Achieving Resilience -
How Masonry Supports Resilient Designs

AIA Course Number: TMS20220512

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The Masonry Society
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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

2

Course Description

This course provides an overview of **resilient design** and discusses how resilient design is and is not covered by **building codes and standards**. The **role of masonry** construction in meeting resilient design goals is explained, and the **inherent properties of masonry** that make it resilient are described. **Examples of resilient design strategies** are provided.

3

Learning Objectives

Upon completion of this course, you will be able to:

1. Define resilience.
2. Explain how resilient designs go beyond the minimum building code requirements.
3. List at least three above-code standards that can be used with resilient designs.
4. Describe inherent properties of masonry that provide resilience.

4

Question No. 1

Do you live in a resilient community (city/county/state)?

5

What is Resilience?

"Resilience is the capacity of individuals, communities, businesses, institutions, and governments to **adapt** to changing conditions and **prepare** for, **withstand**, and rapidly **recover** from disruptions to everyday life, such as hazard events."

Source: FEMA Fact Sheet: *Planning For a Resilient Community*

6

What is Resilience?

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Source: FEMA Fact Sheet: *Planning For a Resilient Community*

7

What is Resilience?

Resiliency encompasses addressing a broad spectrum of social and policy components that start before an event occurs.

8

Starts with awareness

TARGET STATES OF RECOVERY: WASHINGTON'S HOUSING & ECONOMIC DEVELOPMENT SECTOR

	Event occurs	0–24 hours	1–3 days	3–7 days	1 week–1 month	1–3 months	3 months–1 year	1–3 years	3+ years
Finance and banking					×				
Commerce (commercial facilities)						×			
Real estate and construction					×				
Manufacturing (industrial facilities)						×			
Planning and community development						×			
Unreinforced masonry structures									×
Housing									
Detached single-family residential (pre-1950)							×		
Detached single-family residential (post 1950)					×				
Mid- and high-rise structures (pre-1977)								×	
Mid- and high-rise structures (post 1977)						×			

Source: Resilient Washington State: A Framework for Minimizing Loss and Improving Statewide Recovery after an Earthquake

And extends beyond buildings

TARGET STATES OF RECOVERY: WASHINGTON'S TRANSPORTATION SECTOR

	Event occurs	0–24 hours	1–3 days	3–7 days	1 week–1 month	1–3 months	3 months–1 year	1–3 years	3+ years
Interstate 5									
Puget Sound (center & north)								×	
South end (Chehalis south)							×		
Interstate 90									
Puget Sound (Snoqualmie Pass west)								×	
Cascades to eastern WA (Snoqualmie to Idaho)							×		
Interstate 405									
South end (Tukwila to I-90)								×	
North end (I-90 to Lynnwood)								×	
Ferry operations							×		

Achieving Resilience

BUILDING DESIGN

What Role do Buildings Codes Play?

Building codes have been with us for millennia in one form or another, but what is it we attempt to accomplish with them?

The Intent of Building Codes

Do modern building codes meet minimum expectations?

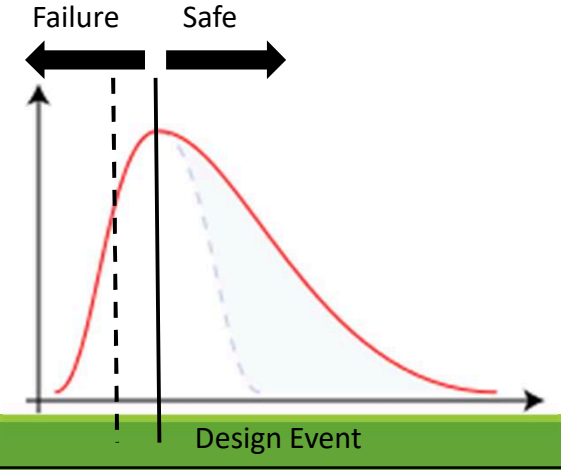
Question No. 2:

Can I shelter in-place during a design wind event for my location?

13

The Intent of Building Codes

If your home exactly met current code requirements…



14

The Intent of Building Codes

Through the years the scope and complexity of building codes has evolved, with one grounding target…

[A] 101.3 Intent. The purpose of this code is to establish the minimum requirements to safeguard the public health, safety and general welfare through structural strength, *means of egress* facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to life and property from fire and other hazards attributed to the built environment and to provide safety to fire fighters and emergency responders during emergency operations.

15

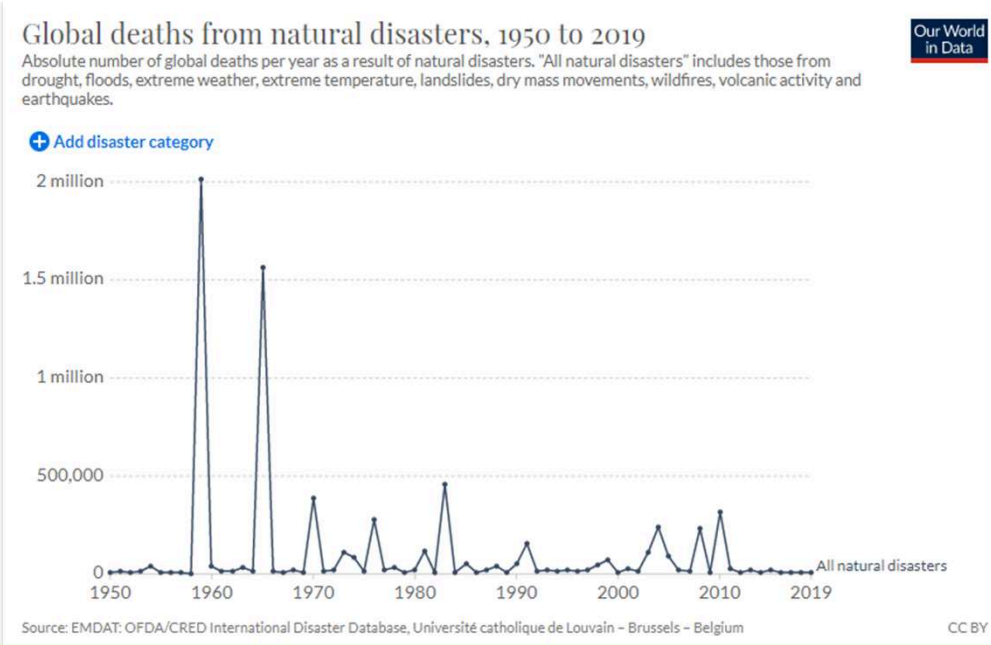
The Intent of Building Codes

Delicate balance – maintaining affordability by reducing/holding the initial cost of construction down

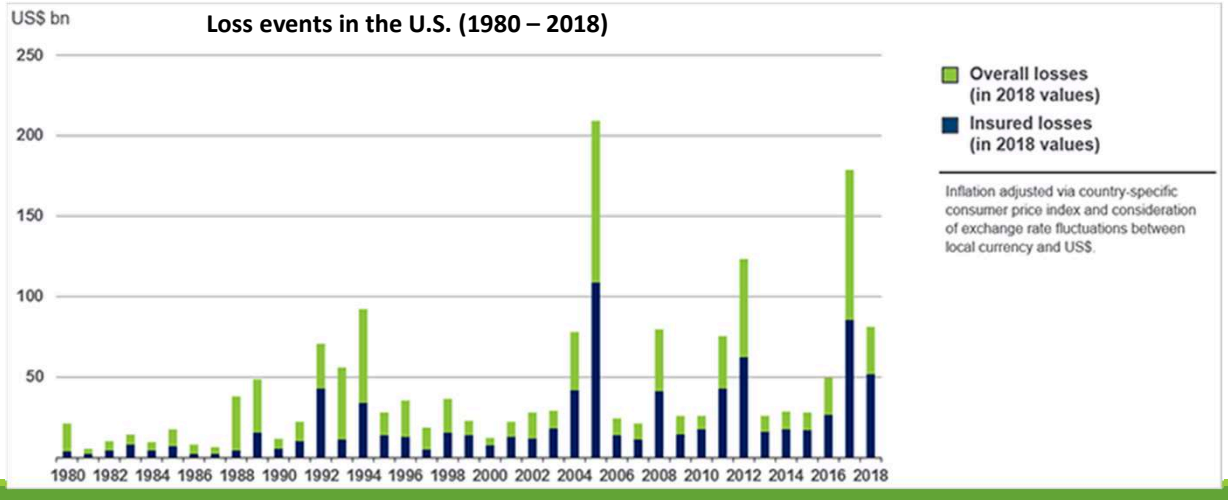
…but often at a compromise

or trade off.

16

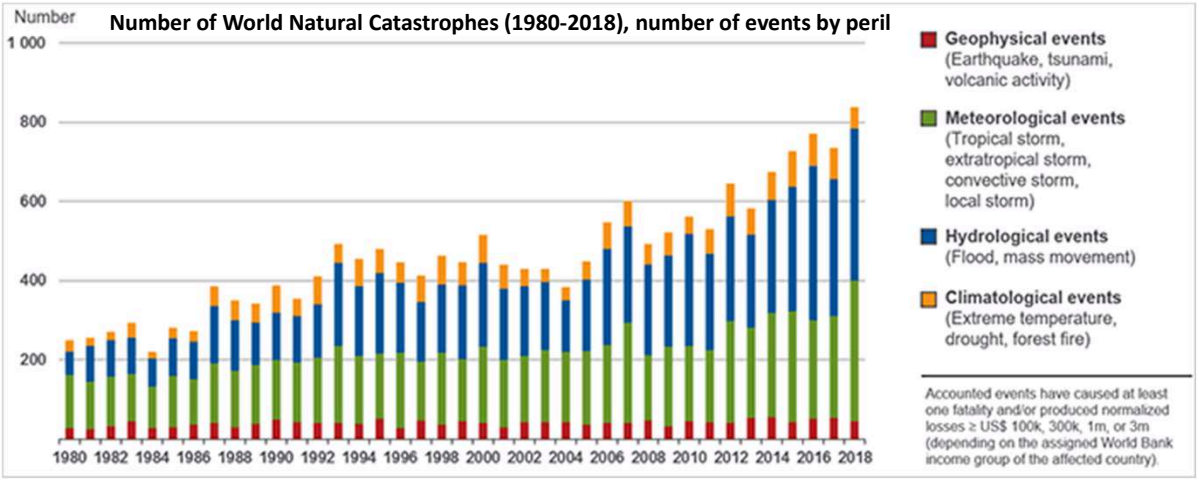


While the loss of life has decreased, the **cost** of disasters has shifted in the opposite direction.



Source: © 2019 Munich Re, Geo Risks Research, NatCatSERVICE. As of March 2019.

And the **number** of catastrophes continues to increase.



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What is Resilience?

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Source: FEMA Fact Sheet: *Planning For a Resilient Community*

20

Communities take action

Local communities are looking at enacting resiliency policies and programs…including:

21

Communities take action

Tools include:

- Estimating and forecasting greenhouse gases

Resources include:

- Publications
- Webinars
- Trainings

22

Communities take action

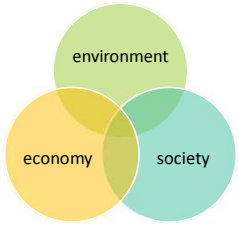
Local community leaders are **networking** across the globe to provide **tools**, **knowledge**, and **resources** on numerous challenges confronting communities.

RESILIENT GLOBAL RESILIENT CITIES NETWORK

Communities take action

Many of these organizations recognize that **environmental**, **economic**, and **social** disruptions are **interconnected**.

INSTITUTE FOR Sustainable Communities



Resiliency Rating Programs

25

Resiliency Rating Programs

LEED includes:

- general sustainability approach
- pilot credits for resilient design
- pilot credits for social equity

26

Resiliency Rating Programs

RELi is a rating program built on LEED. Credits include:

- hazard evaluation and preparedness
- community social and economic vitality
- water, energy, and materials

27

Resiliency Rating Programs

The U.S. Resiliency Council (USRC) building rating system evaluates seismic performance on the basis of:

- safety
- damage
- recovery

28

Resiliency = Above Code

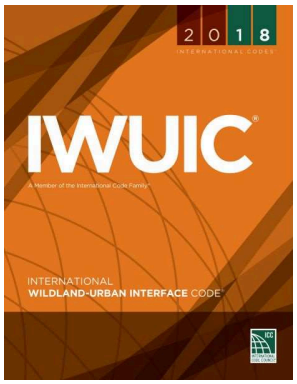
The term **'above code'** is often used to describe resiliency programs and standards.

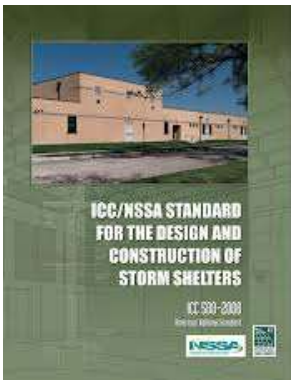
Fire | High Winds | Environment (Green)

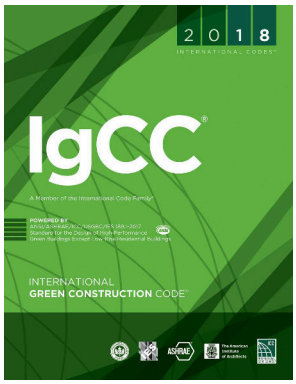
Building Code

Resiliency Standards

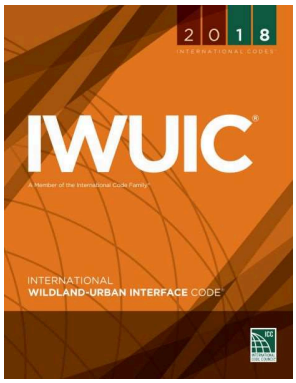
'Above code' standards for construction:







Resiliency Standards

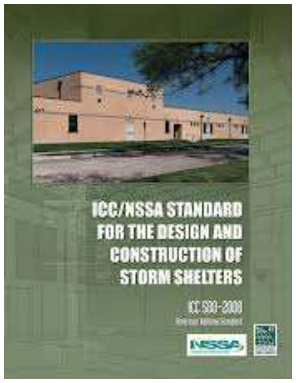


The International Wildland-Urban Interface Code addresses the threat of **wild fires**.

- Roof: non-combustible materials
- Exterior Walls: 1-hr fire rated or non-combustible materials, or fire-retardant-treated wood
- Glazing: tempered or multi-layered glass, glass block, or 20 min fire protection rating

* For Class 1 ignition-resistant construction

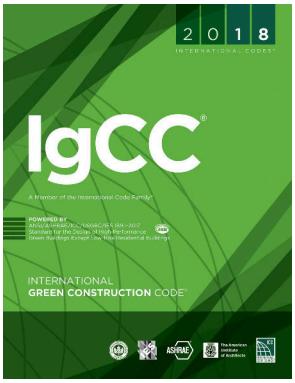
Resiliency Standards



The ICC 500 storm shelter design standard addresses the threat from **high winds and tornadoes**.

- Minimum structural design requirements
- Missile impact testing for exterior materials
- Anchorage requirements: doors, windows, foundations

Resiliency Standards



The International Green Construction Code (IgCC) addresses **sustainable building design.**

- On-site renewable energy
- Construction not permitted in undeveloped 100-year flood plains
- Daylighting requirements

Resiliency Guides

Programs that encourage 'above code' construction practices.

FLASH
FEDERAL ALLIANCE FOR SAFE HOMES

A PROGRAM OF IBHS
FORTIFIED
HOME

The Result

These programs promote tested techniques to reduce damage to homes and businesses.

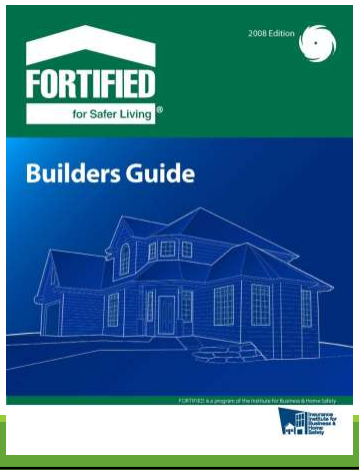
35

The Reality…

Building ‘above code’ costs more than building to the ‘minimum code’.

How much more?

According to IBHS, average cost increase for a FORTIFIED home is 3-10%.



37

The Reality…

How does a masonry building perform?

38

The Reality!

The ‘Common’ building was below current building code minimum…

the ‘Stronger’ building was built to current code minimum.

Masonry constructed today is:

Inherently resilient…inherently **above code**.

What specifically does that mean…

39

Inherent Resiliency

Codes don’t require robustness and durability… but masonry provides it inherently.

40

Inherent Resiliency

Codes don't require noncombustible materials… but masonry provides it inherently.

41

Inherent Resiliency

Above-code IWUIC requires extra attention to the building walls, roof, eaves and more… masonry inherently meets the walls requirements.

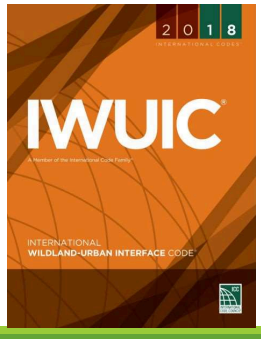
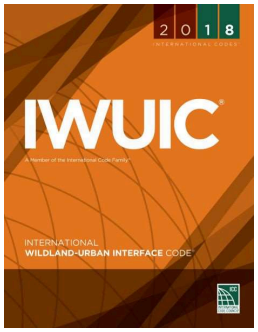


Photo courtesy of ANNE BELDEN/ISTOCK

42

Inherent Resiliency



Standard masonry construction used as the exterior wall (or as veneer) provides non-combustible exterior cladding and meets the minimum fire-rating requirements.

43

Inherent Resiliency

Codes don't require impact resistance*… but masonry provides it inherently.

*Except for storm shelters.

44

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45

Inherent Resiliency

Codes don't require impact resistance*… but masonry provides it inherently.

*Except for storm shelters.

46

Inherent Resiliency

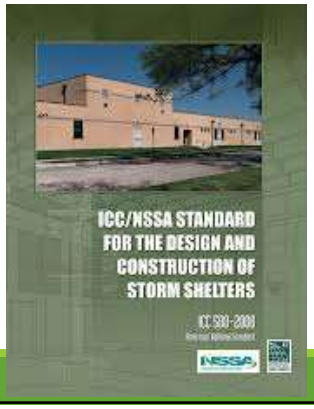
Testing shows that **common masonry construction** can withstand missile strikes equivalent to 250 mph wind.

- fully grouted single wythe concrete masonry walls
- partially grouted concrete masonry walls with a brick veneer

47

Inherent Resiliency

Tornados – Beginning with the 2015 IBC, storm shelters are required for most educational facilities in high risk tornado regions.



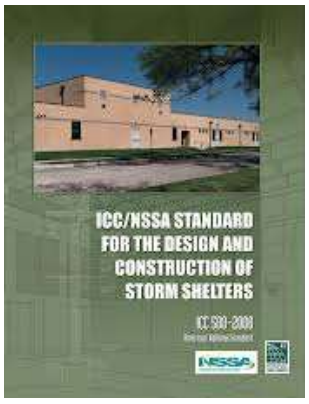
48

Inherent Resiliency

Tornados – Beginning with the 2021 IBC, all regions of the country will need to design for loads resulting from tornados.

49

Inherent Resiliency



- 8-inch fully grouted cmu walls, reinforced with #5 bars at 48 in. on center, can meet the storm shelter requirements for 250 mph wind speed (highest wind speed)
- lower speeds mean less reinforcement and/or smaller units or other materials

50

Inherent Resiliency

Code minimums don't guarantee structure survivability… masonry provides robustness.

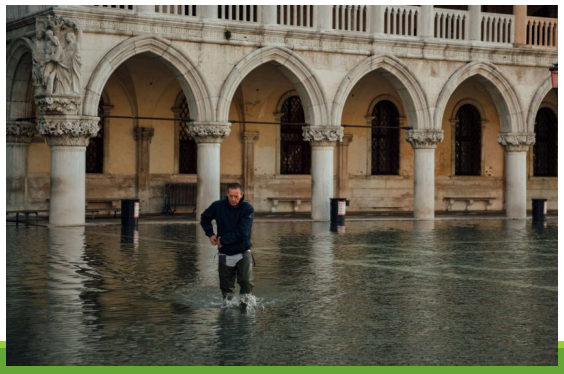
Inherent Resiliency

Codes don't require redundancy… but masonry provides it inherently.

52

Inherent Resiliency

Codes don't require flood-resistant construction… masonry provides it inherently.



Inherent Resiliency

Codes don't require mold-proof construction… masonry provides it inherently.

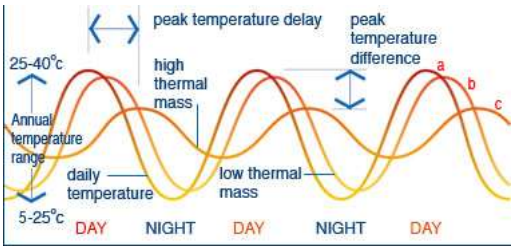
From EPA Mold Remediation in Schools and Commercial Buildings Guide

Ceiling tiles	• Discard and replace.
Cellulose insulation	• Discard and replace.
Concrete or cinder block surfaces	• Remove water with water extraction vacuum. • Accelerate drying process with dehumidifiers, fans, and/or heaters.

54

Inherent Resiliency

Codes don't require passive survivability… masonry provides it inherently.

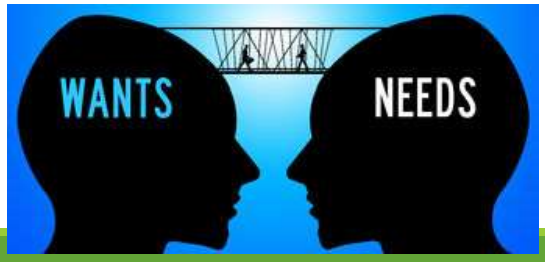


Inherent Resiliency

Masonry is:

Inherently above code…inherently **resilient**.

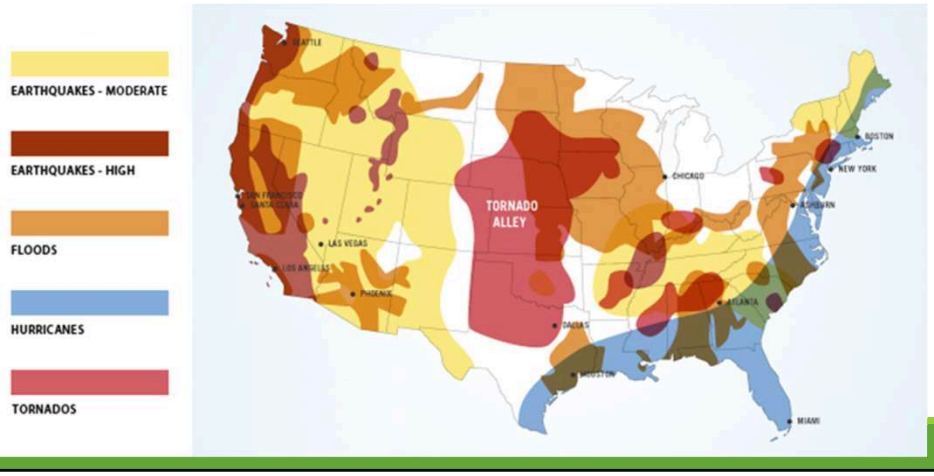
It does come down to balancing our needs with our choices…



56

Balancing Needs

And the reality is ‘disaster free’ zone is relative.



57

What’s Masonry’s Role?

Strength, durability, non-combustibility, impact resistance, flood and mold resistance, and thermal performance…all inherent properties of masonry construction.

While masonry doesn’t define a resilient building or community, it is a key cornerstone to achieving these goals.

58

Examples of Resilient Masonry Strategies

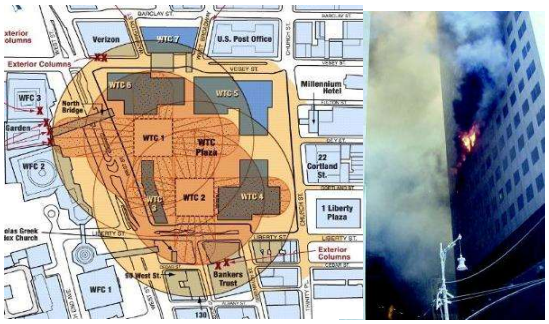
NYC Climate Resiliency Design Guidelines - Recommendations include passive solar cooling and "**thermally massive materials**"

LEED IPpc100 – Passive Survivability and Back-up Power During Disruptions **-** Includes recommendation for **inclusion of thermal mass.**

LEED IPpc99 – Design for Enhanced Resilience – Recommends mitigation strategy processes such as **safe rooms**

FLASH – Recommends **concrete masonry for safe rooms**

Inherent Resilience (Enhanced Durability)



WTC 7, (Built in 1987)
first tall building known to have collapsed primarily due to uncontrolled fires

90 West St. (Built in 1907)
Damaged by WTC collapse, uncontrolled fire for 5 days, and reopened as apartment building in 2005

Inherent Resilience (Enhanced Durability)

Winecoff Hotel, Atlanta
(Built in 1913)

Completely gutted by fire in 1946, became hotel in 1951, then housing for elderly. Sat vacant for 20 years, and finally became the Ellis Hotel in 2007

Inherent Resilience (Enhanced Durability)

The Burke Building, Fourth Avenue, Pittsburgh's oldest standing commercial building. Constructed in 1836, was one of the few survivors of the Great Fire of 1845.

1907 Flood –
Federal St.
(Northside)

1936 Flood –
Manchester

Photos from The Odd, Mysterious & Fascinating History of Pittsburgh

Case Study: Greensburg, KS

On May 4th, 2007 an EF5 tornado leveled the rural town of Greensburg, Kansas

After the disaster, the community came together and decided to rebuild sustainably, striving to become a model green town for the future

Case Study: Greensburg, KS

Kiowa County Courthouse

- Damaged, but not destroyed, making it one of the few historic buildings in Greensburg to survive
- exterior masonry walls of the building remained intact and were able to be reused

What can designers do?

- Understand that building codes are minimum criteria, not 'resiliency' standards.
- Know what mitigation strategies your community has in place.
- Recommend cost-effective design strategies that provide resilience.
- Recognize masonry inherently provides many above code and resilient benefits and use these to fullest advantage.

65

Resources

AIA - https://www.aia.org/topics/56-resilience

FLASH - https://flash.org/

FEMA - https://www.fema.gov/about/offices/resilience

NIBS - https://www.nibs.org/page/mmc

Resilient Design Institute – resilientdesign.org/

RELi - http://c3livingdesign.org/?page_id=5110

Many cities and states have information on resilience

66

Masonry Resources

BIA - https://www.gobrick.com/

IMI - https://www.imiweb.org/

NCMA - http://cmd.ncma.org/functional-resilience/

PCA - https://www.cement.org/cement-concrete-applications/resilient-construction

TMS - https://masonrysociety.org/product/masonry-is-sustainable-brochure-2018/

67

Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

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