NISTIR 6890

Fire Resistance Determination and Performance Prediction Research Needs Workshop: Proceedings

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Editor

National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

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U.S. Department of Commerce
Donald L. Evans, Secretary

Technology Administration
Phillip J. Bond, Under Secretary of Commerce for Technology

National Institute of Standards and Technology
Arden L. Bement, Jr., Director

D. ASCE/SFPE Standard on Performance-based Structural Fire Protection Analyses

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ASCE/SFPE STANDARD ON PERFORMANCE-BASED STRUCTURAL FIRE PROTECTION ANALYSES

RESEARCH NEEDS FOR FIRE RESISTANCE DETERMINATION AND PERFORMANCE PREDICTION

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Scope and Motivation

- **Motivation**
  - The current test procedure is a comparative test and is not easily related to actual fire performance
- **Scope**
  - Develop standard outlining calculation procedures to assess performance of structures to actual fires

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Status

- **Status: Pre-standard developed:**
  - ASCE/Structural Engineering Institute
  - SFPE
  - AISI
  - Several industries within the concrete sector
  - Masonry Alliance for Codes and Standards
  - AFPA
- **Pre-standard distributed to committee in summer 2001**

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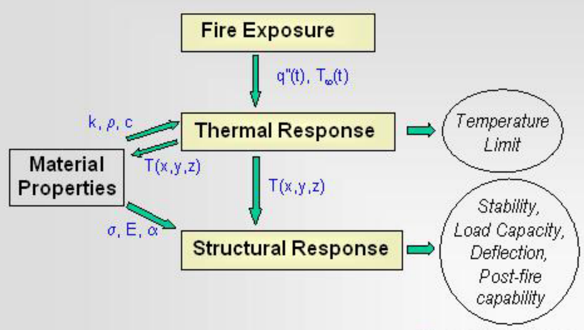
Analytical Framework



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Organization of Pre-Standard

- Fire Exposure
- Concrete
- Masonry
- Steel

Material properties
Thermal response
Structural response

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Structural Analysis Approaches

	Individual Members	Portions of the Structure	Global
Simple Computations	✦		
Advanced Computations	✦	✦	✦
Experiments	✦	✦	✦

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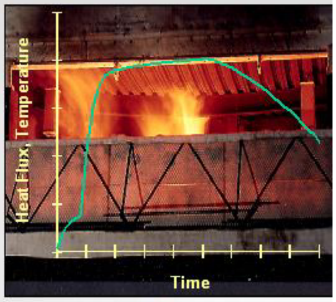
Fire Exposure

- Describe heating conditions
  - Heat flux vs. time
  - Temperature with radiative and convective parameters vs. time
- Methods: algebraic equations, computer models



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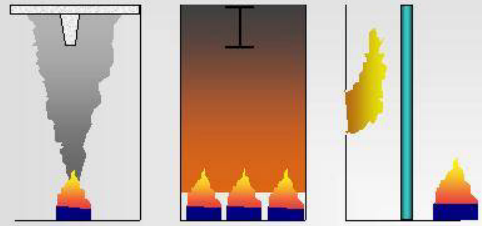
Fire Scenarios



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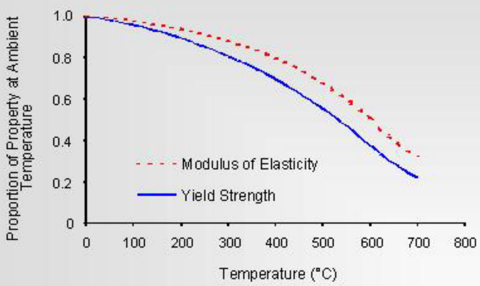
Mechanical Properties - Steel



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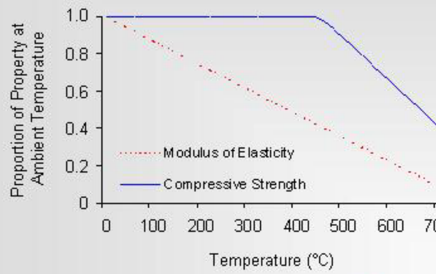
Mechanical Properties - Concrete



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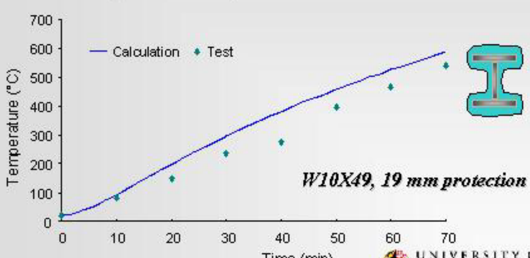
Thermal Response

- Algebraic equations: *uniform temperature of steel member exposed to any fire*



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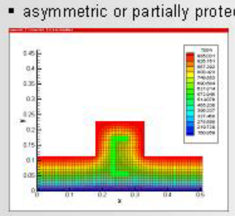
Thermal Response

- Computer analyses: 1-, 2-, or 3-D Temp. Distribution
  - Variable exposure
  - Complex geometry
    - composite floor assembly
    - wall with voids
    - asymmetric or partially protected members



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Structural Response

- 1st order analysis: single member analysis using elementary equations
  - Column stability of isothermal element
  - Moment analysis of slab/beam
  - Apply temperature-dependent material properties
- Computer models
  - Temperature distribution
  - Variable cross-section
  - Complex loading
  - Frame analyses

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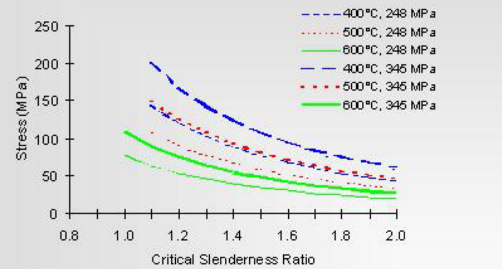
Steel Column Stability



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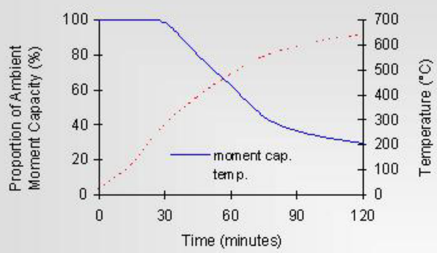
Moment Capacity Analysis



150 mm Siliceous Concrete Slab with cover=25 mm, Standard fire exposure

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Structural FEM

- CEFICOSS (SAFIR)
- CONFIRE
- DIANA
- FASBUS-II
- LENAS-MT
- LUSAS
- SISMEF
- VULCAN

- Input
  - Temp. distribution
  - Strength, modulus, coefficient of thermal expansion, creep
  - Load
  - End conditions
- Output: stresses, strains, deflections

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Summary

- A framework and analytical methods are available to predict the effect of fire on structural components
- Methods are applicable to
  - beams, columns, slabs, walls
  - assemblies comprised of concrete, steel, timber, advanced composites, gypsum, protective materials...

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Summary

- **Experimental data is required to:**
  - Determine material properties at elevated temperatures (via standard test methods?)
  - Characterize material behavior: cracking, adherence, charring and spalling
  - Calibrate models
  - Examine interactions between
    - Components of building assemblies
    - Adjacent building assemblies (as part of structural frame)

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