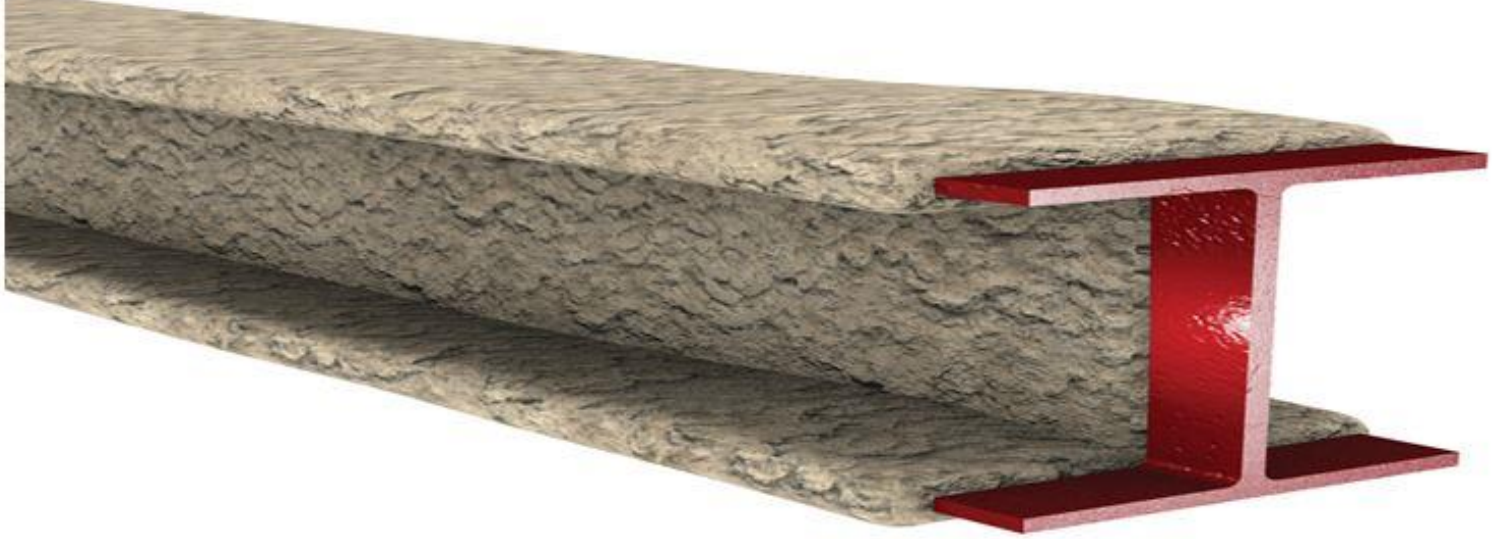


# ADVANCES IN STRUCTURAL FIRE PROTECTION

**OSCAR ZUNIGA, MSc, P.E.**

**MARQUESS & ASSOCIATES, INC. – MEDFORD, OREGON**

# OSCAR ZUNIGA, P.E.

**BSME – University of Texas-Austin, 1973**

**MSFPE – Cal Poly-San Luis Obispo, 2013**

**Registered Mechanical, Electrical, Fire Protection P.E.**

**Private Practice-Consulting, 36 years**

**Southwest Research Institute, 9 years**

# OUTLINE

- Structural Fire Protection- Design Objective
- Overview of Old vs. New Design Approaches
- Details of Old (Prescriptive) Design Approach
- Details of New (Performance-Based) Design Approach
- New BCD “Statewide Alternate Method” (SAM) 18-01
- Looking Ahead
- Q&A, Discussion

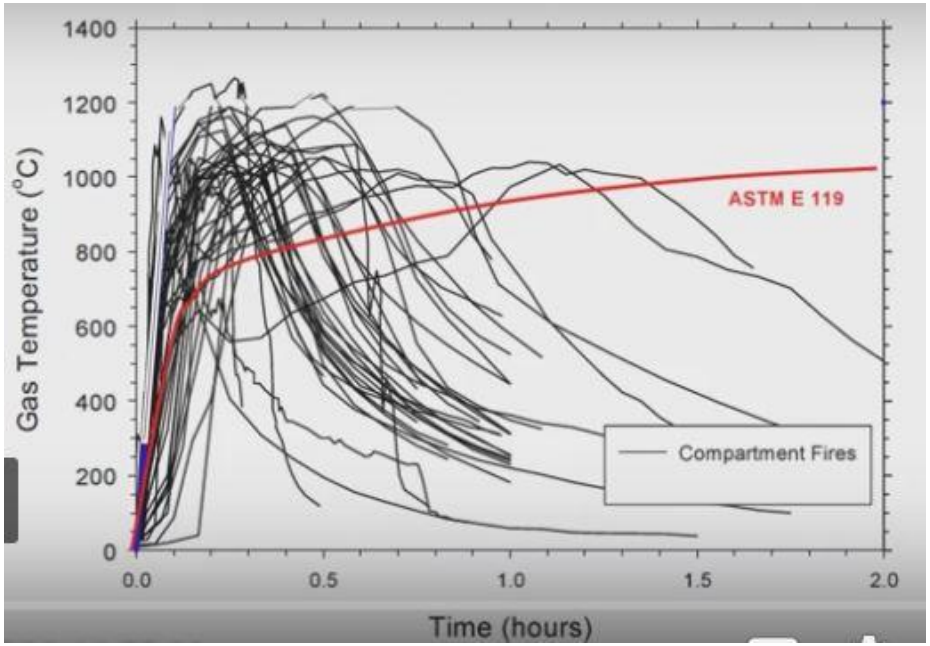
# STRUCTURAL FIRE PROTECTION DESIGN OBJECTIVES

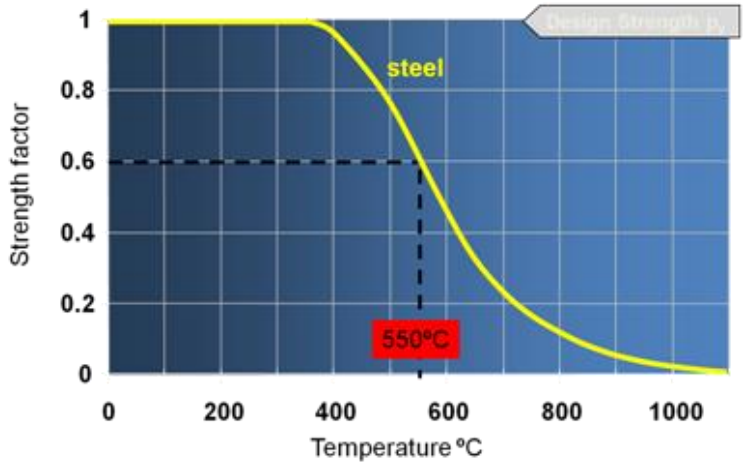
- **Life Safety- occupants, emergency responders**
- **Property Protection- contents, buildings, adjoining**
- **Mission Continuity- essential facilities, infrastructure**
- **Preservation of Cultural Heritage**
- **Environmental**

# DESIGN APPROACHES: OLD VS. NEW

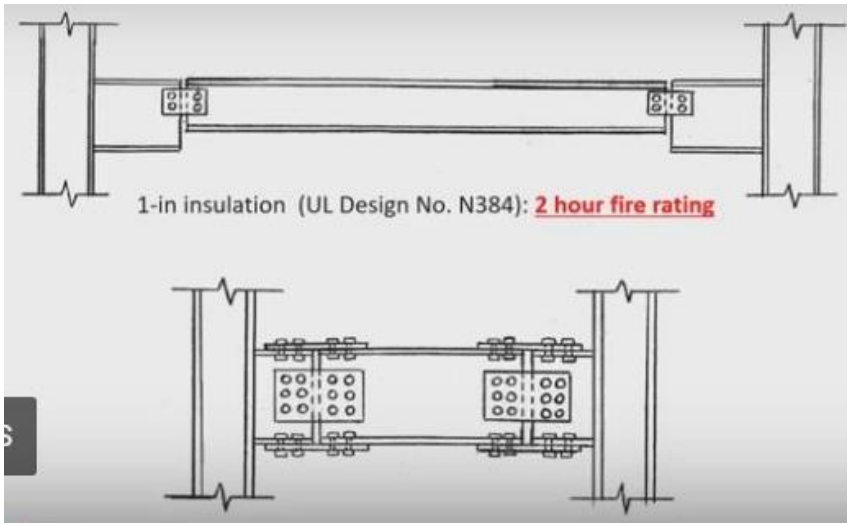
- **“Old”- ASME E119 furnace testing, 1918**
- **“Old”- UBC fire resistive requirements, 1929**
- **“Old”- relatively short spans, no connectivity, individual components tested separately**
- **“Old”- no correlation between tests and real world**
- **“Old”- prescriptive, little structural engineering input**
- **“Old”- no dynamics of the complete assembly (pass/fail)**
- **“New”- numerical fire & structural response modeling**
- **“New”- analysis of complete assemblies**
- **“New”- performance-based, specific design outcomes, intensive structural & fire protection engineering**

# “OLD”

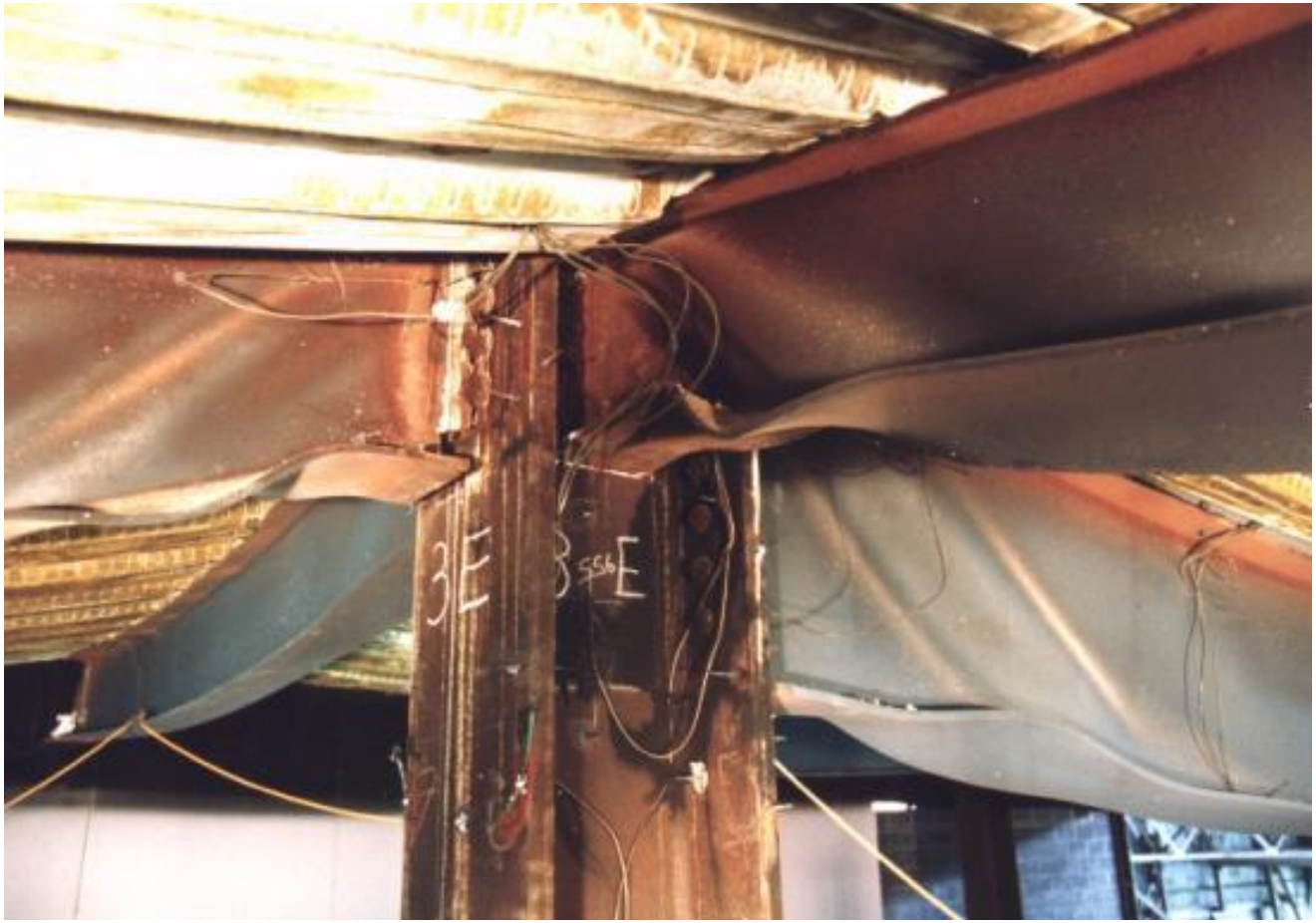

1400
1200
1000
800
600
400
200
0
Gas Temperature (°C)
ASTM E 119
Compartment Fires
0.0
0.5
1.0
1.5
2.0
Time (hours)


1
0.8
0.6
0.4
0.2
0
Strength factor
steel
550ºC
0
200
400
600
800
1000
Temperature ºC

# “OLD”

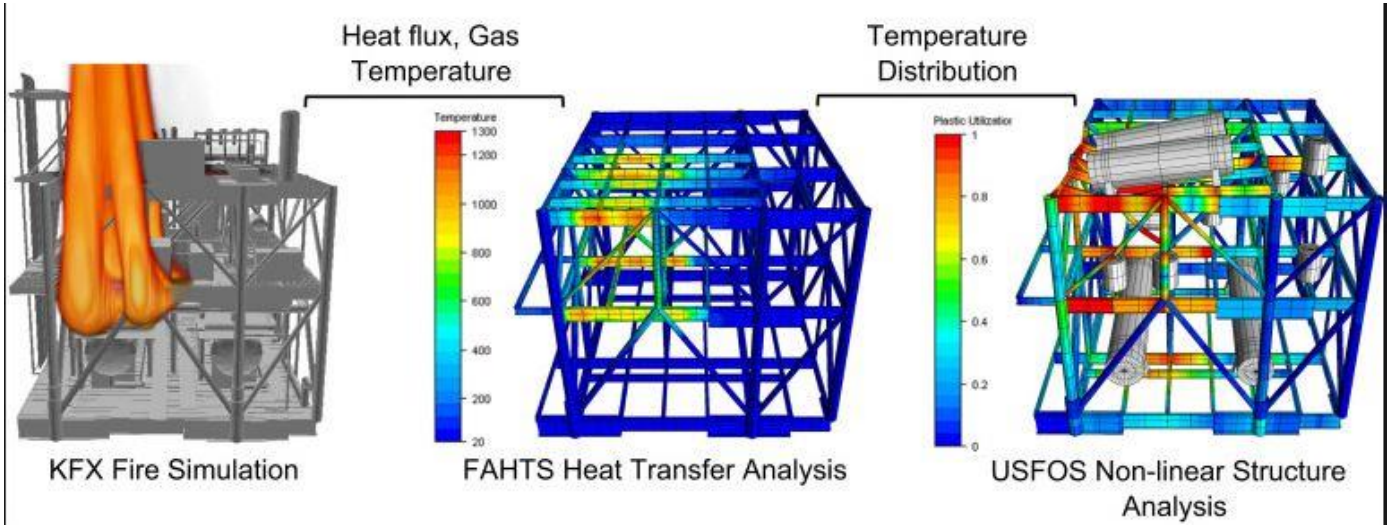


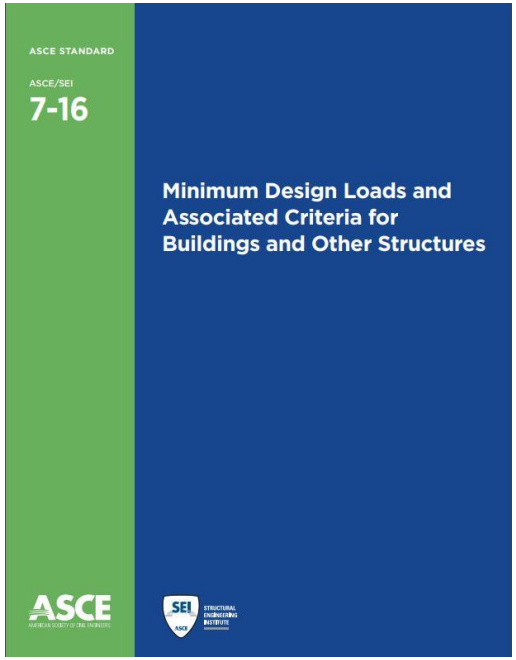

# “OLD”



# "NEW": ENGINEERED METHODOLOGY CAPACITY > DEMAND

- No mixing of prescriptive & performance-based aspects
- Analysis of available capacity by modeling and application of structural & fire protection engineering principles
- Analysis of post-event strength is possible
- Design tailored for specific application and conditions
- Absolutely mandatory involvement by AHJ at all phases

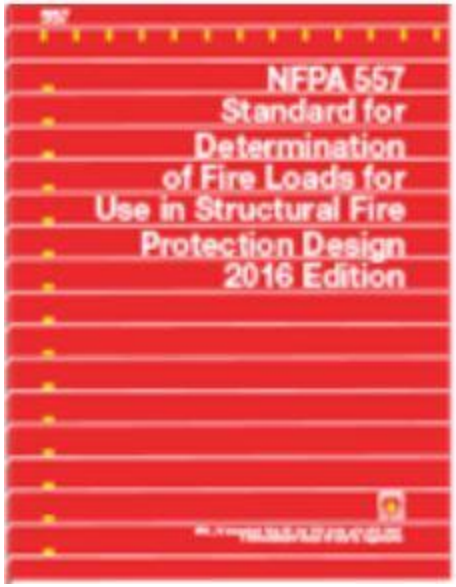




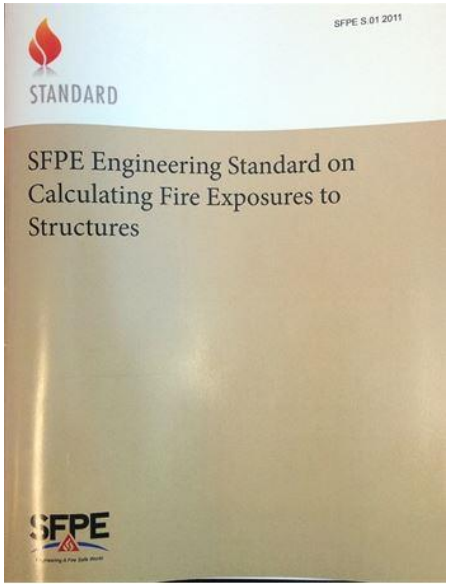

# ASCE/SEI 7-16, APPENDIX E

- NO mixing of methods allowed
- NO sprinkler activation allowed
- Load combination required- 1.2D + A + 0.5L + 0.2S
- "A" = extraordinary event

# ADDITIONAL RESOURCES NEEDED




NFPA 557




SFPE S.01


SFPE S.02

# OREGON BUILDING CODES DIVISION
# STATEWIDE ALTERNATE METHOD 18-01

State of Oregon
Building Codes Division
Better Buildings for Oregon

**Abstract**
**August 2018**

**Statewide Alternate Method**
**No. 18-01 Tall Wood Buildings – Background**

Statewide Alternate Method (SAM) Number 18-01 provides prescriptive path elements for Tall Wood Buildings of mass timber construction. This alternate path includes scientific conclusions established by the International Code Council's Ad Hoc Committee on Tall Wood Buildings that were incorporated into fourteen national proposals and utilizes concrete, steel or masonry for the vertical elements of the seismic force-resisting system.

The provisions detailed in the SAM are crafted to coincide with the *2014 Oregon Structural Specialty Code* (OSSC) when selected for use.

Three new types of construction are introduced under this method, all three of which are organized under Type IV construction, typically referred to as heavy timber.

The new types of construction are:

- Type IV A
- Type IV B
- Type IV C

Prior to this document, heavy timber (wood) structures of this type were limited to six stories.

Major distinctions between these types of construction are found in the required fire-resistance rating of the structure and the protection specified, in terms of timber surface encapsulation.

Type IV A buildings with an automatic sprinkler system require 3-hour fire-resistance-rated primary structural frame elements and bearing walls, with 2-hour fire-resistance-rated floors. Exposed timber surfaces must be entirely encapsulated. For certain occupancies or uses, Type IV A buildings are permitted to achieve eighteen stories and 270 feet in building height.

Type IV B buildings with an automatic sprinkler system require 2-hour fire-resistance-rated primary structural frame elements and bearing walls, with 2-hour fire-resistance-rated floors. A calculated percentage of the exposed timber surfaces may remain exposed under this type, as established in Section 602.4.2.2.2 of the alternate. For certain occupancies or uses, Type IV B buildings are permitted to achieve twelve stories and 180 feet in building height.

Type IV C buildings with an automatic sprinkler system require 2-hour fire-resistance-rated primary structural frame elements and bearing walls, with 2-hour fire-resistance-rated floors. Exposed timber surfaces are permitted to remain entirely exposed under this type. For certain occupancies or uses, Type IV C buildings are permitted to achieve nine stories and 85 feet in building height.

Various additional increased safeguards, manufacturing specifications, material conditions and design configuration prescriptions are detailed in the alternate method.

This statewide alternate method intentionally reinforces the notion that the state building code is not a barrier to innovation or any method, technique or material of construction that is supported by scientific findings, while further preserving Oregon's ability to serve as a single place to obtain statewide approval, providing a predictable regulatory system of business.

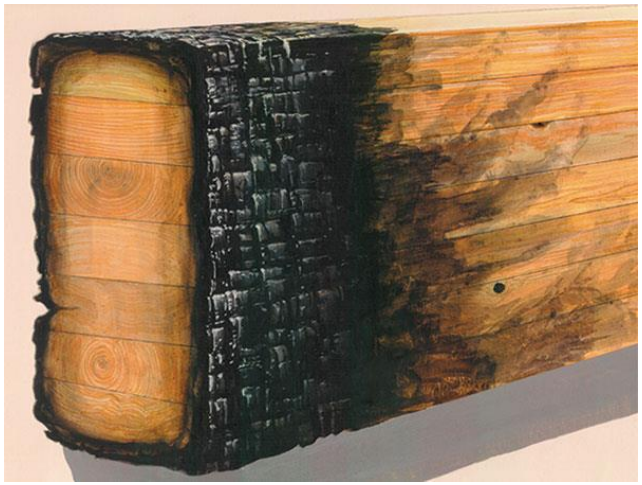
**Building Codes Division ♦ Department of Consumer and Business Services ♦ State of Oregon**
1535 Edgewater St. NW, Salem, OR 97304 ♦ P.O. Box 14470, Salem, OR 97309-0404
503-378-4133 ♦ Fax: 503-378-2322 ♦ oregon.gov/bcd

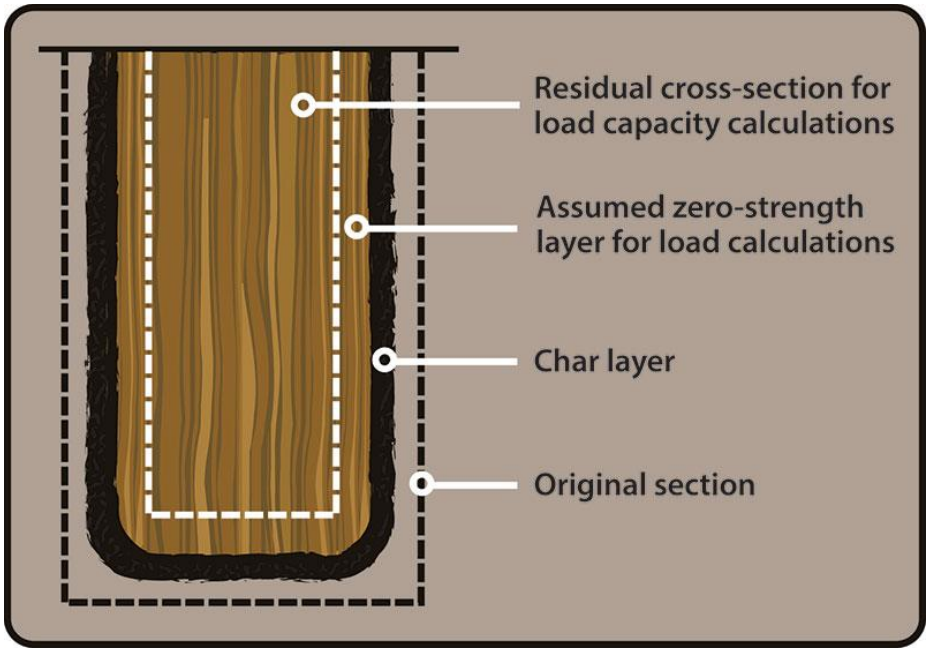
- Approved August 8, 2018
- Modification of Type IV Const.
- Sustainability – no heavy timber
- Full-scale fire tests of CLT
- Still a prescriptive path to compliance
- Still requires concrete, steel, masonry, or a combination for vertical elements of the seismic force-resisting system

# NEW TYPE IV CONSTRUCTION SUB-TYPES

| CONST. TYPE | PRI. STRUCT. HR. RATING | FLOOR HR. RATING | ENCAPSULATION REQ'D. | MAX.NO. STORIES | MAX. BLDG. HEIGHT | SPRINKLERS REQ'D. |
|---|---|---|---|---|---|---|
| IV | HT | HT | N/A | 5 | 65' | N/A |
| IV A | 3 | 2 | Y- 100% | 18 | 270' | Y |
| IV B | 2 | 2 | Y- PARTIAL | 12 | 180' | Y |
| IV C | 2 | 2 | N | 9 | 85' | Y |

# TIMBER PERFORMANCE IN FIRE






- No way to use remaining strength analysis post-fire
- No way to analyze wood performance or dynamics in fire events

# BROCK COMMONS, UNIV. OF BRITISH COLUMBIA, VANCOUVER BC

- 18 Stories
- 53m (174 ft) high

# THE FUTURE-?

- **Will Oregon allow use of ASCE 7-16 Appendix E in the next OSSC code cycle?**

NY La Guardia Airport

# DISCUSSION / FORUM / Q&A