

# Performance of Structural Systems in Fire

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## A Literature Review on:

- Past Fire-Induced Collapse of Structures
- Thermal Expansion Effects on Performance of Structures in Fire
- Future Research

## - Past Fire-Induced Collapse of Structures:



Pentagon Building Collapse, Sept. 11, 2001



The World Trade Center, Sep. 11, 2001



6-Story Reinforced Concrete Textile Factory in Alexandria, Egypt, July 19, 2000



21-Story Reinforced Concrete Office Building, in Sao Paulo, Brazil May 21, 1987



Fire after a Natural Disaster: 1995 Kobe Earthquake

## Number of Building Collapses in the Past Due to Fire from 1970 to 2002:

- Concrete: 7 (1 in Pentagon 9-11 event)
- Structural Steel: 6 (4 in 9-11 WTC events)
- Brick/Masonry: 5
- Wood: 2
- Unknown: 2

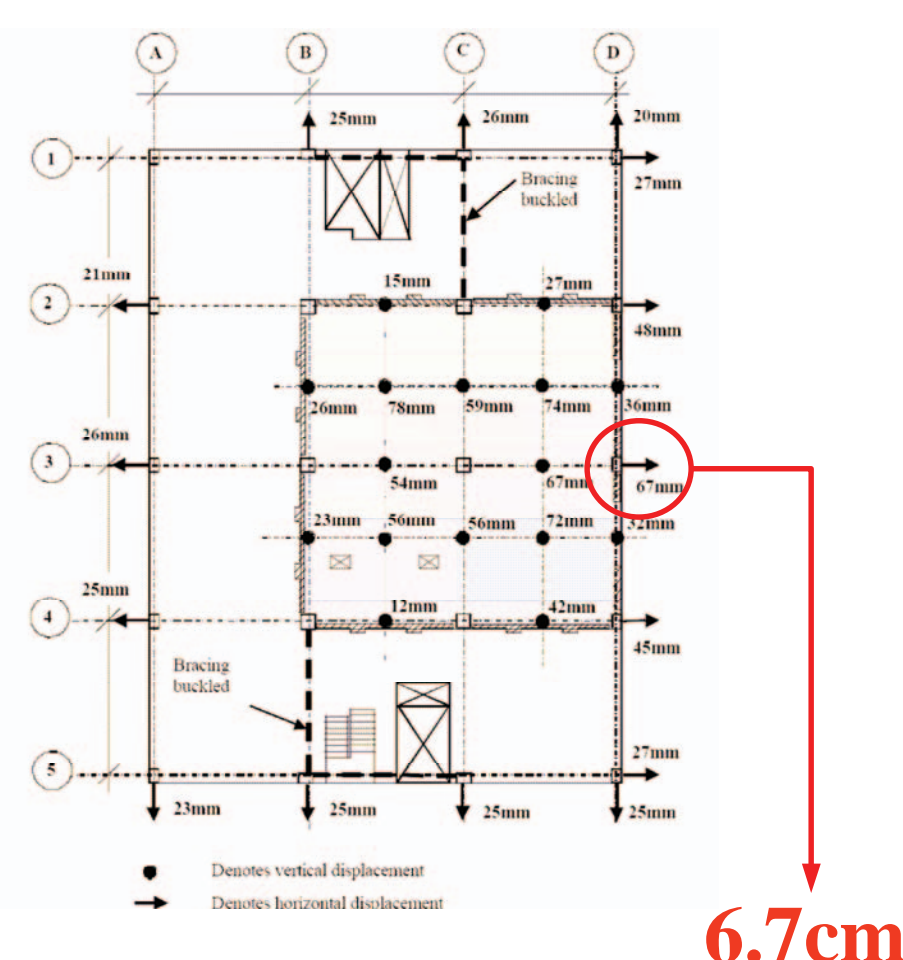
**What Could be The Major Cause of These Structural Collapses?**

## - Thermal Expansion Effects on Performance of Structures in Fire:

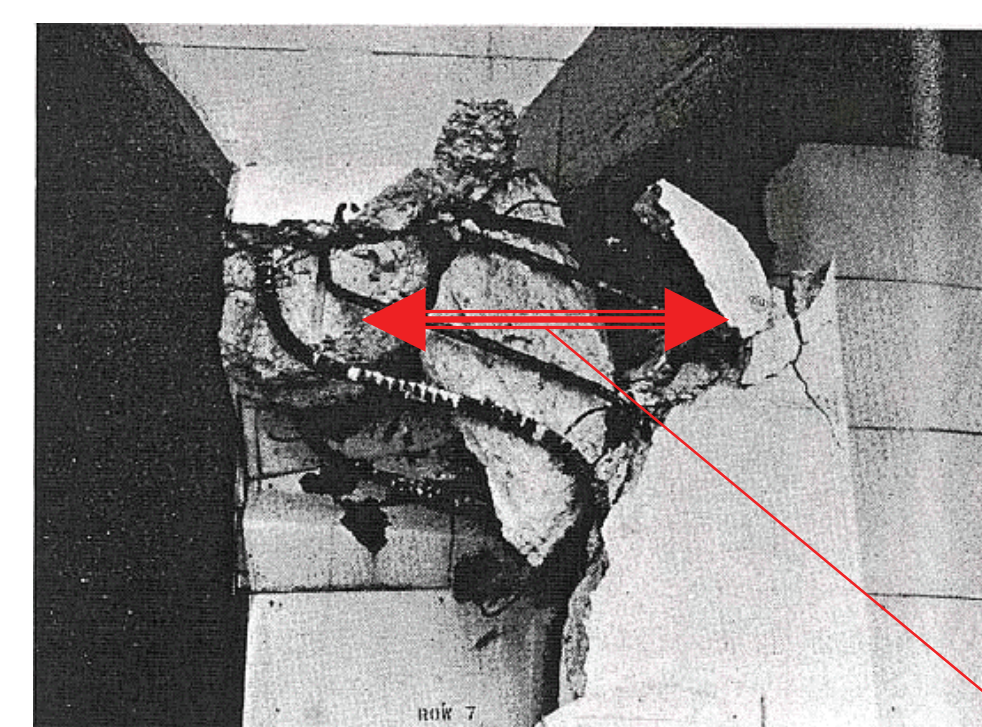
### What Floor Lateral Displacement is Expected Due to a Fire?



2001 Fire Test on the Full-Scale, Seven-Storey, Concrete Building (BRE) Cardington



### How about in the Real World?



Is it True that;  
Lateral Displacement Due to Floor Thermal Expansions Could be a Major Cause for Collapse of Structures in Fire!?

60cm

Large Lateral Deformations and Failure of Columns at Sixth Floor of Military Personnel Records Center (NIST 2002)

## - Future Research

- Effects of Thermal Expansion on Performance of Structures in Fire
- Simple Approaches to Assess Floors Thermal Expansion
- Shear Failure of Reinforced Concrete Elements in Fire
- Consideration of Structural Thermal Expansion Effects in Design Codes and Standards
- Performance Evaluation and Fire-Resistance of Fire-Damaged Structures
- Performance of Structures in Fire and Earthquake

## A Special Session on Structures in Fire and Earthquake at the 9th NCEE and 10th CCEE

9th US National and 10th Canadian Conference on Earthquake Engineering:  
*Reaching Beyond Borders*  
**toronto**  
july 25-29, 2010  
9ième Conférence Nationale Américaine et 10ième Conférence Canadienne de Génie Parasismique: *Au delà des Frontières*

Convened jointly by:  
EERI Earthquake Engineering Research Institute  
The Canadian Association for Earthquake Engineering L'Association Canadienne du Génie Parasismique