The Evolution of Building Codes

Submitted by: United States
The Evolution of Building Codes

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Evolution of Building Codes

- Basics of Code Development
- The U.S. Landscape
- Technical Challenges
- Trailing Improvements
- Effective Implementation
Codes and Standards Basics

- Codes:
  - Tell us **what** we must do
  - Address broad topics – health, safety & welfare
  - Have a significant impact on society

- Standards:
  - Tells us **how** to do it
  - Address specific technical issues

Codes and Standards Basics

- Safety - What is it?
- Health - What is it?
- Welfare – What is it?
  - How do we measure the value of human life?
  - Mentioned in important treaties and procedures
  - Not clearly defined
  - Depends…
  - Tolerance to risk
  - Willingness to commit resources
Codes and Standards Basics

• What is a Model Code?
  – **Code**: A systematic collection of regulations and rules of procedure and conduct
  – **Model**: An example for imitation or comparison
  – Practical definition: Reflection of the will of society on a particular subject

Building Codes in the U.S.

*Typical Codes for the Built Environment*

• Building; Fire Prevention; Plumbing; Mechanical; Fuel Gas; Electrical; etc…
• Various other topics…
  – (Residential, Premises Security, Energy, Accessibility, Sustainability, etc…)
Building Codes in the U.S.

• How the U.S. is different:
  – Self-regulated system: private independent developers
  – 200+ organizations accredit >10,000 documents through ANSI
  – Market regulated model documents
  – Governments must adopt in order to have force of law
  – Decentralized federal government oversight

Building Codes in the U.S.

• American National Standards Institute (ANSI)
  – 1918 Private, non-profit organization
  – Administers and coordinates the U.S. voluntary standardization and conformity assessment systems
  – ANS Process features:
    • Openness
    • Balance
    • Consensus
    • Due Process
Building Codes in the U.S.

• U.S. Federal Government Role
  – National Technology Transfer & Advancement Act
  – National Institute of Standards and Technology (NIST)
  – Encourages participation and document use
  – Acknowledges efforts of private developers
  – Defers to States and Local Jurisdictions
  – Mission-specific Federal exceptions

Safety Challenges
The Great Chicago Fire of 1871

The fire started at about 9 p.m. on Sunday, October 8, in or around a small shed belonging to the O’Learys.

Before the fire died out in the early morning of Tuesday, October 10, it had cut a swath through Chicago about four miles (6 km) long and averaging 3/4 mile (1 km) wide; more than 2,000 acres.

The fire left complete devastation in the heart of the city. At least 300 people were dead, 100,000 people were homeless, 17,500 buildings worth $200 million were destroyed.
Safety Challenges

Iroquois Theatre – Chicago, IL 12-30-1903

- 602 Fatalities
  - Ignition
  - Spotlight/Scenery

Contributing Factors
- Crowd Crush
- Combustible Contents
- Opened Door

Safety Challenges
The Great Baltimore Fire of 1904

The Great Baltimore Fire of 1904
Safety Challenges
Triangle Shirtwaist Fire 3-25-1911

141 Men and Girls Die in Waist Factory Fire; Trapped High Up in Washington Place Building; Street Strewn with Bodies; Files of Dead Inside


Technical Challenges
Innovations...Mid- to late 1800s

Elisha Graves Otis, an American inventor, developed an improved elevator with safety devices to keep it from falling (1853).

The architect, Major William Le Baron Jenney, built the first metal-frame skyscraper, the 12-story Home Insurance Building, in the mid-1880s. This development led to the "Chicago skeleton" form of construction.

Henry Bessemer in England and William Kelly in the United States developed a process that made it possible to produce large quantities of inexpensive steel (1855).
Technical Challenges

The Equitable Building, 1891

The Equitable building “…is to be a modern office-building, absolutely fireproof…” (The American Architect and Building News, March 28, 1891)

“The tests shall consist of four kinds as follows:

A. – A Still Load, increased until each arch breaks down;
B. – Shocks, repeated until the arch is destroyed;
C. – Fire-and-Water, alternating until the arch is destroyed;
D. – Continuous Fire of high heat, until the arch is destroyed”

The tests shall all be upon arches ten inches (10”) in depth, with mid-web built between I-beams five feet (5’) on centres; length of each arch along the beams not less than four feet (4’).

Technical Challenges

History of Fire Tests of Floors

• 1890 - Denver Equitable Building ~ 1500 °F (816 °C)
• 1891 - Wainright Building, St. Louis ~ 1500 °F (816 °C)
• 1896 - Stevenson Constable, Superintendent of Buildings, New York City
  • First series of tests ~ 2000 °F (1093 °C)
  • Second series of tests ~ 1700 °F (926 °C)
• 1902 – Prof. Ira Woolson, Columbia University
  • (for New York Bureau of Buildings) ~ 1700 °F
  • (926 °C)

Thinking at the time:

• Fires were considered to have a single representative temperature and last for up to 4 hours
• A building assembly passing a test under these conditions could withstand a fire burnout
The Standard Fire Test...

- Committee P was organized by ASTM in 1905 largely as a result of the Baltimore fire of the year before.
- By 1906, ASTM Committee P (which would later become C-5 and eventually E-5) proposed a standard specification for testing floors.
- A standard was adopted in 1918 as a specification for “Fire Tests of Materials and Construction”.
- Thus, the standard fire curve was prescribed without knowledge of actual temperatures in building fires!
- Standard ASTM E-119 is still referenced in the Building Code.

ASTM Curve vs. Earlier Curves

1 Babrauskas and Williamson
Technical Challenges: Research at NBS

NBS Federal Triangle fire test

NBS column furnace, 1920s

Relationship Between Fire Load and Fire Severity

The first systematic effort to measure fire temperatures was begun in 1922 by Simon Ingberg at NBS where he conducted tests to burnout of typical office furnishings (furniture and paper) and measured the temperatures.

<table>
<thead>
<tr>
<th>Fire Load</th>
<th>Assumed Combustible Load</th>
<th>Equivalent Fire Duration</th>
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<tbody>
<tr>
<td>(lb/ft²)</td>
<td>(kg/m²)</td>
<td>(Btu/ft²)</td>
</tr>
<tr>
<td>10</td>
<td>48.8</td>
<td>80,000</td>
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<td>15</td>
<td>73.2</td>
<td>120,000</td>
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<tr>
<td>20</td>
<td>97.6</td>
<td>160,000</td>
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<td>30</td>
<td>146.5</td>
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<td>40</td>
<td>195.3</td>
<td>320,000</td>
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<tr>
<td>50</td>
<td>244.1</td>
<td>380,000</td>
</tr>
<tr>
<td>60</td>
<td>292.9</td>
<td>432,000</td>
</tr>
</tbody>
</table>

S.H. Ingberg, “Fire-Resistance Requirements in Building Codes,” Quarterly of the National Fire Protection Association, Boston, October, 1929
Trailing Improvements
IBC 2012 Height & Fire Area Limitations

We still use this rationale!

Trailing Improvements
Building Codes in the U.S.

- 1905 National Building Code
- 1915 BOCA National Building Code
- 1927 ICBO Uniform Building Code
- 1940 SBCCI Standard Building Code
- 2000 NFPA 5000 Construction Code
Trailing Improvements
Means of Egress

- 1916: Pamphlet "Outside Stairs for Fire Exits"
- 1918: Pamphlet "Safeguarding Factory Workers from Fire"
- 1921: Committee enlarged to include interest groups
- 1927: 1st Edition of "Building Exits Code"
- 1942: Cocoanut Grove Fire
- 1948: Reworked to mandatory language

Health & Welfare Challenges
Community concerns

- Light
- Ventilation
- Sanitation
- Space

“How the Other Half Lives” Jacob Riis 1890
Trailing Improvements

- First Tenement House Act 1867
- Second Tenement House Act 1901
- Local Plumbing Codes
- Uniform Plumbing Code 1926

Effective Implementation

- Hammurabi’s Code of Laws: Babylonia 1772 BC

“If a builder build a house for someone and does not construct it properly, and the house which he built fall in and kill its owner, then that builder shall be put to death.

If a builder build a house for someone, even though he has not yet completed it; if then the walls seem toppling, the builder must make the walls solid from his own means.”
Effective Implementation
Federal administration and enforcement (OSHA)

- **Authorship**
  - Most States modify the model building code documents
  - Local jurisdictions follow State requirements/allowances

- **Custodial**
  - States update - are encouraged to use most recent codes

- **Administration**
  - Training of Code Officials – Inspectors & Plan Checkers
  - Technical Assistance
  - Compliance Assistance – Variance & Appeal Processes
  - Public Education and Outreach
Effective Implementation
State/Local Responsibilities

- Enforcement
  - Policies, procedures & interpretations
  - Permit, Notices & Orders
  - Inspections
  - Construction Document Reviews
  - Approvals
  - Alternative Materials, design, methods and equipment
  - Certificate of Occupancy
  - Appeals & Variances
  - Oversight

Effective Implementation
Working together to get greener

- Built environment as sustainable backdrop: back to the future?
- How do we develop a common understanding of ?
- How do we work together to evaluate ?
- How do we identify needed performance measures?
- How do we develop plans to meet information needs?
Effective Implementation

Standards enable innovation by providing a stable platform:

- On which to build vertical applications
- To expand existing markets and create new markets
- For propagating innovation across industries

Standards may become barriers when:

- Platforms compete
- Technology is prematurely frozen
- Consensus fails; standards compete
- Regulatory mandates differ
- Deliberate trade barriers are enacted

Questions?

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