


Agenda




- Disasters
- Applicable Regulations
- Precast Advantages
- Design Flexibility
- Aesthetics

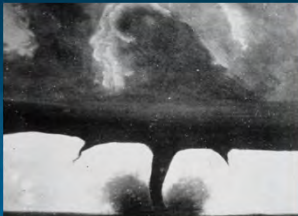
1

Disasters





Garnett, Kansas



Howard, Dakota Territory (now South Dakota)

First tornado photos ever taken in 1884

2

Disasters








ONE OF THE GREAT BEND, KAN. FLOUR MILLS -
AFTER THE CYCLONE, NOV. 10, 1915.

Great Bend, Kansas ~ November 1915

3


Disasters 



Chapman High School 


Chapman Elementary & Middle School 

Chapman, Kansas - June 11, 2008
1/2 mile wide tornado

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Disasters 


 



Twin Tornadoes
Pilger, Nebraska - June 16, 2014

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Disasters 



Savage House - lifted off foundation and rotated 180 degrees

6


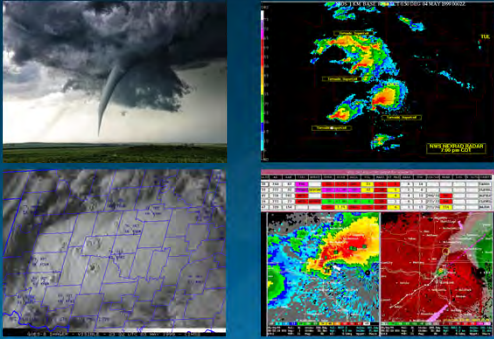
Disasters

Wisner-Pilger Middle School

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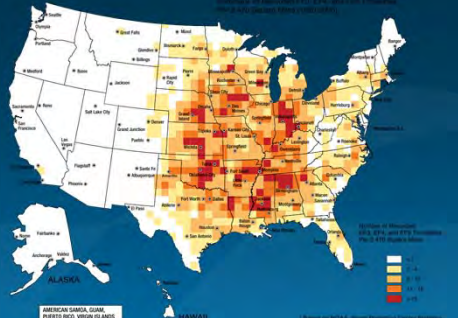
Disasters

EF5 Tornado, Moore, Oklahoma ~ 1999


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Disasters





TORNADO ACTIVITY IN THE UNITED STATES:
1953-2014 and EF5 Tornadoes
1953-2014

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Tornado Awareness 


Although hurricanes and earthquakes generally generate higher losses per event, since 1953, tornadoes (and, related weather events) have caused an average of **57 %** of all U.S. insured catastrophic losses. Source: A.M. BEST, CNN



Orchard, Iowa ~ June 17, 2008

- Recent Year (2017):**
 - 1,418 recorded tornados
 - 35 deaths
 - \$5 billion property loss
- Average Year:**
 - 62 deaths
- Deadliest Year (1953):**
 - 519 deaths
- Longest tornado track (1925):**
 - 293 miles


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Tornado Awareness 

Terminology

Tornado Watch
 • Tornadoes are possible. Remain alert for approaching storms. Watch the sky and stay tuned to NOAA Weather Radio, commercial radio, or television for information

Tornado Warning
 • A tornado has been sighted or indicated by weather radar. Take shelter immediately!




February 5, 2008 ~ Multiple tornadoes ~ 13 deaths


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Applicable Regulations

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ICC/NSSA 





ICC 500-2014
ICC/NSSA Standard for the Design and Construction of Storm Shelters

ICC 500-2014
Standard for the Design and Construction of Storm Shelters

- ICC 500 is referenced in the International Building Code (IBC)
- And the International Residential Code (IRC)
- Readily enforceable standard
- Must also use the FEMA 361 guide to qualify for federal grants

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International Building Code 

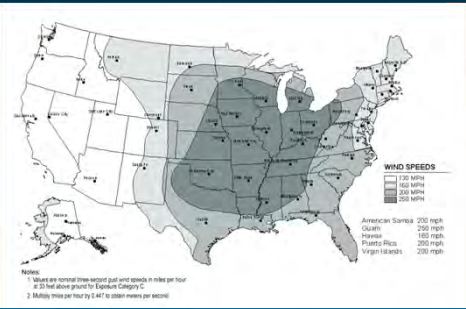


IBC 2018 Section 423

- Adopts ICC 500 as a Technical Standard
- Communities located in 250 mph wind zone **must** construct a storm shelter in new:
 - Schools
 - 911 call centers
 - Emergency operation centers
 - Fire stations
 - Ambulance facilities
 - Police stations
- Must accommodate entire occupant load of building
- Some Group E Occupancies

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International Building Code 



WIND SPEEDS


- 150 mph
- 160 mph
- 180 mph
- 200 mph
- 250 mph

American Samoa 250 mph
Guam 250 mph
Hawaii 180 mph
Puerto Rico 200 mph
Virgin Islands 200 mph

Notes:
1. Values are nominal three second gust wind speeds in miles per hour at 33 feet above ground for Exposure Category C.
2. Multiply three per hour by 0.447 to obtain meters per second.

ICC Figure 304.2(1) ~ Shelter Design Wind Speeds For Tornadoes


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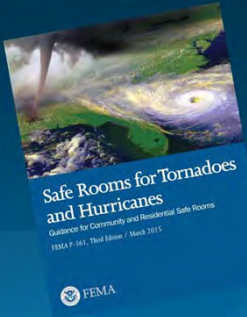
International Building Code 

Additional IBC Shelter Requirements

- Peer review
- Special inspections
- Protected openings
- MEP penetrations
- Ventilation
- Support systems
- Emergency lighting
- Resist hydrostatic loads
- Support progressive collapse
- Accessible



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FEMA 




FEMA P-361
Safe Rooms for Tornadoes and Hurricanes

- Published March 2015
- Also incorporates ICC 500 as Technical Standard





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FEMA 


FEMA recommends comprehensive risk assessment:

- Type of extreme-wind hazard (tornado, hurricane or both)
- Threat or probability based on historic occurrences
- Vulnerability of the building intended for safe room
- Population size
- Community-specific consequences as a result of the hazard



Minneola, Kansas ~ May 24, 2016
 Composite sequence of eight tornado images

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FEMA 

P-361 A1.3.2 Terminology

Safe Room


- A single room within a residence used as a shelter during a natural disaster
- Maximum 16 person capacity for residential

Community Safe Room

- A large room – either internal within a building (such as a school) or a separate building – which provides shelter to a group of people

Sometimes the terms “safe room”, “tornado shelter”, and “storm shelter” are used interchangeably

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FEMA Financing Options 

Hazard Mitigation Grant Program (HMGP) Funds


- Private or public projects
- New shelters
- Existing structures
- Residential or community
- FEMA funds up to 75 percent of the eligible cost

Pre-Disaster Mitigation Program (PDM) Funds

- Provides funding to eligible communities
- Priority is placed on projects that address National Flood Insurance Program (NFIP)
- FEMA funds up to 75 percent of the cost, up to \$3 million

Visit: www.fema.gov/safe-room-funding

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Other Financing Options 

- Small Business Administration (SBA) Disaster Loans
- Housing and Urban Development (HUD) Block Grants
- Federal Housing Authority (FHA) Initiatives
- Local city and state organizations may also offer funding

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Precast Advantages




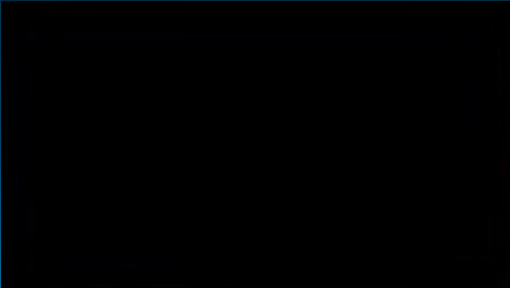
PCI Standards

- PCI MNL-116 Quality Control of Structural Precast Concrete
- PCI MNL-117 Quality Control of Architectural Precast Concrete




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Precast Advantages


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Precast Advantages



Structural Framing Components


- A Double Tee Roof**
 - Meets FEMA P-361
 - Concrete topping
 - Long spans
- B Insulated Wall Panels**
 - Meet FEMA P-361
 - Pre-stressed reinforcement strands minimize cracking
 - Many exterior finishes available
 - Interior concrete surface may be exposed
 - High consistency, quality, and durability
 - Resistance to missile impact
- C Thermal Efficiency**
 - Minimize thermal bridging
 - Insulation yields R-5 per inch
 - High R-factors easily achieved



McEachron Elementary School - Topeka, Kansas

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Precast Advantages



Accelerated Schedule

- Prefabrication
- Less site disturbance
- No jobsite waste
- Reduced delays
- Reduced contractor overhead-costs and risks
- Lower financing costs
- Quick enclosure



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Precast Advantages




Construction Speed



Buffalo High School, Buffalo, Missouri

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Precast Advantages



School Community Shelter


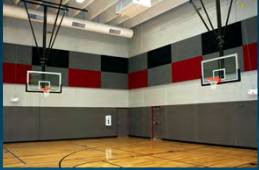
- 10,450 square feet
- 95' x 110'

Roof Structure

- 14 Double Tees
- 95' span x 8' wide x 50" deep
- Each DT component = 75,700 lbs.
- 28 strands per DT

Wall Structure

- 59 Wall Panels
- 38' high x 8' wide
- Each panel = 37,400 lbs.
- 12 strands per panel
- 4"+2"+6" = 12" total wall thickness
- Exposed painted concrete interior finish
- Insulated with 2" Polyisocyanurate (R12)
- Roof Live Load = 100 psf
- Wind Velocity Design Load = 250 mph



Buffalo High School, Buffalo, Missouri

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Precast Advantages




Composite Load-bearing Panels

- Finished exterior
- Pre-insulated edge to edge
- Interior finished wall (ready for paint)
- Column-free
- Built-in electrical conduit and boxes


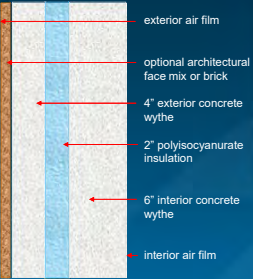


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Precast Advantages




Continuous Insulation



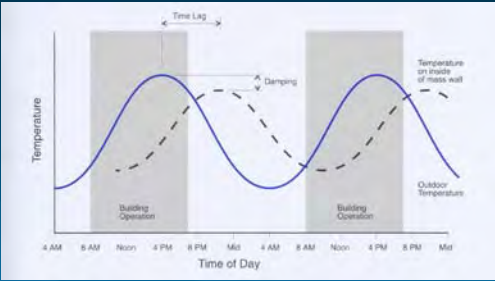
Buffalo High School, Buffalo, Missouri

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Precast Advantages




Thermal Mass Cycle Effect



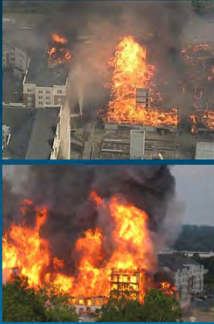
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Precast Advantages



Fire Resistance

- Use building codes to determine fire rating
- Reference PCI Handbook to satisfy rating based on:
 - Concrete density
 - Thickness
 - Reinforcement cover
- 2 hour and 3 hour fire ratings easily achieved



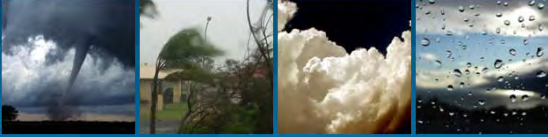
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Precast Advantages



Water & Mold Resistance

- Effective moisture barrier
- Not damaged by water exposure
- Resistant to wind driven rain
- Mold resistant
- Joints between panels and other building elements need maintenance



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Precast Advantages



PCI Certification Programs include:

- Plants
- Personnel
- Erectors

Plant Certification assures owners, specifiers, and designers that:

- Components manufactured to meet nationally accepted standards
- Comprehensive internal quality management systems are followed
- Plants are randomly audited to ensure compliance



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Precast Advantages



Personnel Certification Program Levels:

- Level I: 6 months of industry experience + training + exam
- Level II: 1 additional year of experience + training + exam
- Level III: 2 additional years of experience + training + exam

Training programs cover:

- Maintaining and improving quality levels
- Strand tensioning and elongation
- Accelerated curing techniques
- Material-control tests
- Welding basics



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Precast Advantages



- Engage early!
- Design as a team
- Coordinate disciplines
- Consider multi-function solutions
- Set goals

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Design Flexibility



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Design Flexibility




Safe Rooms



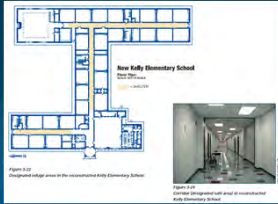
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Design Flexibility



Shelters in Schools

- Convenient and familiar locations
- Part of a community's identity
- Protect children
- Hallways work as refuge areas
- School gyms as shelters are also ideal



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Design Flexibility




Educational Facilities - Gymnasium



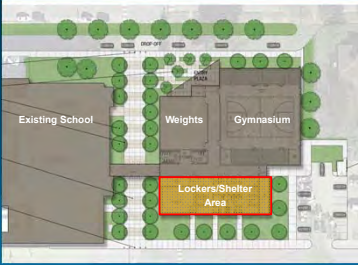


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Design Flexibility




Educational Facilities ~ Lockers






Pittsburg Middle School Gym Addition ~ Pittsburg, Kansas

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Design Flexibility



Educational Facilities ~ Cafeteria



Pittsburg High School Cafeteria/Shelter Addition ~ Pittsburg, Kansas

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Design Flexibility




Multiple Uses or Phased Construction



Houston, Missouri ~ Storm Shelter with Future Phase

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Design Flexibility 

Giovannetti Community Shelter

- Urbandale, Iowa
- Originally planned as park shelter with \$850K budget
- 4,500 SF Safe room added and covered by \$1.03M HMGP grant
- 45 precast wall panels and 180 hollow core roof panels



ASK Studio ~ Des Moines, Iowa 46


Design Flexibility 

Healthcare Facilities

- Mercy Hospital ~ Joplin, Missouri
- Rebuilt after St. John's Regional Medical Center was destroyed
- \$500M cost, nine stories, 200 beds ~ 890,000 SF
- Precast panels with brick veneer designed to withstand 250 mph winds



May 22, 2011 tornado aftermath HKS Architects ~ Dallas, Texas 47



Aesthetics

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Aesthetics




- Face Mix Design
- Paste
 - Typically White Cement
 - SCM: Supplemental Cementing Materials
 - Pigmentation
 - Potable Water
- Local Aggregates
- Accent Materials

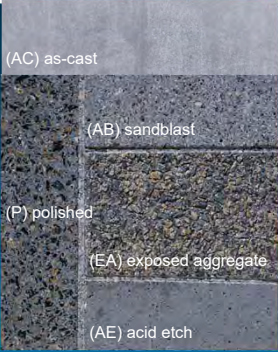


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Aesthetics




- Aggregate Exposure
- None – skin, paste only (AC)
- Light – matrix dominant (AE, AB)
- Medium – 50/50 matrix and coarse dominant (AE, AB, P)
- Deep – coarse aggregate dominant (AB, EA, P)

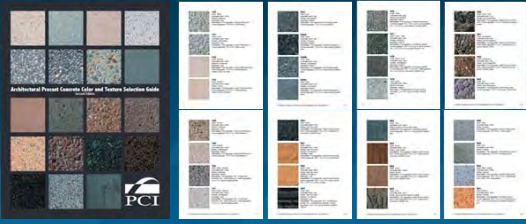


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Aesthetics



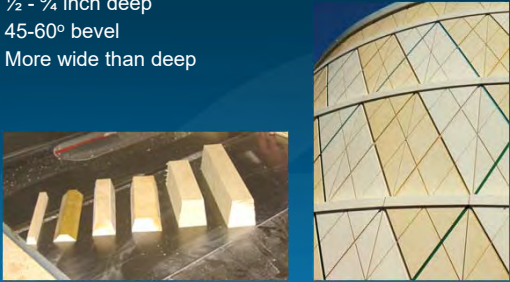
- PCI Color and Texture Selection Guide




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Aesthetics 

- Reveals
 - False joint
 - 1/2 - 3/4 inch deep
 - 45-60° bevel
 - More wide than deep



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Aesthetics 

Form Liners






Fig. 3.5.21 Some of the available form liner patterns

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Aesthetics 

Veneer Benefits

- Simplified design
- Saves time
- Reduces construction site impact
- More durability = reduction of life cycle costs
- Less subcontractors = less risk
- Reduced material (5/8" brick instead for full brick)



Fairview Elementary ~ Carroll, Iowa

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Aesthetics



Embedded Thin Brick



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Aesthetics




Combination Finishes



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Resources




PCI Midwest
Printed Publications

- PCI Architectural Precast 3rd Edition
- PCI Design Handbook 8th Edition
- PCI Journal
- Ascent Magazine

Websites

- pcimidwest.org
- pci.org
- iccsafe.org
- fema.gov
- hud.gov
- sba.gov

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