Better Building Codes: Demanding Minimum Construction Practices—“It’s the Least We Can Do!”

The Webinar will begin shortly …
Better Building Codes: Demanding Minimum Construction Practices—“It’s the Least We Can Do!”

Multihazard Mitigation Council Webinar Series
National Institute of Building Sciences

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www.flash.org
Today’s Webinar

Is based on a FLASH commentary published May, 2014 entitled,

Building Codes: The Foundation for Resilience

As our nation rightfully seeks enhanced community resilience in the face of natural disasters and climate change, it’s time to embrace the most essential aspect to resiliency—an uncompromising system of building codes and standards that guarantee a minimum level of home safety, durability and sustainability.

http://www.flash.org/building-codes.pdf
Today’s Webinar

• FLASH Organizational Background

• U.S. Building Code System Through a Policy Lens
  – Contrasting cases that highlight success/challenges at the local levels where codes succeed or fail and how researchers are driving breakthroughs by rethinking old myths about building
    • Memphis, Tennessee - Earthquake
    • Moore, Oklahoma - Tornado

• Insights for Building Safety and Resilience Advocates

• Questions/Discussion
Mission: Strengthening Homes & Safeguarding Families

• We *partner* with leading public, private and nonprofit academic, consumer, entertainment, financial services, product, research, service and technical organizations to deliver the latest advances in disaster safety information to the public

• *Create* a public value for resilience

• *Develop and deliver* initiatives focused on:
  – Storytelling for the public (Consumer Awareness)
  – Curriculum for students & professionals (Education & Training)
  – Policy leadership for influencers (Leadership)

• *Mainstream* the science of safe, strong and sustainable buildings
Mission: Strengthening Homes & Safeguarding Families

- Consumers, Leaders who understand, value & demand stronger, safer buildings
- Higher Education that includes building codes, mitigation & resilience
- Banking, insurance, real estate, safety & tax Incentives
- Innovation across all sectors
- Building science and social psychology Research
- Strong, well-enforced Codes & Standards
A System of Strong, Well-Enforced Codes & Standards …

- Research-informed, consensus-based and timely code development with diverse stakeholders
- Adoption of modern, model codes intact without weakening amendments by state and/or local leaders
- Effective code enforcement by well-trained and empowered code officials with adequate resources
- Consistent use and application of codes by builders, designers, developers and product manufacturers
- Identification of beyond-code options and innovation (major factor in why communities need to keep codes current)
Where do leaders fit in?

- Leadership support at all levels (federal, state, local) is essential to ensure public policies and resources are in place to support adoption, enforcement and continuous improvement of codes and standards.
- Pre- and post-disaster relief should reward communities that maintain current, model codes.
Where do leaders fit in?

• Local leadership support flows from communities that understand, demand and accept the investment necessary to deliver a high performing system of building codes and standards

- Relevant, timely and trusted information can drive the right kind of support overall, if:
  - Local stakeholders collaborate;
  - Good science is in hand; and,
  - Political will comes alive (often post-disaster)

–Safety for families is paramount, but proving the economic case is critical
Today’s contrasting cases reflect different levels of leadership support for codes and standards

1. Memphis, Tennessee
   – Forty-plus year struggle towards adoption of modern seismic provisions

2. Moore, Oklahoma
   – New, unprecedented residential building codes designed to meet 135 mph winds
GREETINGS FROM MEMPHIS, TENN.
Memphis is in the heart of NMSZ
Memphis has historic seismic activity

• Several historic earthquakes
  – New Madrid earthquakes of 1811-1812; M 7.7
  – Northeast Arkansas 1843; M 6.3
  – Memphis, Tennessee 1865; M 5.0
  – Eastern Tennessee 1928; M 4.5

Memphis has abundant expertise …

- Applied Technology Council (ATC)
- Central United States Earthquake Consortia (CUSEC)
- Consortium of Universities for Research in Earthquake Engineering (CUREE)
- Federal Emergency Management Agency (FEMA)
- Memphis Office of Emergency Management
- Mid-America Earthquake Center
- Tennessee Structural Engineers Association (TN-SEA)
- United States Geological Survey (USGS)
- University of Memphis-Center for Earthquake Research and Information (CERI)
- West Tennessee Seismic Safety Commission
- West Tennessee Structural Engineers Association (WTSEA)
And large employers …

- Building well beyond out-of-date codes and using modern, model codes and beyond-code enhancements
  - FEDEX
  - Bass Pro Shops
• The City of Memphis has an aging infrastructure, and many of its large buildings, including unreinforced schools and fire and police stations, would be particularly vulnerable when subjected to severe ground shaking.

• Relatively few buildings were built using building codes that have provisions for seismic-resistant design. Soil liquefaction and related ground failures are likely to occur in downtown Memphis along the Mississippi River and along the Wolf River that passes through Memphis.

• Older highways and railroad bridges that cross the Mississippi River, as well as older overpasses, would likely be damaged or collapse in the event of a major NMSZ earthquake. Some of the bridges and pipelines crossing the Wolf River might be damaged or destroyed.
Yet some dispute the presence of the hazard …

- Map of the New Madrid and Wabash Valley seismic zones. Red circles indicate earthquakes that occurred from 1974 to 2002 with magnitudes larger than 2.5 (University of Memphis).

- Green circles denote earthquakes that occurred prior to 1974 (USGS Professional Paper 1527). Larger earthquakes are represented by larger circles. From USGS Fact Sheet 131-02, "Earthquake Hazard in the Heart of the Homeland"
Memphis Seismic Codes - History

- Interests blocked enactment of updated seismic provisions for decades despite widely accepted innovations and a state law requiring current codes within at least seven (7) years.

- Local large businesses were building beyond local requirements (FEDEX) or requiring lease terms for enhanced practices (Bass Pro Shops)

- Some local leaders relied disproportionately on an academic minority report regarding seismic risk

- Despite a National Level Exercise in 2011, the strong local disaster safety and professional community was unable to advance the updated seismic provisions and remained frustrated

- In late 2012, interests put forth a measure to repeal the state law and avoid any mandatory, current codes beyond seismic to include all codes
Guest column: Upgraded seismic code puts safety first

By Leslie Chapman-Henderson, Special to The Commercial Appeal
Tuesday, December 18, 2012

Like it or not, Tennessee is earthquake country.

After the West Coast, it is the region in the United States most at risk from earthquakes. An overwhelming majority of earthquake scientists, structural engineers and building code experts agree that the earthquake threat to the central United States is very real.

For that reason, we are deeply disappointed that the Shelby County Commission has delayed the implementation of seismic building code provisions. We are equally concerned that the Memphis City Council will follow suit.

The seismic standards provide the minimum life-safety protections for families no matter where they are when an earthquake strikes — at work, school or home. The provisions in the International Residential Code (for homes) and International Building Code (for commercial structures and schools) have the goal of preventing buildings from collapsing or suffering significant damage that would prevent the evacuation of occupants.

Stronger building codes, particularly seismic-related provisions, are proven to protect lives. Not unlike a crumple zone in a car crash, you may lose the building but you will save the occupant.

http://www.commercialappeal.com/opinion/guest-column-city-county-leaders-should-put-in

- Life Safety
- Efficacy
  - Most efficient time to build right is during new construction
- Economic Vitality & Interdependency
  - Tax Burden
Thirty percent (30%) of all U.S. goods flow through Memphis each year. The interdependent nature of the Memphis economy with national resilience became a major factor in the debate.
Case Study – Memphis Seismic Codes - Status

• The Tennessee Legislature declined to delay or otherwise weaken the state’s building code statutes in 2013

• State Insurance Commissioner/Fire Marshal publicly declared intent to enforce although unclear status at this time

• Memphis/Shelby County now have updated IBC & IEBC (eff. 10/1/13)
  – IRC effective date was delayed until December and it was amended (eff. 12/31/13)
  – Issue will not be revisited until 2021 when seven year law triggers review

• Disaster Safety Movement leaders can work together for strong codes. Local engineers led the way in Memphis.
U.S. Tornado Climatology

Average Annual Number of Tornadoes
Averaging Period: 1991 - 2010

An average of 1253 tornadoes occur in the United States each year

Monthly Tornado Occurrence Maps

January | February | March | April | May | June | July | August | September | October | November | December

http://www.ncdc.noaa.gov/climate-information/extreme-events/us-tornado-climatology
Deadly, high frequency legacy

- 156 tornadoes hit the Oklahoma City area between 1893 and May 31, 2013
  - 13 of 156 were severe tornadoes (11 were F4/EF4 and 2 were F5/EF5)
  - Five tornadoes occurred in a single day on both June 8, 1974 and May 31, 2013
  - The area has been struck 26 times by two or more tornadoes on the same day
  - Since 1950, there have been only three instances of a recess from tornadoes for more than two years
Case Study - Moore, Oklahoma

- The search for solutions in Moore led to destruction of a persistent tornado myth that we cannot affordably build to prevent destruction from tornadoes.

**Myth - *Impractical to design for low probability events***

- Tornado-resilient design not considered in current model building codes ostensibly because of the low probability of tornado occurrence, despite the fact that a tornado occurrence is a high-consequence natural hazard event.

- “For the wind hazard, ASCE 7 specifies a basic wind speed for use in determining design wind loads on structures in and outside of hurricane-prone regions. ASCE 7 allows the use of regional climatic data for estimating the basic wind speeds used in design in lieu of the ASCE-specified values as long as the data and data-analysis procedures meet certain statistical requirements. **Although the commentary to the current ASCE 7 standard provides a tornado hazard map for the contiguous United States... neither ASCE 7 nor the model building codes specify tornadoes as a design condition for conventional buildings, or require conventional buildings in tornado-prone regions to have occupant shelters at present. Thus, even though the requirements for wind-resistant design have been revised through regular updates to the model codes and ASCE 7 standard over the years ... neither the main wind-force resisting system (MWFRS) nor the components and cladding (C&C) of conventional buildings that have been designed to today’s minimum code requirements for wind hazard are expected to withstand the combined hazards of extreme wind speeds and wind-borne debris impact associated with strong tornadoes.**”

While constructing a home to withstand an EF4 or 5 tornado may not be feasible, what about constructing one to withstand EF3, 2, 1 and 0 wind speeds?

- The NCDC estimates that 77 percent of U.S. tornadoes are in the EF0 to EF1 range and 95 percent have wind speeds less than EF3 intensity.

- The Final Draft NIST Report of the Technical Investigation of the May 22, 2011 Joplin Missouri Tornado states,
  “Tornadoes rated EF–3 or lower have accounted for approximately 96 percent of all tornadoes in the official record and are associated with significant fatalities and economic losses. Over one-third (36 percent) of fatalities and about 80 percent of insured property losses have been caused by EF–3 or lower tornadoes. Even in tornadoes rated higher than EF–3, the majority of affected areas encounter EF–3 or lower wind speeds. In the case of the Joplin tornado, approximately 40 percent of the fatalities and up to 90 percent of the tornado area were associated with EF–3 or lower wind speeds.”

- A Dual-Objective-Based Tornado Design Philosophy (van de Lindt et al., 2012). Defies traditional assertions that “there is nothing you can affordably build to withstand tornadoes”}

The research informed effort comes in response to field investigations that documented a pattern of disproportionate structure collapse in tornado outbreaks.
A Dual-Objective-Based Tornado Design Philosophy (van de Lindt et al., 2012).

- “…a dual-objective-based design philosophy for residential buildings can reduce damage and save lives by focusing on separate tornado intensity levels. The performance of buildings
  - (1) at EF0 and EF1 wind speeds can be improved at the component level (i.e., connections),
  - (2) at the EF2 and EF3 wind speed design can be improved a the system level (e.g., shear walls, load paths), and
  - (3) at EF4 and EF5 wind speed LS can be provided using alternate means (e.g., safe rooms).”

- “several critical issues need to be addressed before the engineering community can develop and implement a dual-objective design philosophy for tornado hazard mitigation of residential buildings…[including]…
  - Identify realistic threshold wind speeds that a light-frame wood building can resist…. For economic viable residential buildings it is likely to be in the 120-150 mi/h range…. Develop a better understanding of the spatial characteristics of tornado loading…. [“the low probability of tornado occurrence combined with the high consequences of a tornado strike make for a very challenging load scenario to consider in structural design. Unlike straight line winds, it is difficult to attach a specific probability to tornado wind speed at a specific building site because of the low occurrence rate.”]
  - Acceptable and implementable approaches in the design and construction of residential buildings to reduce tornado damage are needed…. Implementation of shelters or safe rooms for extreme wind speeds.”
Effective April 17, Moore, Oklahoma City Council unanimously adopted residential building codes based on research and proven engineering technology proposed by civil engineers, Dr. Chris Ramseyer and Dr. Lisa Holliday.

Ramseyer and Holliday were part of the National Science Foundation (NSF) Rapid Response team that evaluated residential structural damage after the tornado, and were asked by city leaders to present findings and recommendations for consideration to the City Council in February.

Ramseyer explained that “A home is deconstructed by a tornado, starting with the breaching of the garage door….The uplift generated by the wind causes the roof to collapse until the pressure pulls the building apart. These new residential building codes could possibly prevent that in the future.”

Ramseyer has been working with local builders and contractors for nearly a decade to devise improved housing structures. His assessment immediately following the tornado proved the new building techniques worked.
– The NSF team found a neighborhood hit by the May 20 tornado. It was a new subdivision constructed by a builder known for constructing homes with tornado safe elements
  • two of the homes were completely wiped off the foundations, one was filed with debris and two other homes remained standing, but with damage
  • only 70 feet between the house with EF-5 tornado damage and the one that suffered EF-2 damage
– The amendments to the residential code were based on the results of the NSF team’s research, the loads and strengths outlined by the IBC principles, and laboratory testing
– Estimates cited indicate that the amendments would only increase construction costs by $1 per square foot
  • However, improvements can cost even less. A 2011 cost study conducted by Simpson Strong-Tie Co. with homebuilders revealed that an average increase of baseline construction costs of only $.50 per square foot or $1,000 in metal connectors installed in an average 2,000 square foot home made significant improvements.
  – connectors were placed from the roof to foundation and the projected increase in wind uplift resistance went from EF-0 to EF-2 level winds.

Twelve Elements of the New Code

Added 12 provisions “for the purposes of establishing minimum regulations governing residential construction for High Wind Resistance…

1. **Roof sheathing** (OSB or plywood) shall be nailed with 8d ring shank (0.131” x 2.5”) or 10d (0.148”x 3”) nails on 4” on center along the edges and 6” on center in the field. Dimensional lumber decking is not allowed.

2. **Maximum spacing for roof framing shall be 16 inches on center.** Minimum nominal sheathing panel size shall be 7/16. Minimum wood structural panel span rating shall be 24/16.

3. **Connections for roof framing shall be designed** for both compression and tension and may include nail plates or steel connection plates. Connections for roof framing shall include connections on rafters, web members, purlins, kickers, bracing connections, and the connections to interior brace wall top plates or ceiling joists.

4. **Gable end walls shall be tied to the structure**, and may include steel connection plates or straps. The connections shall be made at the top and bottom of the gable end wall.

5. **Structural sheathing panel (OSB or plywood)** shall be required for gable end walls.

6. **Hurricane clip or framing anchor shall be required** on all rafter to wall connections.
7. The upper and lower story wall sheathing shall be nailed to the common rim board.

8. All walls shall be continuously sheathed with structural sheathing (OSB or plywood) using the CS-WSP method. Garage doors shall be framed using the sheathed portal frame method CS-PF. No form of intermittent bracing shall be allowed on an outer wall. Intermittent bracing may only be used for interior braced wall lines.

9. Nailing of wall sheathing (OSB or plywood) shall be increased to 8d ring shank (0.131” x 2.5”) or 10d (0.148” x 3”) nails on 4” on center along the edges and 6” on center in the field.

10. Structural wood sheathing shall be extended to lap the sill plate and nailed to the sill plate using a 4” on center along the edges. Structural wood sheathing shall be nailed to rim board if present with 8d ring shank (0.131 x 2.5”) or 10d (0.148” x 3”) nails on 4” on center along both the top and bottom edges of the rim board.

11. Garage doors shall be rated to 135 mph wind or above.

12. Exterior wall studs shall be 16” on center.

Why did Moore adopt a new landmark code?

- Community and political will was brought to life by violent weather and widespread awareness that translated into an unprecedented high wind building code because:
  - Innovative thinking, years of high wind research following major outbreaks (esp. Tuscaloosa and Joplin) and good science came together
  - Coalition of willing and able stakeholders drove it forward
  - Local leaders abandoned the myth that building to withstand tornadoes is unaffordable
Tale of Two Homes: Tornado
Safe Rooms & Storm Shelters – Life Safety

Despite the many benefits to making structures more resilient to lower intensity tornadoes, safe rooms or storm shelters—above and below ground—constructed to FEMA P-361 guidelines or the ICC/NSSA 500 standard for each and every component are the only current structures to withstand EF 4 and 5 tornadoes

- Life safety
- No compromises should be made
- Individual and community storm shelters are invaluable investments in safety and community resilience
- Safe rooms/storm shelters are critical part of dual-objective design philosophy for EF4 and EF5 tornadoes
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• We partner with leading public, private and nonprofit academic, consumer, entertainment, financial services, product, research, service and technical organizations to deliver the latest advances in disaster safety information to the public

• Create a public value for strong, safe and sustainable homes

• Deliver initiatives that fit into two program tracks – Storytelling for the public – Curriculum for students & professionals

• Mainstream the science and policies of safety and make mitigation cool

Tale of Two Homes: Tornado

The Harrison’s inspirational story of survival is now on display at the National Building Museum. Watch the video at the FLASH Channel at www.YouTube.com/stronghomes
FLASH partners work together to move science to the street and deliver safety through storytelling.

In Oklahoma, safe rooms can save lives

By Laura Conaway

The tiny town of Tushka, Oklahoma, sits a couple hours drive southeast of Moore. And like Moore, Tushka is vulnerable to tornadoes. A twister rated EF-3 struck Tushka in 2011, leveling much of the town. But as the Tulsa World noted at the time, Tushka was not defenseless:

Nearly 100 men, women and children crowded shoulder-to-shoulder into a six-year-old, above-ground, concrete-reinforced safe room adjacent to the Tushka pre-school. A block away, about 100 other residents, their kids and their dogs in tow, rushed into the 90-year-old, below-ground, public shelter – 45-feet long and shaped like a tube, with dirt floors and steel doors at either end.

Guest column: Upgraded seismic code puts safety first

By Leslie Chapman-Henderson, Special to The Commercial Appeal

Posted December 18, 2012 at midnight

Like it or not, Tennessee is earthquake country.

After the West Coast, it is the region in the United States most at risk from earthquakes. An overwhelming majority of earthquake scientists, structural engineers and building code experts agree that the earthquake threat to the central United States is very real.

For that reason, we are deeply disappointed that the Shelby County Commission has delayed the implementation of seismic building code provisions. We are equally concerned that the Memphis City Council will follow suit.

In tornado alley, building practices add to damage

By GregMcCune

In a residential neighborhood near the center of a monster tornado that struck Moore, Oklahoma last month, two partially damaged houses stand like an island among others flattened by the storm.

The walls and roofs of the buildings in a new housing development called Featherstone Addition are still upright while there is nothing left but a concrete foundation where other homes once stood nearby.

The two homes were not completely spared but are salvageable, according to David Prevatt, a civil engineer who saw them when he surveyed the damage after Moore took a direct hit from an EF5 tornado, the strongest rating.

He is convinced that the two houses survived because they were built stronger than most in Oklahoma and the rest of "tornado alley" - the region stretching from Texas to Iowa that accounts for roughly a fourth of all U.S. tornadoes.
Challenges in building code policymaking

• Facts and logic necessary but not always sufficient
• Steady supply of reliable cost data is essential but difficult
• Interdependence of economic interests creates conflict
• Harder when society fails to perceive risk (Memphis)
• Technical and political transparency is challenging
• Difficult to present consumer perspective throughout code development
• Special interests adverse to change
  – Can be difficult to sustain the “win” over time
Change Elements – Policy-driven

- Sustain a relatable narrative to connect diverse stakeholders and community
  - Life safety and building performance
  - Accurate, relevant economic facts and understandable scenarios
  - Demonstrate how interdependence affects resilience (Memphis)
- Inform and empower local leaders/heroes with solutions
  - National organizations can deliver “hard news” to shield locals
- Enhance transparency
  - Public notice of meetings, etc.
Change Elements – Consumer-driven

• Transparency - Consumer
  – Home Identification Number
    • Year built and square feet
    • Building code
    • Builder and inspector license #’s
  – Resilient Scoring Utility (ResQ Score)
    • Score home for threat level, building score and combined score
    • Index to demonstrate home strength by hazard with structure and site specific vulnerability
    • Leverage MLS database, Zillow and Tulia

• Transparency - Policy
  – Conflict of interest disclosures on councils, code development committees
  – Consumer committee or representatives in code development
  – Balanced representation of interests
Trends Watch - Challenges

• Jurisdictions abandoning or skipping code development cycles (North Carolina, Arizona)
  – Communities suffer without benefit of latest building science insights and innovations
  • Critical insights for code improvement come via FEMA MAT reports
  – Insurability can suffer when codes are absent or outdated

• States and Jurisdictions stripping out proven features
  – Michigan working to remove AFCI’s despite proven track record in thwarting electrical fires and affordability ($200 - $400 per home). Why?
Trends Watch - Progress

• Emerging Resilience Indices for Communities
  – Recognize economic impact of strong codes
    • Score up or down based on resilient policies, e.g. codes and enforcement

• Incentives for sound building
  – BCEGS
  – Firewise Communities insurance discounts
  – Fortified
  – Individual insurer programs (individual filing for specific attributes)
You’re Invited!

You say you want to join the revolution?

Join disaster safety thought and policy leaders, nonprofits, government officials and industry representatives for the…

2014 FLASH Annual Conference
Resilience Revolution

http://www.flashannualconference.org

November 19 – 21, 2014
Wyndham Grand Resort Bonnet Creek
Lake Buena Vista, FL
Questions?

Disaster Safety: One Movement, Many Voices

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