickly one construction worker was still on the top floor of the building as it began to collapse.

# Safety - Fire

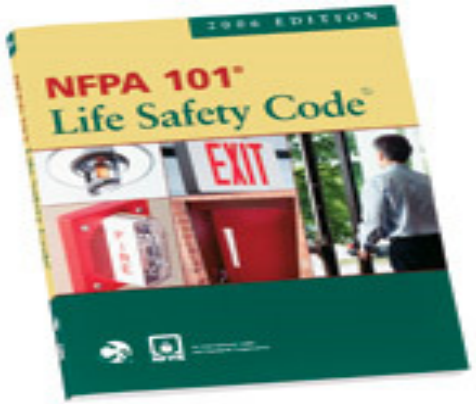



## Non-Combustible Concrete Construction

A key to saving lives and reducing property damage.

# Building and Fire Codes

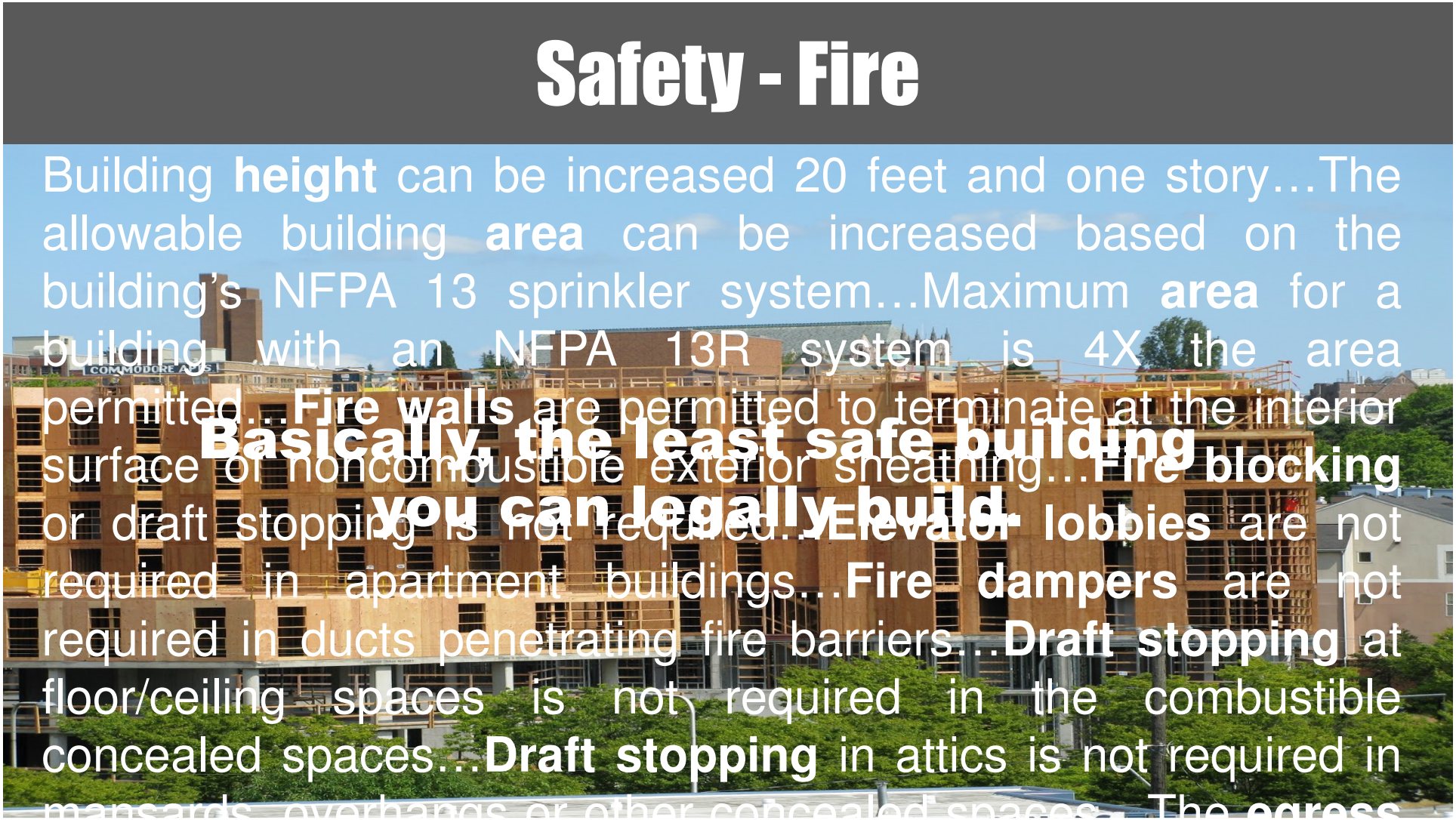
- Building and Fire Codes are state or jurisdiction specific
- Codes are the minimum requirements – “the basement”



# Limitations to the Building Code

- Recent building code revisions have reduced the use of passive fire protection and provided an over-reliance on active fire protection systems
  - Sprinkler trade-offs: the concept of exchanging established passive fire containment code provisions for active protection
  - Sprinkler system reliability unknown

# Safety - Fire



Building **height** can be increased 20 feet and one story…The allowable building **area** can be increased based on the building's NFPA 13 sprinkler system…Maximum **area** for a building with an NFPA 13R system is 4X the area permitted…**Fire walls** are permitted to terminate at the interior surface of noncombustible exterior sheathing…**Fire blocking** or draft stopping is not required…**Elevator lobbies** are not required in apartment buildings…**Fire dampers** are not required in ducts penetrating fire barriers…**Draft stopping** at floor/ceiling spaces is not required in the combustible concealed spaces…**Draft stopping** in attics is not required in mansards, overhangs or other concealed spaces…The **egress**

**Basically, the least safe building you can legally build.**

# Code Trade Offs

"We think we've gone too far with the trade-offs in the codes, and we're seeking to reverse that trend," says New York State Fire Administrator James Burns, president of the National Association of State Fire Marshals."

- USA Today 2/12/06

# Safety - Fire

**Too much Reliance on Sprinklers?**

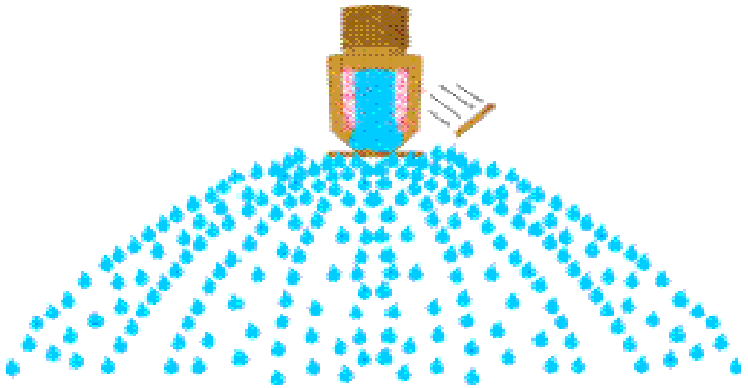
- **Failure of Sprinklers**
  - 12.4% in apartments
  - 17.3% in hotels and motels
  - 20.5% in educational properties
  - 20.2% in healthcare/correctional facilities

# Why sprinklers may fail

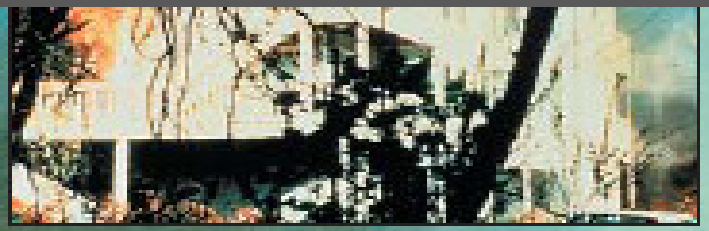
- Natural Events (earthquake, tornado, etc.)
- Terrorist Events
- Inadequate water pressure
- Human Error
- Lack of maintenance
- Installation Error
- Wrong sprinkler for occupancy/fire
- Coverage Issues
- Building under construction
- Other

# Role of Sprinklers

- Fire Sprinklers act to extinguish a fire after a specified temperature is achieved in the upper gas layer



# Role of Compartmentation



- **Compartmentation** acts to contain fires to a specified area of the building or structure
- Without compartmentation, fire may spread from one room or building to another

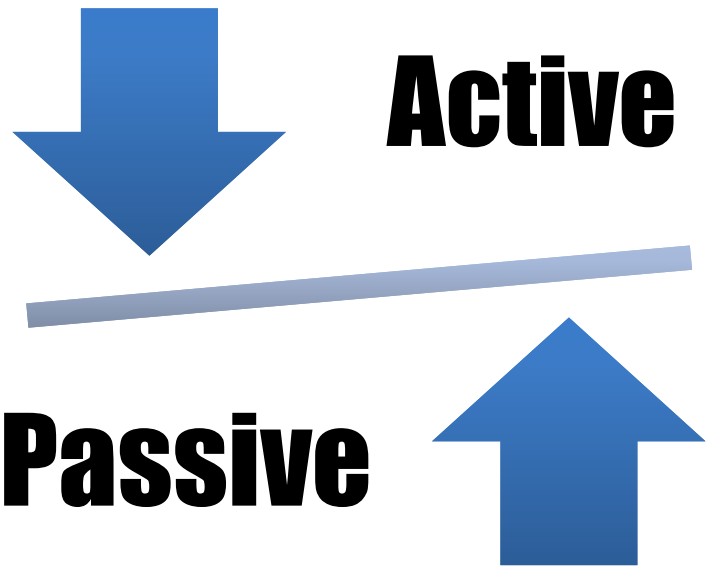
# Toxicity

Most fire deaths result not from heat or burns but from inhaling smoke and toxic gasses.

- Gases produced in a fire include: water, CO2, styrene, bromide, and CO
- Concrete does not produce toxic gases when involved in a fire
- Compartmentation with concrete construction reduces the spread of toxic gas or smoke.

# Safety – Balanced Design

**Active Fire Protection +**
**Passive Fire Protection**
**= BALANCED Design**



# Balanced Design

Active Fire Protection

- Smoke detectors
- Sprinklers
- Duct detectors
- Fire alarms

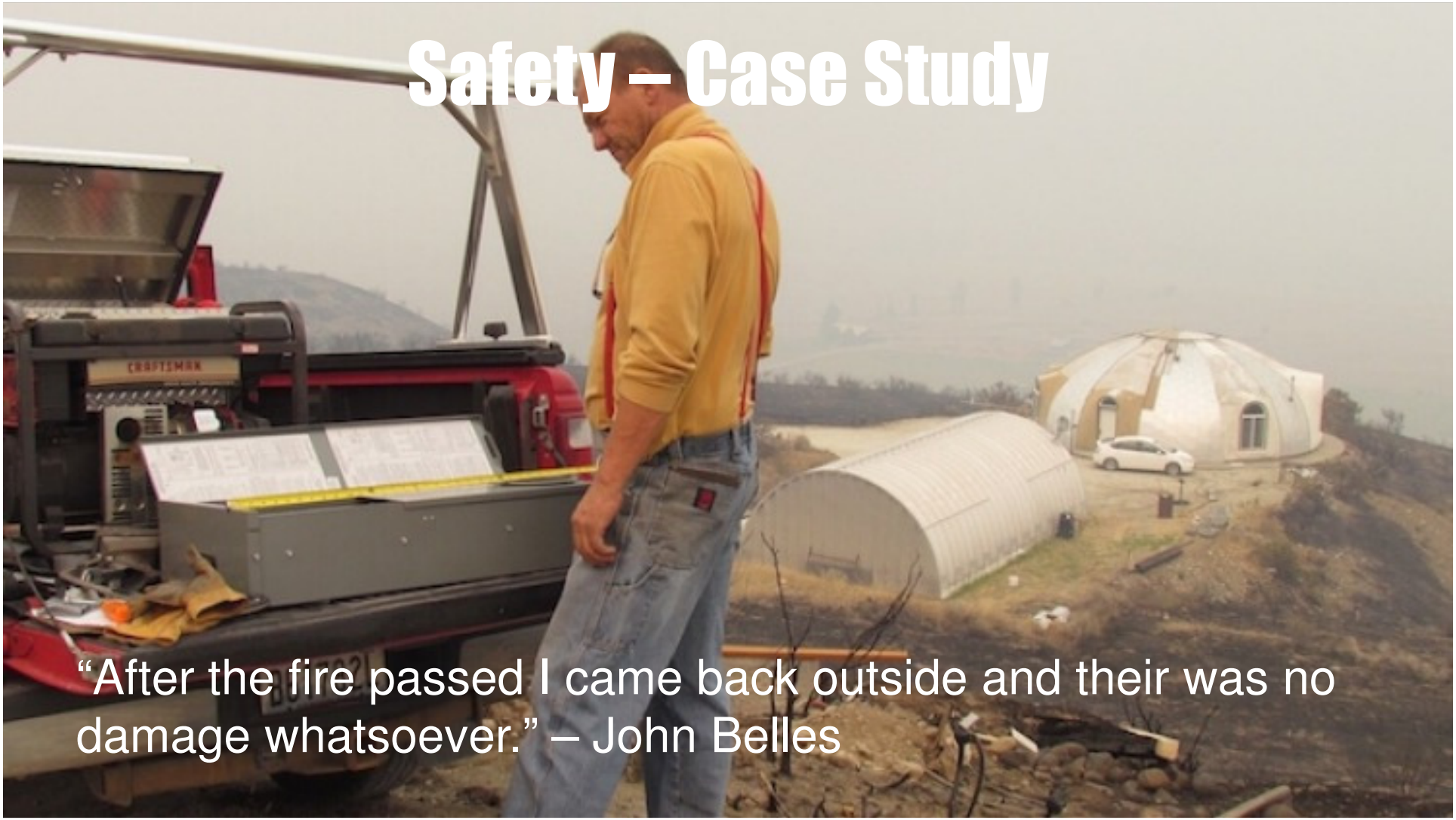
Passive Fire Protection

Fire rated walls

Fire rated floors

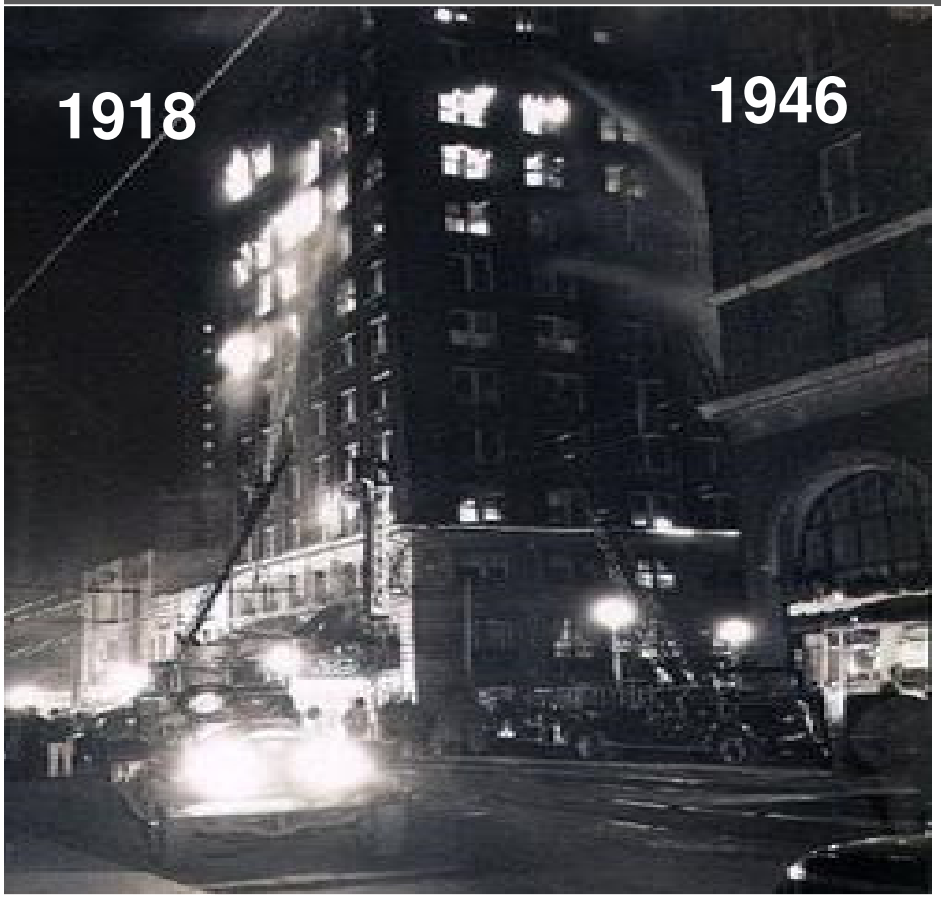
Fire rated separations

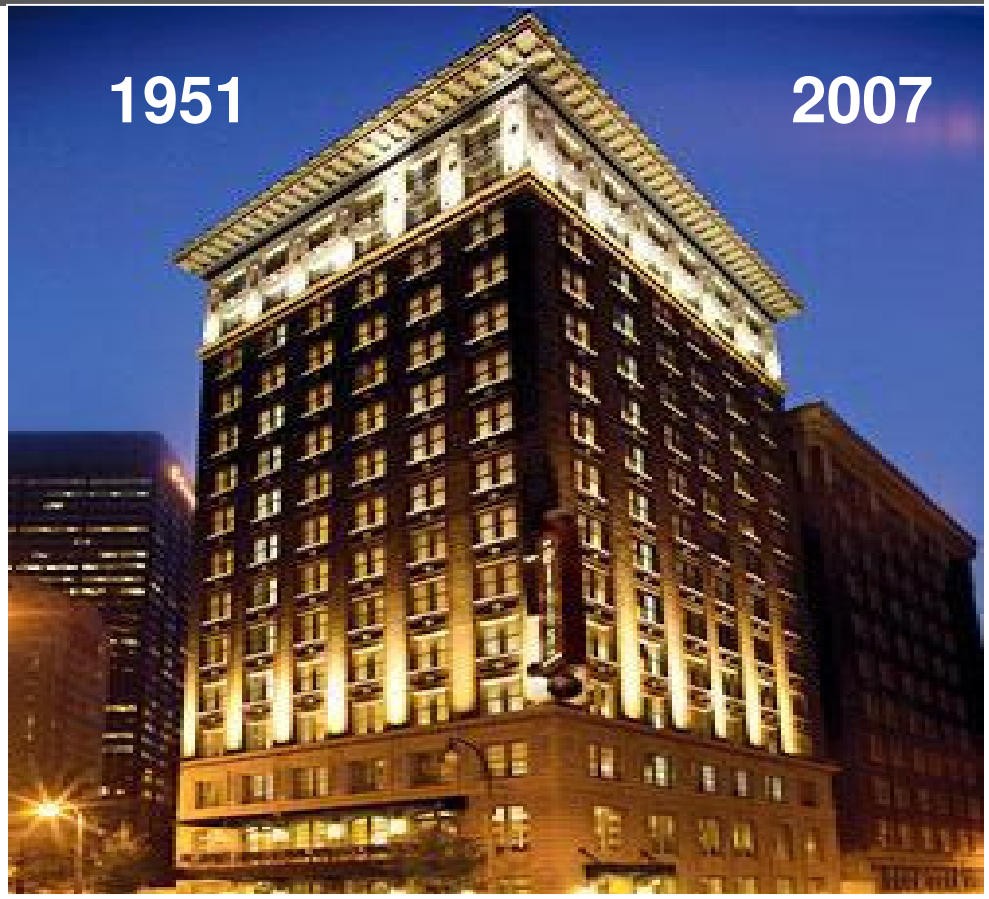
# Safety – Case Study




"After the fire passed I came back outside and their was no damage whatsoever." – John Belles

# Safety – Case Study



# Questions?

Safety

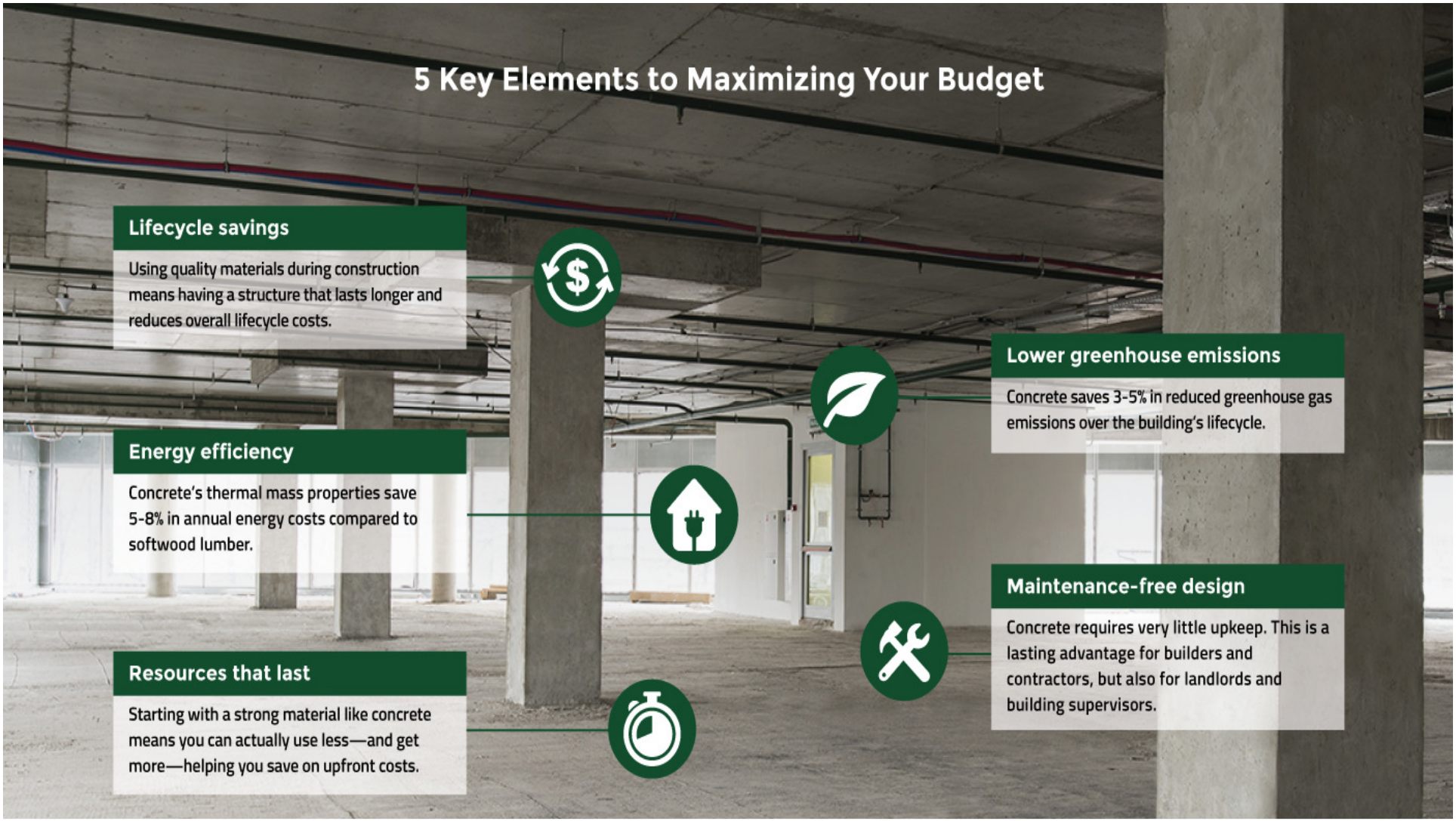

Ease of Use

# ICF - Village Suites, Oshawa, ON


University of Ontario Student Housing
6-storey, 315,000 sq ft
Logix ICF
Reduce heating and cooling loads by 75%
Completed in 10 Months

# Questions?

Ease of Use


5 Key Elements to Maximizing Your Budget
Lifecycle savings
Using quality materials during construction means having a structure that lasts longer and reduces overall lifecycle costs.
Lower greenhouse emissions
Concrete saves 3-5% in reduced greenhouse gas emissions over the building's lifecycle.
Energy efficiency
Concrete's thermal mass properties save 5-8% in annual energy costs compared to softwood lumber.
Maintenance-free design
Concrete requires very little upkeep. This is a lasting advantage for builders and contractors, but also for landlords and building supervisors.
Resources that last
Starting with a strong material like concrete means you can actually use less—and get more—helping you save on upfront costs.

# Value

**“A smarter way to build. You can make more money, have a better impact on the environment, and build a legacy that will last for generations.“**


SECOND + DELAWARE
WILL FEATURE
ROOFTOP GARDENS
EV CHARGING STATIONS
TRIPLE-GLAZED WINDOWS
SMALLER HVAC SYSTEMS

# Value

**“Our sandwich wall technology that puts foam in the middle of the form and concrete on both sides allows us to have a virtually thermal leak free envelope at a cost that is almost unheard of.”**

# Value

**“you will see a lot of institutional investors gravitate to the value added with the use of concrete”**

# Value Case Study: Drury Inn

**“We have projects that have required little more than a fresh coat of paint in 30 years. You just can’t beat that when it comes to value.”**

# Value Case Study: Drury Inn

**“With ICF’s we can set the walls and pour the concrete without scaffolding and without our people potentially being in harm’s way. This is paramount for us.”**

# Value Case Study: Drury Inn

# Energy - Richardsville Elementary, KY


Nation's First NZE School
$14.2 M
77,466 sf, 550 student
Nudura ICF, geothermal, daylighting, PV
$37,227 check from utilities (2012)
http://www.warrencountyschools.org/20/Content/680

Forbes

Peter Kelly-Detwiler, Contributor
I write about energy technologies and policies.

ENERGY | 12/10/2012 @ 8:05AM | 2,395 views

## Net Zero Schools in Kentucky: Models for the Future Come from Surprising Places

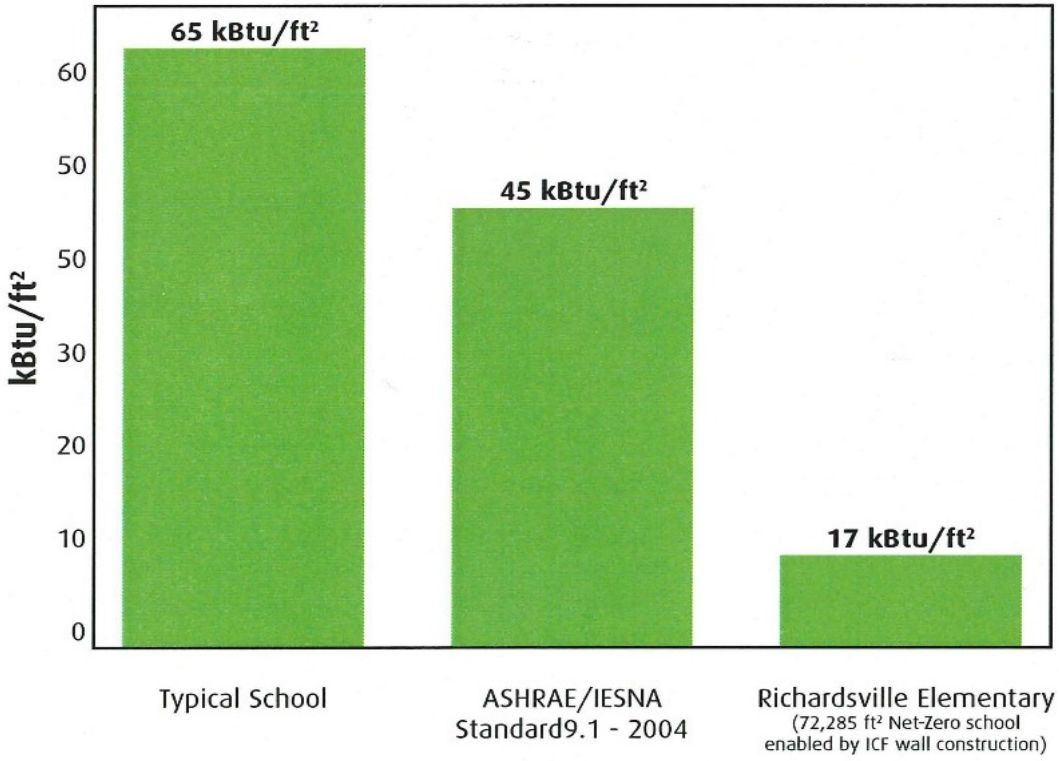
This week, I asked a close friend to guess which state boasted the nation's first net zero public elementary school. "California?" he ventured. "Vermont?" "Massachusetts?" No, no, and no. How about Kentucky, the nation's third largest coal producer, with $5 bn in annual coal revenues and the nation's fourth lowest electricity costs (at just over 7 cents per kilowatt-hour)?

(Richardsville School - Architect: Sherman Carter Barnhart Architects; Photo courtesy of CMTA, Inc.)

Almost everybody thinks about ambitious energy policy as coming from the right or left coasts, where avoided costs are higher and environmental fervor is often stronger. You only have to look at the location of Prius ownership to see that bias reflected. But if you have been paying attention to the Kentucky Governor Steve Beshear's energy plan, "Intelligent Energy Choices for Kentucky's Future," you might have guessed that the first net zero elementary school would be claimed by the Bluegrass State. It is a very ambitious strategy, and includes seven specific goals to be reached by the year 2025:

1) improve energy efficiency to meet

# Energy - Richardsville Elementary, KY




**HVAC Energy Use Comparison**

| Annual Estimated Energy Savings (Richardsville) | | | |
|---|---|---|---|
| | 65 kBtu/ft² | 17 kBtu/ft² | Savings |
| Year 1 | $109,039 | $46,080 | $62,959 |
| Year 2 | $112,310 | $47,462 | $64,848 |
| Year 3 | $115,679 | $48,886 | $66,793 |
| Year 4 | $119,150 | $50,353 | $68,797 |
| Year 5 | $122,724 | $51,863 | $72,989 |
| Year 6 | $126,408 | $53,419 | $72,989 |
| Year 7 | $130,198 | $55,022 | $75,176 |
| Year 8 | $134,104 | $56,673 | $77,431 |
| Year 9 | $137,127 | $58,373 | $78,754 |
| Year 10 | $142,271 | $60,124 | $82,147 |
| Year 11 | $146,539 | $61,928 | $84,611 |
| Year 12 | $150,935 | $63,785 | $87,150 |
| Year 13 | $155,464 | $65,699 | $89,765 |
| Year 14 | $160,127 | $67,670 | $92,457 |
| Year 15 | $164,931 | $69,700 | $95,231 |
| | $2,027,006 | $857,037 | $1,172,097 (58%) |

# Value – Cost Study

- Comparative study undertaken by the Fire Safe Construction Advisory Council to accurately document the increased cost associated with the use of **balanced design** in a typical multi-family residential building.

**Concrete and Masonry Systems are Cost Effective Compared to Wood Frame**

| Location | Relative Cost of Concrete and Masonry | |
|---|---|---|
| | One Bedroom Scheme | Mixed Bedroom Scheme |
| Framingham, MA | 5 % more | 1 % more |
| Harrisburg, PA | 5 % more | 2 % more |
| Towson, MD | 3 % more | 3 % less |

4 story multi-family residential
25,000 gross square feet

- Conventional Wood Framing (Type V-A, V-B)
- Light gauge Steel
- Insulated Concrete Forms
- Concrete Masonry
- Precast Wall

# Value - Insurance Benefit

- With increased emphasis on risk avoidance in the insurance industry, property insurers and risk insurance managers have noticed the fire-resisting advantages offered by non-combustible construction

| Occupancy Apartment Building three-story, six-unit | | Precast Concrete Roof and Floors, Brick/Block Wall | Wood-Frame Walls, Floors and Roof |
|---|---|---|---|
| Type of Insurance | | Annual Premium | Annual Premium |
| Building | Fire | $150.82 | $3,438.53 |
| | Ext. Cov. | $ 80.00 | $ 876.00 |
| Contents | Fire | $ 88.50 | $ 131.58 |
| | Ext. Cov. | $ 20.00 | $ 219.00 |
| Total Annual Premium | | $339.32 | $4,665.11 |
| Total Monthly Premium Per Unit | | $ 4.71 | $ 64.79 |

Source: Concrete & Masonry Industry Firesafety Committee's Fire Protection Planning Report No. 9

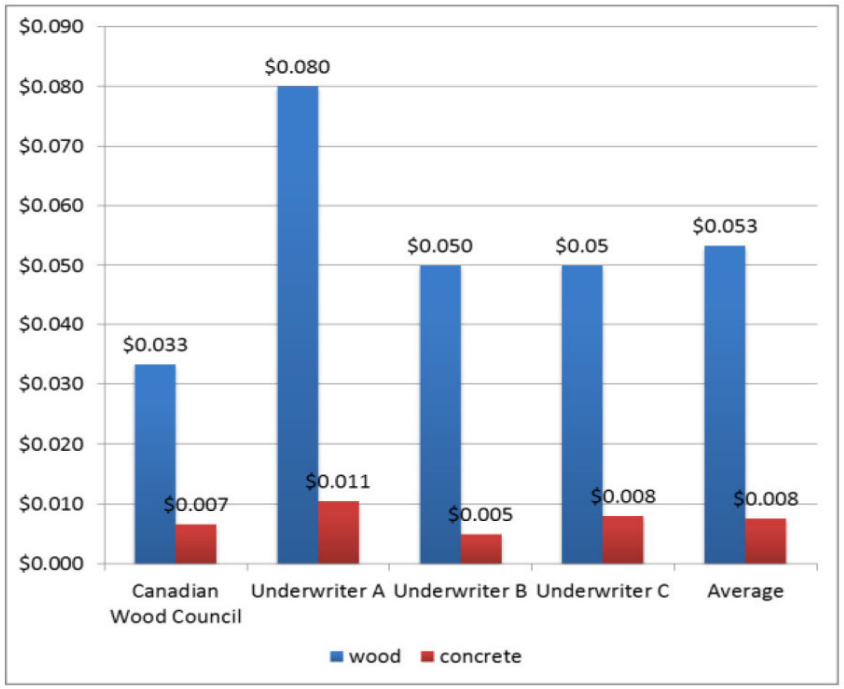
# Value - Insurance

- Insurance costs more than six times greater for wood frame buildings than for concrete building

  - Globe Advisors

  *Study of Insurance Cost for Midrise Wood Frame and Concrete Residential Buildings, 2015*

**Course of Construction, Builders Risk Insurance Rates per $100 Monthly**




Source: Data drawn from Confidential Interviews and Canadian Wood Council

# Value Case Study: Bluestone Group, NYC

THE BLUESTONE ORGANIZATION
DEVELOPERS
BUILDERS
PROPERTY MANAGERS

# Value: NYC Unit Costs (non-union)

| 2008 | 2016 |
| --- | --- |
| CMU - $14.00/SF | CMU - $22.00/SF |
| ICF - $21.00/SF | ICF - $18.00/SF |

THE BLUESTONE ORGANIZATION
DEVELOPERS
BUILDERS
PROPERTY MANAGERS

# Questions?

Value

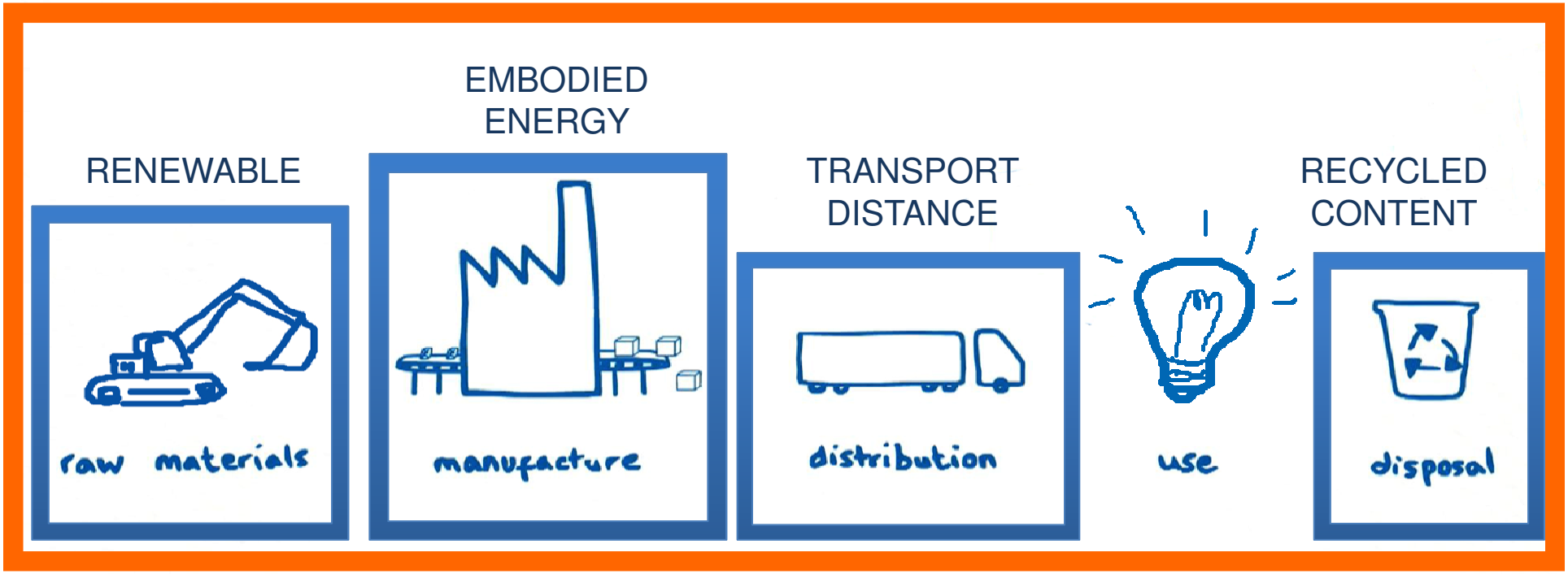
# Sustainability

Climate Change

- Embodied Carbon
- Energy Conservation
- Urban Sprawl
- Ozone Depletion
- Air Pollution
- Toxins – CFC's, DDT, etc.
- Deforestation
- Heat Island Effect

- Resource Depletion
- Light Pollution
- Water Pollution
- Waste Disposal
- Human Health
- Soil Erosion

# Sustainability

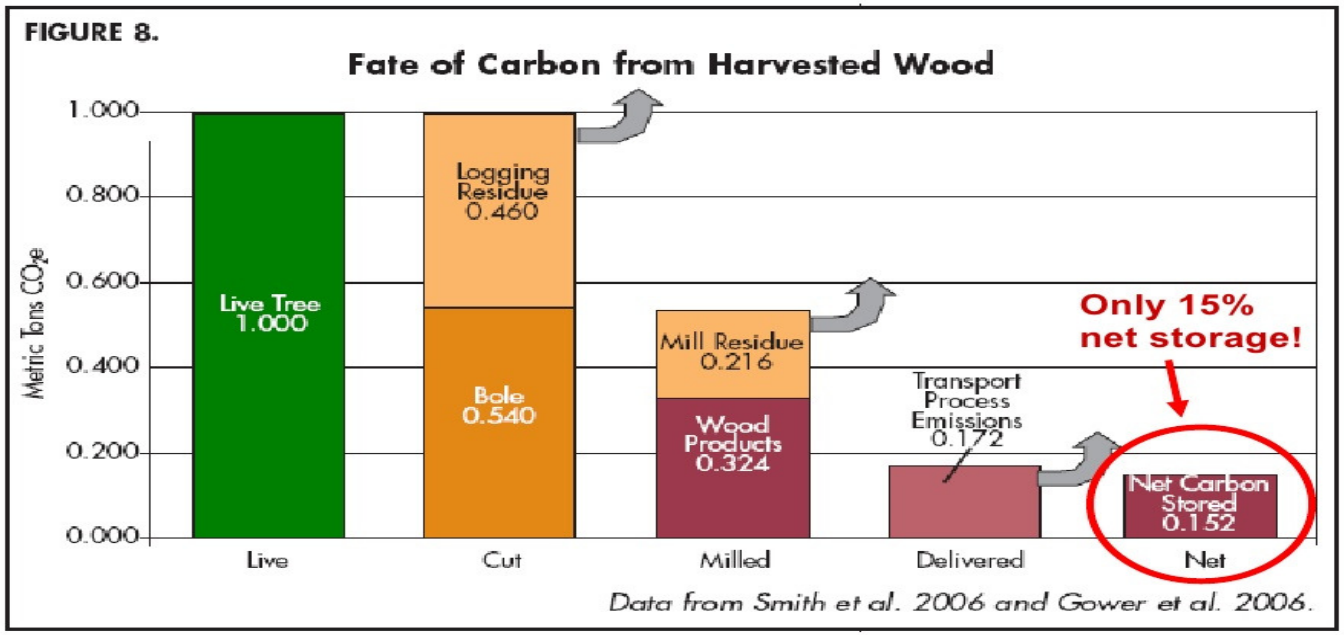


# Sustainability – Wood Claims

- *"Wood sequesters carbon"*
- *"Each year, 10-45 million tons of CO2 are stored in new wood products"*
- *"A big advantage of the product is that it is more sustainable than traditional building materials, such as concrete and steel, because of wood's capacity to store carbon."*

# Sustainability – Reality

Only a small fraction of forest carbon is stored in wood products.




Logging transfers most of the carbon in the forest to the atmosphere as logging slash, mill waste, and processing emissions.

Ingerson, Ann L. 2007. U.S. Forest Carbon and Climate Change. Washington, D.C.: The Wilderness Society.

# Sustainability - Reality

**Reality** : The most significant impacts of industrial forestry— harm to forest ecosystems, biodiversity, and soil and water quality—are not addressed.

**Acres of Certified Forest in North America (mil of acres)**

| | |
|---|---|
| Canadian Standards Association | 179.3 |
| Sustainable Forestry Initiative | 131.6 |
| Forest Stewardship Council | 56.8 |
| American Tree Farm System | 24.4 |

Source: www.certificationcanada.org

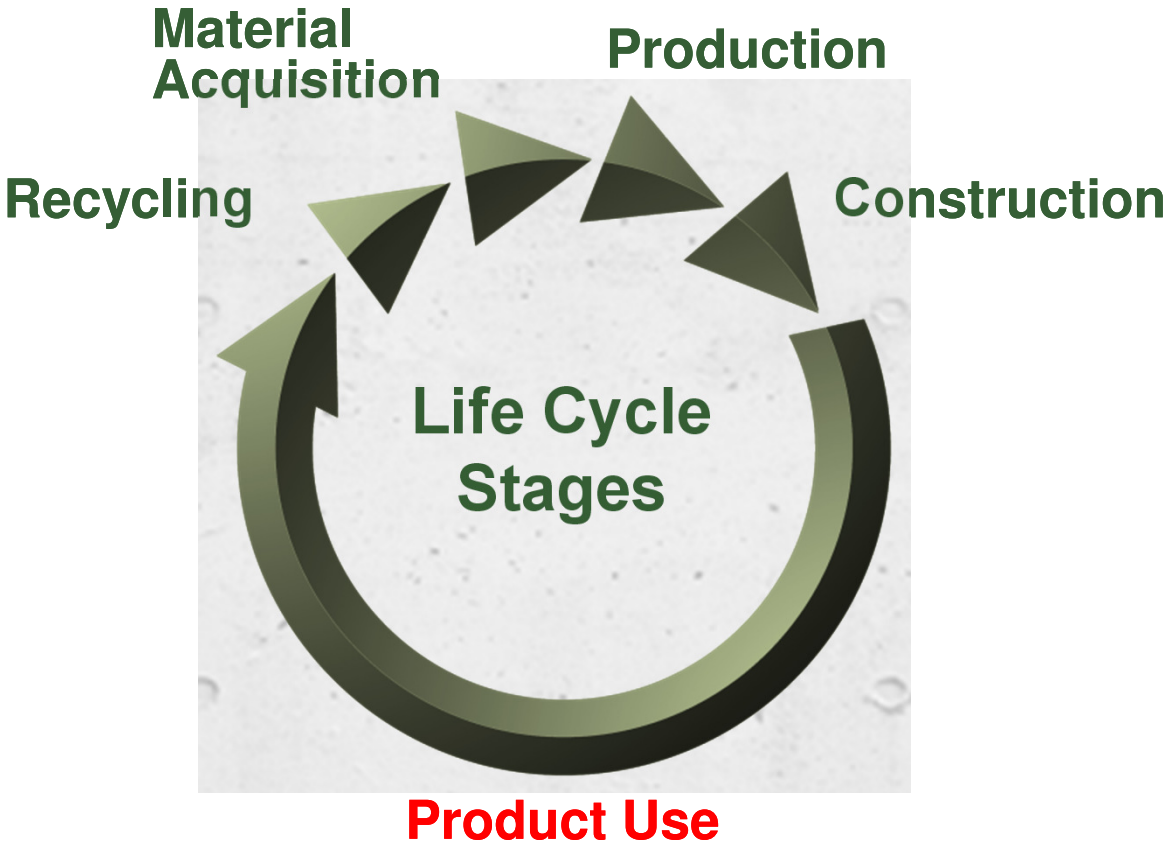
# Sustainability - Reality

## Do Oregon's clear–cut and pesticide buffers protect drinking water from creeks, rivers?

*“Atrazine is a toxic pesticide banned in many countries but legal in the United States. It is a known endocrine disruptor and likely carcinogen, yet it is common in logging practices…”*

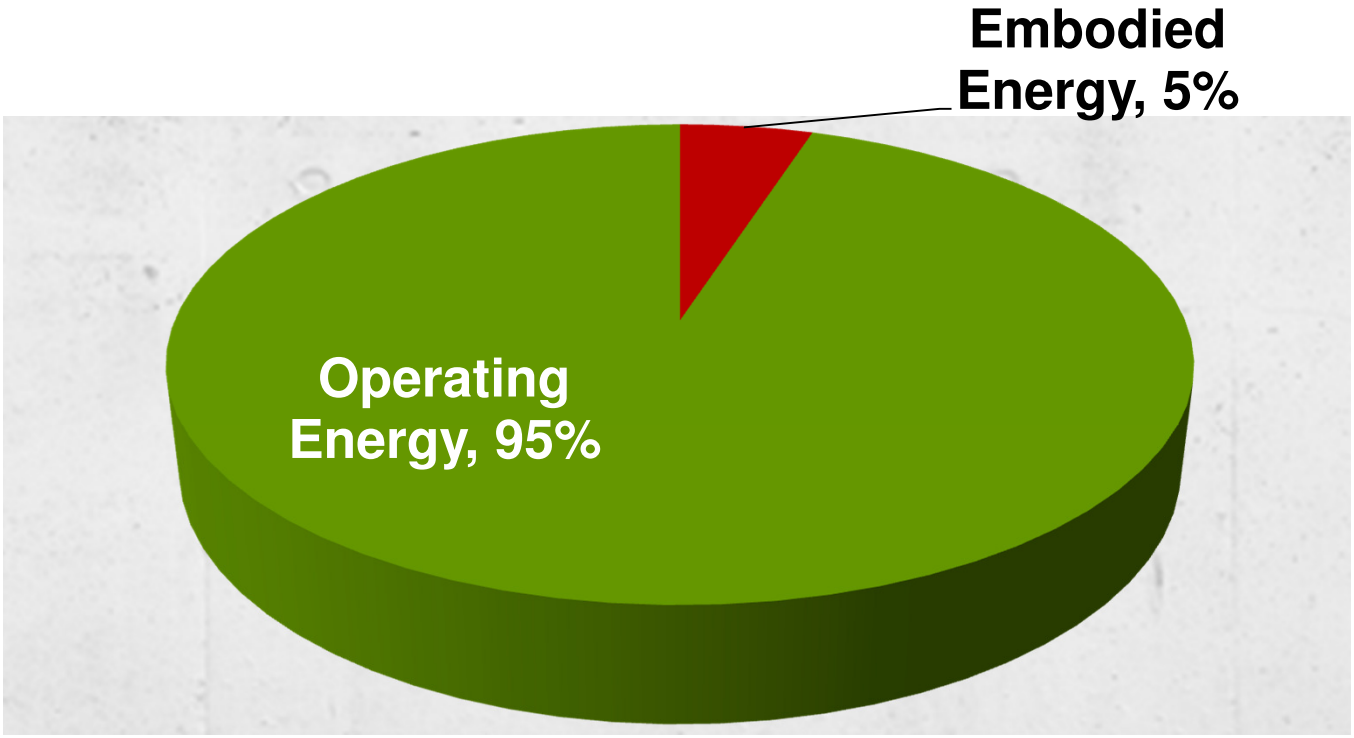
*- OregonLive.com*

# Sustainability = Life Cycle Perspective



# Sustainability – Operation is Key

## Global Warming Potential



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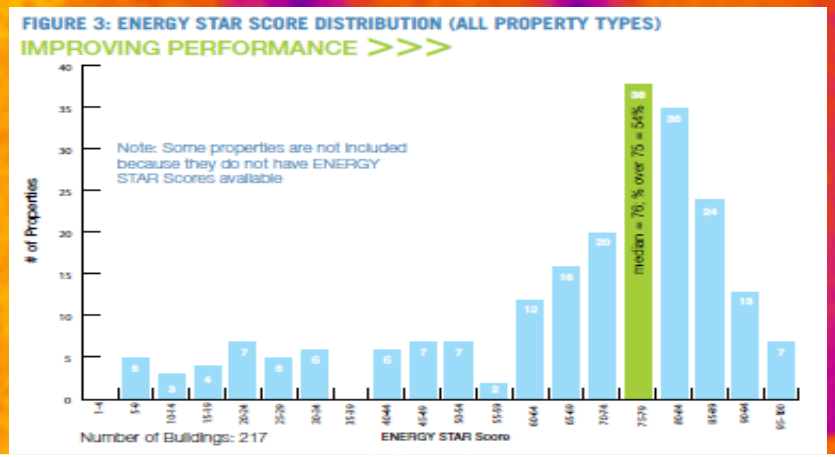
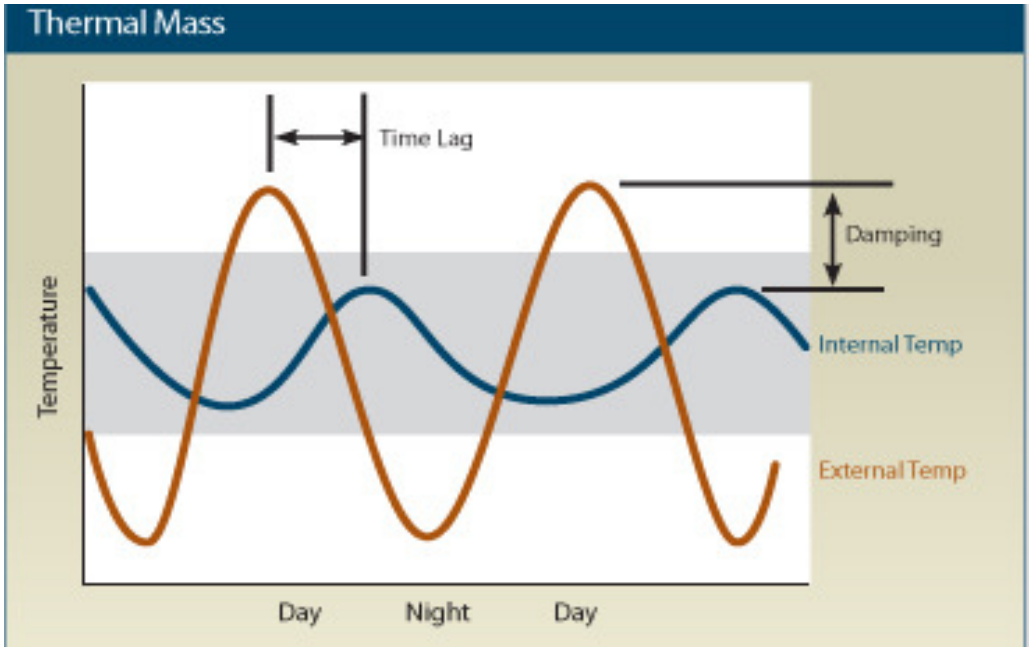
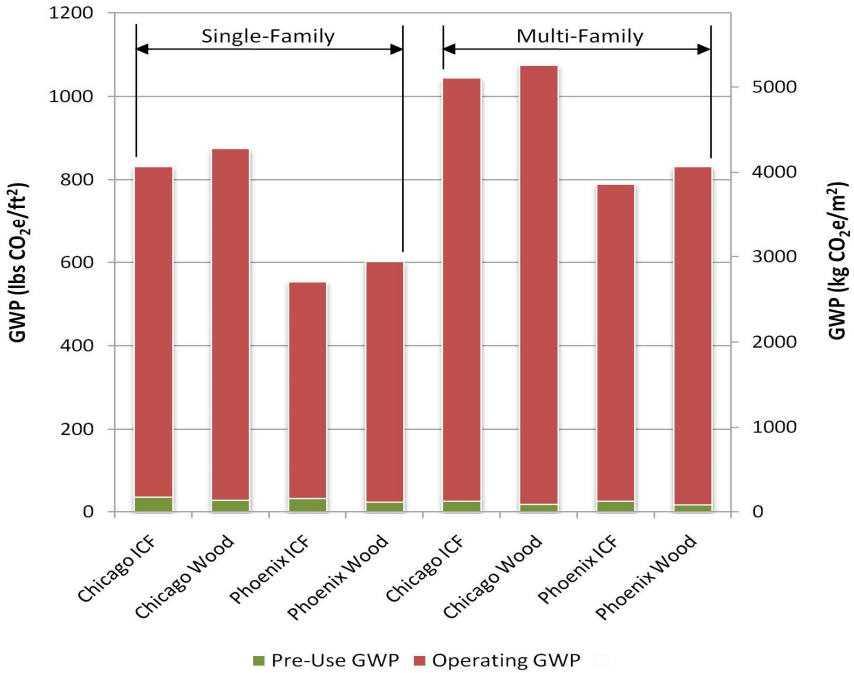


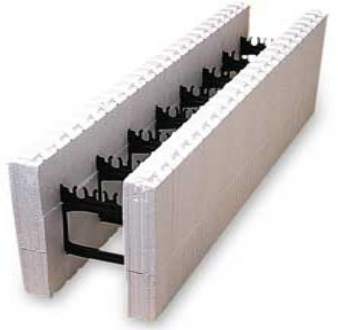
# Sustainability – Thermal Mass

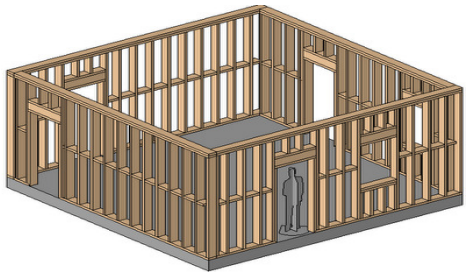
- Increase thermal lag
  - Off peak demand
  - Lower energy costs
- Lower peak energy
  - Smaller, more efficient HVAC equipment
- Reduce temperature swings
  - Less heating and cooling energy required



# Sustainability – MIT Study





Ochsendorf, J., et al., *Methods, Impacts, and Opportunities in the Concrete Building Life Cycle,* Massachusetts Institute of Technology Concrete Sustainability Hub, Cambridge, MA, 2011.

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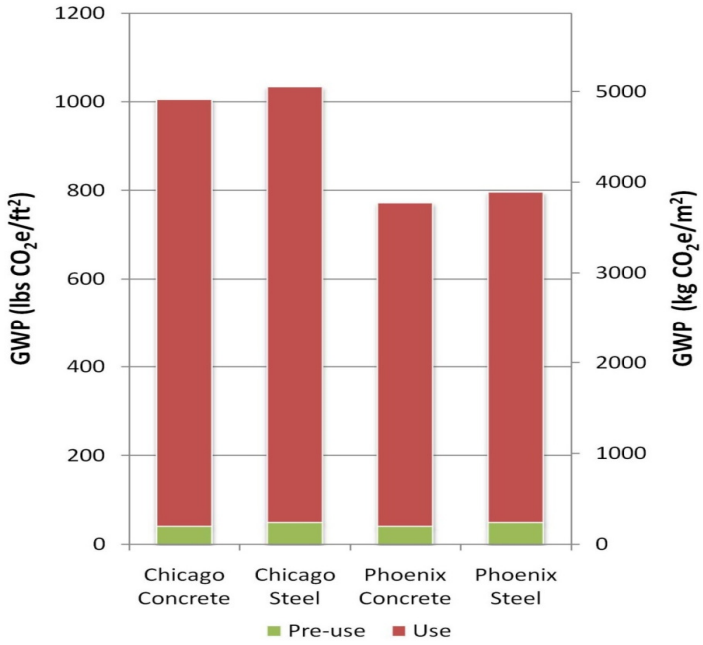


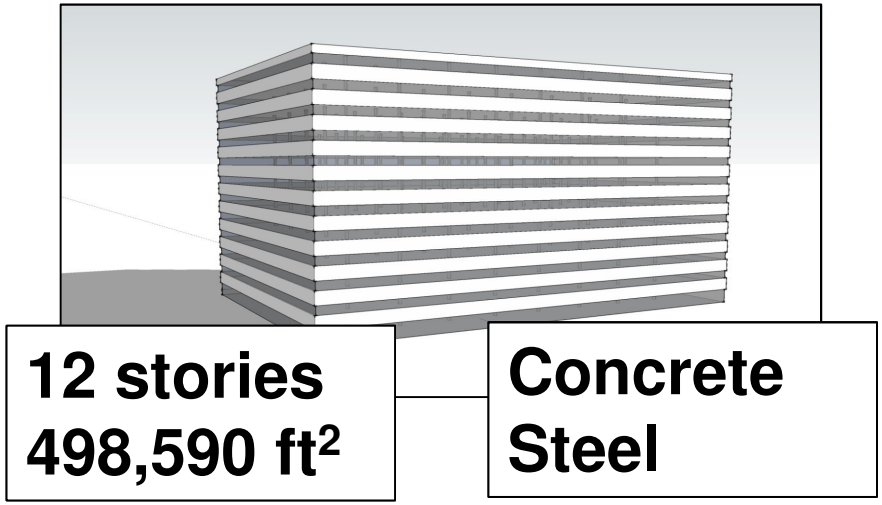


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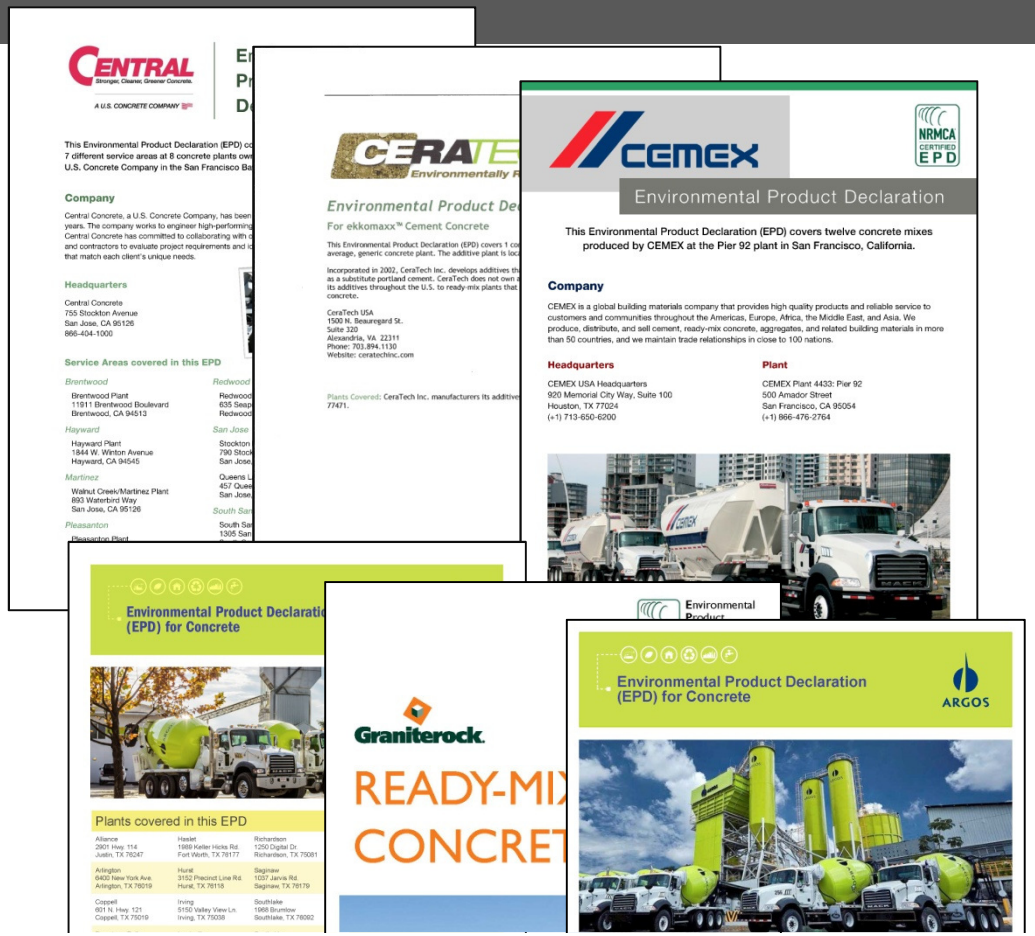
# Sustainability - Transparency

# Sustainability - Transparency

- 9 EPDs in NRMCA EPD Program
- 2500+ products

- 8 EPDs in other programs

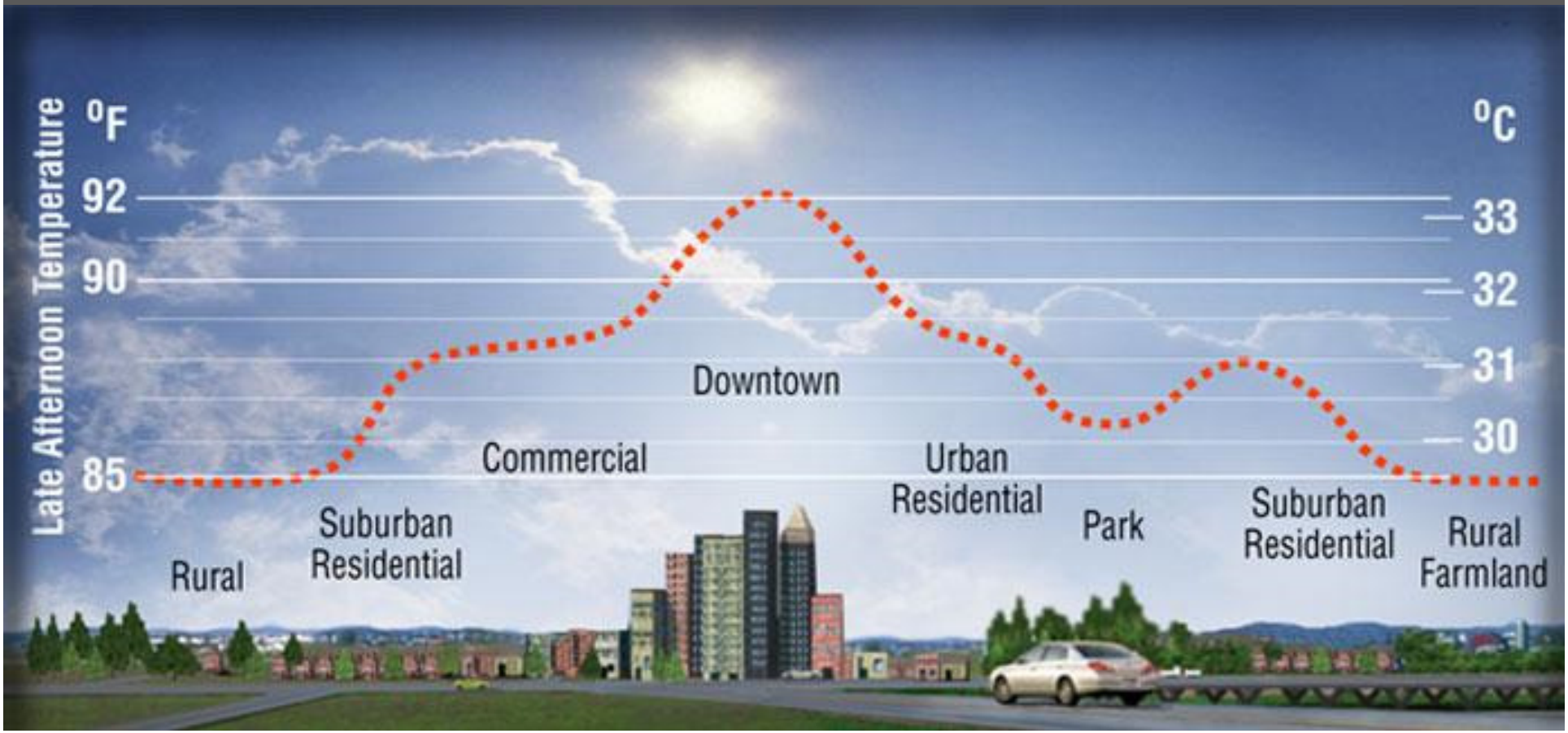


# Sustainability – Transparency

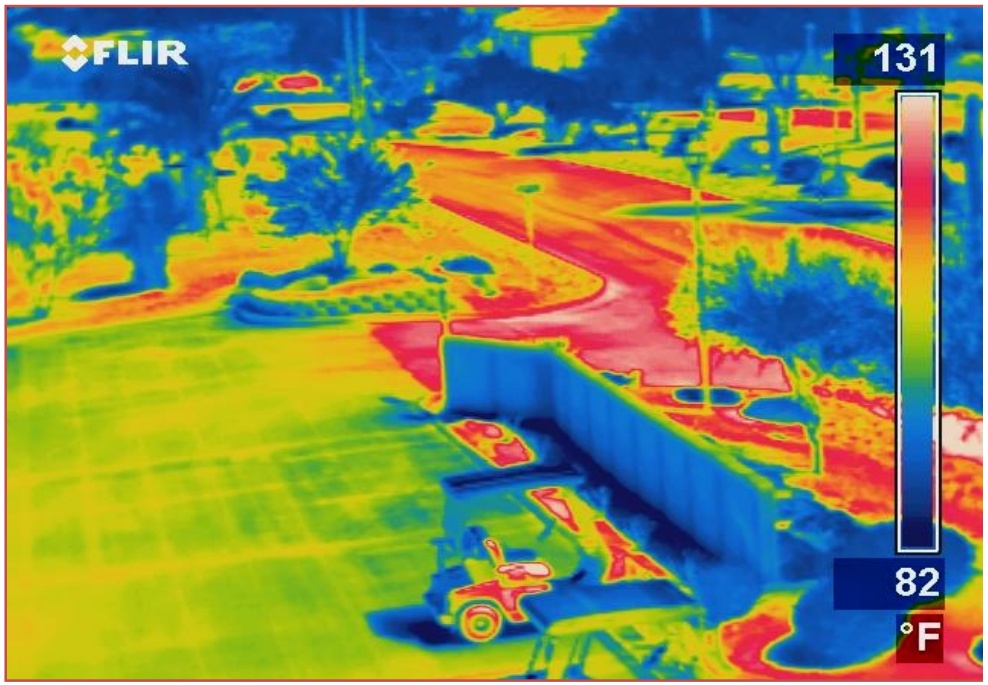
**Capitol Tower**
**35-story, 750,000-SF Class A , Houston**

MRc1: Whole Building LCA Option: 3 Points

# Urban Ambient Temperature



# Sustainability - Heat Island Mitigation




Photos courtesy of the American Concrete Pavement Association

# Sustainability - Los Angeles Example

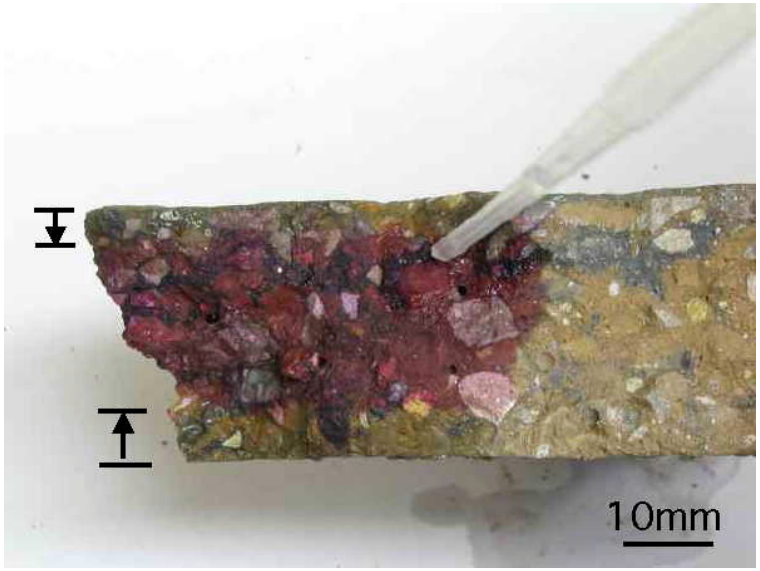
If **30%** could be more reflective, next resurfacing…

- **5 to 9° F** Lower Peak Temperatures
- **1/2 to 1 GW** Less in Peak Power Consumed
- **$100,000**/Hour Save Energy
- **10%** Reduction in Smog
- Same as removing **3 million** cars from the road

Source: http://eetd.lbl.gov/HeatIsland/LEARN/LAIsland/

# Sustainability – Carbon Uptake

- $CO_2$ reabsorbed into concrete throughout lifetime
  - Small amount during service life
  - Significantly more from crushed concrete (increased surface area)
- Process is called **carbonation**
- 33% to 57% of $CO_2$ emitted from calcination is reabsorbed through carbonation over 100-year life



# Questions?

Sustainability