The Balanced Design Approach to Fire Safety

Presented by Shamim Rashid-Sumar, PE, FSFPE, Vice President, Fire Codes and Standards, NRMCA

In partnership with National Ready-Mix Concrete Association
Learning Objectives

Understand the reasons for the increase of fire losses in single family and multifamily buildings from structure fires and wildfires.

Learn how the building code has evolved to increase the reliance on active fire protection systems and reduced their reliance on passive fire protection systems.

Recognize the balance fire design principles that can improve fire safety in buildings.

Understand the contribution noncombustible materials such as concrete makes to fire safety.
Questions?

Click on the Q&A button located on the black menu bar either on the top or bottom of your computer screen. Type in any questions you might have.
Donate to the 2020 California Fire Relief Fund by Texting CAFIRES to 41444
Shamim Rashid-Sumar, PE, FSFPE, Vice President, Fire Codes and Standards, NRMCA
The Balanced Approach to Fire Safety
How Concrete Building Systems can Help Reduce Risk
Shamim Rashid-Sumar, PE, FSFPE

About the Course

Learning Units
- AIA-CES FIR-001 (1LU/HSW / 1 PDH)

Learning Objectives
- Identify the reasons for the increase of losses in single-family and multifamily buildings from structure fires and wildfires.
- Examine how the building code has evolved to increase the reliance on active fire protection systems and reduced their reliance on passive fire protection systems.
- Recognize the balanced fire design principles that can improve fire safety in buildings.
- Demonstrate the contribution noncombustible materials such as concrete makes to fire safety.
The Balanced Approach to Fire Safety - Contents

• Impact of Natural Disasters
• Structure Fires
• Wildfires
• Minimum Code Requirements
• Recommendations
• Noncombustible Building Systems and Finishes
• Case Studies
• Conclusion

The Impact of Natural Disasters

Natural disasters caused at least $306 billion in destruction in 2017
• Costliest year on record
• 16 separate events > $1B damages each
• Hurricanes in Texas, Florida, Puerto Rico

Photo credit: ghomephoto/iStock
Structure Fires

According to the report *Total Cost of Fire in the United States* by the Fire Protection Research Foundation and National Fire Protection Association (NFPA), the total cost of fires in 2014 was $328.5 billion, equaling 1.9% of the U.S. Gross Domestic Product.

- Fire Protection expenditures = $273.1 billion (firefighting, fire fighting infrastructure, insurance, etc.)
- Losses = $55.4 billion (deaths, injuries, property loss)

The U.S. Fire Administration reports that every year, fire kills more Americans than all other natural disasters combined.

Photo credit: REKINC1980/iStock

Structure Fires

According to NFPA, there were 499,000 structure fires in 2017, causing 2,815 civilian deaths, 12,160 civilian injuries, and $23 billion in damages.

NFPA estimates 262,500 fires occurred in homes resulting in 2,290 deaths, 7,470 injuries, and $6.1 billion in damages, and 95,000 occurred in apartment buildings resulting in 340 deaths; 3,130 injuries; and $1.6 billion in damages.

Property damages from fires have been increasing over time.

Photo credit: whiterabbit83/iStock
**Structure Fires**

As a result of relaxed building codes, developers have increased the use of combustible wood-frame construction for multifamily construction (apartments, condominiums, hotels, dormitories, and long-term care facilities) resulting in a rash of fires across the country that are reducing these buildings to ashes, putting lives and communities at risk.

Not only are these wood-frame building fires total losses, but they often cause considerable damage to surrounding buildings and property.

Image courtesy of: Build with Strength, [www.buildwithstrength.com/america-is-burning](http://www.buildwithstrength.com/america-is-burning)

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**Insurance Risk**

The National Ready Mixed Concrete Association (NRMCA) undertook a research study to understand if insurance companies offered lower insurance rates for structures built using noncombustible materials for both builder’s risk insurance and commercial property insurance.
The NRMCA study, titled *Survey of Insurance Costs for Multifamily Buildings*, revealed that insurers are aware of the risks of building with combustible construction and the benefits of building with noncombustible construction.

**Builder’s Risk Insurance**
- 22% – 72% less for concrete

**Commercial Property Insurance**
- 14% - 65% less for concrete

According to Verisk Insurance Solutions, 4.5 million U.S. homes are at high or extreme risk of wildfire, with more than two million in California alone.

According to Munich RE, a reinsurer, there have been $23.1 billion in losses to wildfires in the U.S. over the past five years.

2017 was by far the worst year with $17 billion losses and that number will likely continue to grow due to climate change which is creating warmer and drier conditions.
Aftermath of Wildfires in California

2017 - Tubbs Fire
• One of 131 wildfires across California in October of 2017
• > 1 million acres and 10,000 buildings destroyed by end of 2017.

2018 - Camp Fire
• 85 civilian fatalities
• 240 m² and 18,804 structures destroyed within the first four hours
• $16.5 billion in damage ($4 billion of which was uninsured)

2019
• >7,860 fires recorded in CA
• Estimated 406 m² burned land

2020 Wildfires: CA, OR, WA

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Start Date</th>
<th>Cause</th>
<th>Notes</th>
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<tbody>
<tr>
<td>North Complex</td>
<td>California</td>
<td>Aug 17</td>
<td>Lightning</td>
<td>Absorbed Bear Fire</td>
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<tr>
<td>Slater Fire</td>
<td>California</td>
<td>Sep 15</td>
<td>Collided with Devil Fire; 2 deaths</td>
<td></td>
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<tr>
<td>Creek Fire</td>
<td>California, Sierra National Forest</td>
<td>Sep 4</td>
<td></td>
<td>350 people rescued; Destroyed hundreds of structures</td>
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<td>Bobcat Fire</td>
<td>California, 25 miles NE of Los Angeles</td>
<td>Sep 6</td>
<td></td>
<td></td>
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<tr>
<td>August Complex</td>
<td>California, 37 fires Mendocino Nat'l Forest</td>
<td>Aug 17</td>
<td>Lightning</td>
<td>Largest fire in modern California History; 800,000 acres</td>
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<tr>
<td>Riverside, Beachie, Creek, Lionshead Fires</td>
<td>Oregon, Cascade Mountains</td>
<td>~Sep 10</td>
<td>Lightning</td>
<td>Beachie Fire: 4 deaths; Beachie and Lionshead: 200,000 acres burned</td>
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<tr>
<td>Alameda Fire</td>
<td>Oregon</td>
<td>~Sep 10</td>
<td>Arson</td>
<td>4 deaths; 600 homes + 100 commercial buildings destroyed</td>
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<tr>
<td>Holiday Farm Fire</td>
<td>Oregon</td>
<td></td>
<td></td>
<td>1 death</td>
</tr>
<tr>
<td>Archie Creek Fire</td>
<td>Oregon</td>
<td>Sep 11</td>
<td></td>
<td>Destroyed &gt; 100 homes as well as other structures</td>
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</tbody>
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Data compiled from NASA FIRMS by The New York Times as of Sept 18, 2020
Wildfire Risk

Although recent attention has been on California because of the major wildfires in 2017, there are wildfire risks in most states.

According to Forest and Rangelands, the map shows the counties with the greatest risk of wildfires characterized by the higher-than-average annual area burned, structures lost, and homes exposed within the wildland urban interface.

Image courtesy of: https://www.forestsandrangelands.gov/

Is Minimum Life Safety Enough?

The United States historically has one of the highest fire death rates in the industrial world.

- Civilian deaths trending downwards ~ 4,000 fatalities annually
- Risk of death in fire has not decreased over time
- Damages due to fire increasing over time

Model building codes establish minimum requirements for buildings.
Minimum Code Requirements

- Height and area tables – building higher and higher with combustible construction without technical justification
- Automatic sprinkler protection not implemented in all multi-family residential buildings
- Mass Timber contributes to fuel load
- Currently not designing buildings to withstand burnout
- Recent conflagrations
- Losing balance in our approach to fire protection and life safety

Minimum Code Requirements

A Literature Review of Sprinkler Trade-offs

by
Nicholas A. Drebney
Dustin J. Mackrour
Honggang Wang

Fire Protection Engineering
Worcester Polytechnic Institute

WPI

National Association of State Fire Marshals
(NASFM)

- Conducted an extensive literature review
- Concept of trade-offs lacks scientific justification
- No reliable data from a holistic building perspective on whether the cumulative effects of comprises that make buildings and people safer
- Fire safety, means of egress, and general safety declined by appreciable amounts with the adoption of the IBC over the legacy codes (pre-2000)
The Balanced Approach to Fire Safety

NFPA 550: Fire Safety Concepts Tree

FIGURE 4.3 Top Gates of the Fire Safety Concepts Tree with Selected Lower-Tiered Gates.

National Fire Protection Association 2017
NFPA 550: Fire Safety Concepts Tree

FIGURE 4.3.4 “Manage Fire” Branch of Fire Safety Concepts Tree.

National Fire Protection Association 2017

NFPA 550: Fire Safety Concepts Tree

FIGURE 4.5.2.1 “Manage Exposed” Branch of Fire Safety Concepts Tree.

National Fire Protection Association 2017
Recommendations: A Balanced Approach

• Combining active fire protection systems with passive fire protection systems
• Three key elements:
  – Smoke detection (Fire alarm system)
  – Fire suppression (Automatic sprinklers)
  – Containment (Compartmentation)
    • Fire walls
    • Fire-resistance rated floor assemblies
    • Through penetration firestop systems

Recommendations: Multifamily Structures

• Engage fire protection engineer in design
• Automatic sprinkler protection
• Construction type determined based on number of stories from lowest level of fire service access
• Provide identifying sign at building entrance for light frame, combustible construction (Type III, IV or V).
• Provide two fire department access roads for projects exceeding 30 units to accommodate site fire and emergency vehicle access
Recommendations: Buildings Under Construction

- Progressively clad exposed combustible materials with fire-resistant coverings to limit the number of stories with significant exposed combustible materials to two below the current construction level
- Progressively commission automatic sprinkler systems to limit the number of unprotected stories with significant exposed combustible materials to two below the current construction level
- Employ 24-hour fire-watch and construction site intrusion detection to reduce the risk of fire
- Additional guidelines from NFPA 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations

Recommendations: Wildfire Safety

International Wildland Urban Interface Code (IWUIC)
- Part of the model codes
- Mitigate the risks of wildfire
  - Remove flammable materials from around the building
  - Construct the building of fire-resistant materials
Wildland Urban Interface Code

International Wildland Urban Interface Code (IWUIC)

- Structure density and location
  - Limit # of structures permitted in at-risk areas
- Building materials and construction
  - Noncombustible roof assembly, exterior walls, windows and doors
- Vegetation management
  - Construct the building of fire-resistant materials
- Emergency Vehicle Access
  - Requirements for driveways, turnarounds, emergency access roads, marking of roads and property address markers
- Water Supply
  - Approved water sources and adequate water supply for firefighting
- Fire Protection
  - Automatic sprinkler systems, spark arresters, and propane tank storage

NFPA 1144

Standard for Reducing Structure Ignition Hazards from Wildland Fire

- Provides a methodology for assessing wildland fire ignition hazards around existing structures, residential developments, and subdivisions that will be located in a wildland/urban interface area
- Provides minimum requirements for new construction to reduce the potential of structure ignition from wildland fires
- Used to assess fuel sources in the structure ignition zone for their potential to ignite structures and identify possible mitigation measures to reduce the possibility of structure ignition
NFPA 1144

- Wildland fire hazard assessment of each structure ignition zone in the development to determine relative risk, extent of wildland fire hazard, and applicable mitigation measures
- Development of Wildland Fire Hazard Mitigation Plan
- New structures – Building Design, Location and Construction
  - Building materials will not ignite, burn, support combustion, or release combustible vapors when subjected to fire or heat
  - Building materials shall maintain their fire performance and their mechanical performance under conditions of use
  - Limitations on flame spread index of building materials
  - Class A roof coverings only; Vent assemblies and eaves must resist the intrusion of flames and embers
  - Exterior walls shall be noncombustible, fire-resistant, or ignition resistant
  - Limitations on overhanging projections and overhanging buildings
  - Requirements for exterior windows, windows in exterior doors, skylights, and exterior doors

Noncombustible Building Systems and Finishes

- Concrete Frame
  - Conventional reinforced concrete frame made of columns and one- or two-way slabs
  - Used for high-rise applications or buildings with a significant amount of glass on the exterior

- Bearing Wall Systems
  - Tilt-up walls, precast walls, concrete masonry, and insulating concrete forms (ICF) are examples of systems
  - Used for many low- to mid-rise buildings, including single family and multifamily residences
Noncombustible Building Systems and Finishes

- **Concrete Floor Systems**
  - Floor is primary component
  - Several options for bearing walls including slab spans, precast hollow-core planks with concrete topping, or ICF floor systems

- **Concrete Finish Systems**
  - Cement-based concrete finish materials and products used to increase fire resistance rating and reduce combustibility
  - Examples include plaster, decorative concrete masonry, and manufactured stone
  - Consider also fiber cement and soffits and concrete roof tiles

Case Study: Concrete Apartment Building Survives Blast and Fire

Massive natural gas explosion in East Harlem, New York City (2014)

- Destroyed two apartment buildings, vacated four neighboring properties, and shattered windows blocks away
- Nearby, buildings and households affected by the blast
- Eight (8) deaths, 70 injuries and 100 displaced families
- > 250 firefighters, paramedics, and police officers responded
- Local utility was responsible for $153.3 million damages,
- Adjacent concrete building survived a blast and subsequent fire and reopened after repairs.
Case Study: Concrete Walls Provide Fire Separations at Infill Site

Walker’s Landing, Milwaukee, Wisconsin (2016)

• Urban infill site requiring fire rated exterior walls
• Two (2) buildings, 6 stories each (4 residential floors atop 2 parking levels)
• Site restricted due to 10-ft setback from river, a bridge, and two streets
• Access for material storage and construction difficult

Photo credit: Bedford Development

Case Study: Concrete Walls Provide Fire Separations at Infill Site

Walker’s Landing, Milwaukee, Wisconsin (2016)

• Developer chose insulating concrete forms (ICFs) precast hollow-core floors
  – Thermal efficiency
  – Speed of construction

Photo credit: Bedford Development
**Case Study: Noncombustible Exterior Finishes Saves Home from Devastating Wildfire**

**Wildfire in Laguna Beach, California (2013)**
- 17,000 acres of brushland consumed
- 366 homes destroyed; 500 damaged in a single day
- Extreme demand on District’s water supply
- $528 million in damages
- 345 engines, 17 dozers, 30 aircraft, 11 hand crews, and 1,968 fire personnel responded
- Santa Ana winds contributing factor
- One single-family home survived due construction and landscape design
  - Stucco cladding
  - Class A concrete tile roof, ends sealed with concrete
  - Double-paned glass
  - Landscaping zones of fire-resistant plants

**Case Study: Concrete Construction Used for Student Dormitories**

**New Martin Hall and New Hall B at Eastern Kentucky University (2017)**
- Part of University revitalization program
- Martin Hall – 199,480 ft²
- Hall B – 165,580 ft²
- University chose ICFs for walls and hollow-core plank for floors

**NFPA data for Fires in Dormitories**
- Increased 24% over the last decade
- Fire departments respond to 11 dorm fires each day
- Annually: 1 death, 32 injuries, $14 million in property damage
Summary

• Structure fires and wildfires continue to result in increase of losses in single and multifamily buildings.

• Building codes have evolved to increase the reliance on active fire protection systems, reduced their reliance on passive fire protection systems and permitted taller buildings of non-combustible construction.

• A balanced approach to fire protection strategy reduces fire risk in buildings and provides life safety as well as property protection.

• Noncombustible concrete construction contributes to an overall fire protection strategy by confining/containing fire and providing structural stability without significantly increasing costs.
www.buildwithstrength.com/design-center

• Structural system recommendations
• Cost comparisons
• Specification review
• Design/construction team collaboration
www.buildwithstrength.com/education

- Concrete Innovations (On-demand)
- Specifying Sustainable Concrete (On-demand)
- Pathway to Resilience (On-demand)
- Zero Energy Schools (On-demand)
- The Business Case for Building Multifamily Buildings with Concrete (On-demand)
- Life Cycle Assessment of Concrete Buildings (On-demand)
- The Balanced Design Approach to Fire Safety (On-demand)
- The Environmental Impacts of Building Materials (On-demand)
- A New Generation of Tilt-up Buildings (On-demand)
- Achieving Resilience with ICF Construction (On-demand)
- Economical Design of Insulating Concrete Forms (On-demand)
- YouTube: Top 10 Ways to Reduce Concrete’s Carbon Footprint
- Hanley Wood University: Search “NRMCA”

www.GlobalConcreteSummit.com

TOPICS
- Innovation
- Resilience
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- Low Impact Development
- Social Responsibility
- Human Health
Thank you