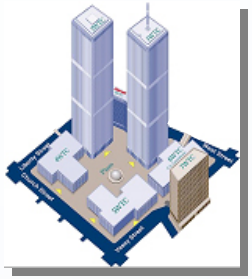

Technical Conference on the Federal Building and Fire Safety Investigation of the World Trade Center Disaster

Session VI
Structural Fire Response and Collapse Analysis

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Objectives of the WTC Investigation Addressed in Project 6

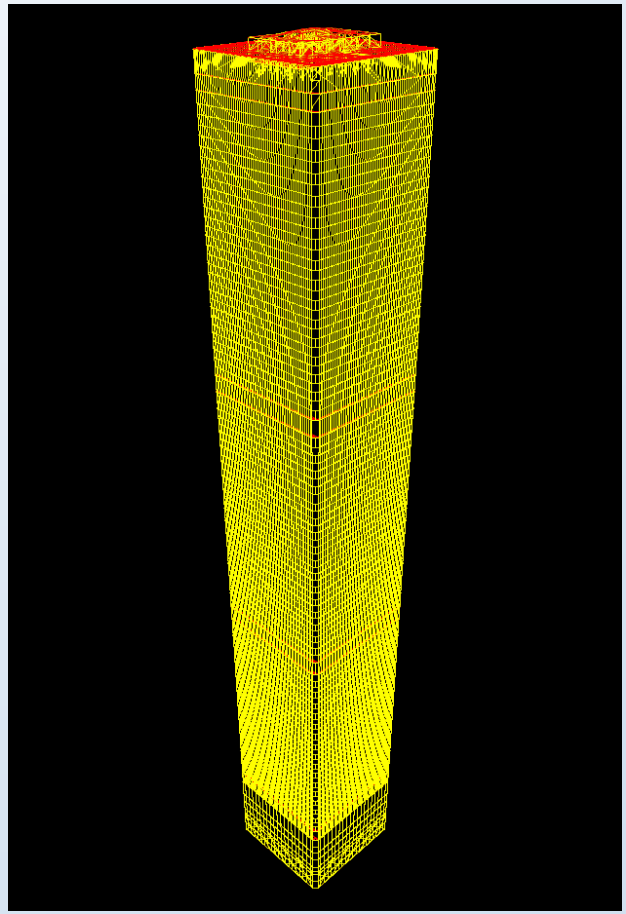
- Determine why and how WTC 1 and WTC 2 collapsed following the initial impacts of the aircraft

- Determine what procedures and practices were used in the design, construction, operation, and maintenance of WTC 1 and 2, more specifically, the procedures and practices that were used in establishing the fire resistance ratings and in providing fire protection of the structural steel

Information/Data – Reference Structural Models

- Reference global structural models of the WTC 1 and WTC 2 towers, and typical floor and exterior wall subsystem models

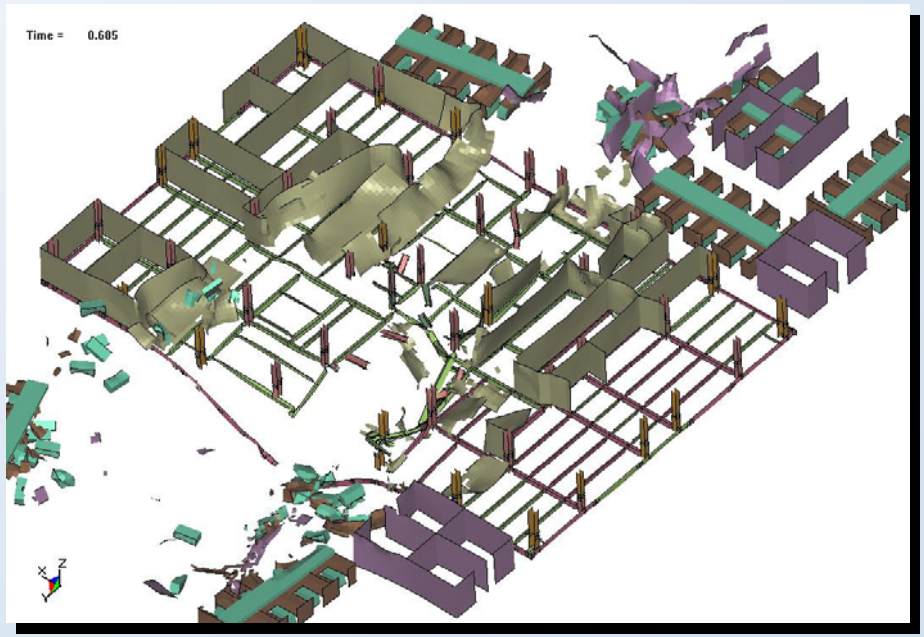
- NIST NCSTAR 1-2



Information/Data – Aircraft Impact Damage

- Extent of damage to the structural systems and interior contents of the WTC 1 and WTC 2 towers resulting from aircraft impact

- NIST NCSTAR 1-2



Information/Data – Material Properties

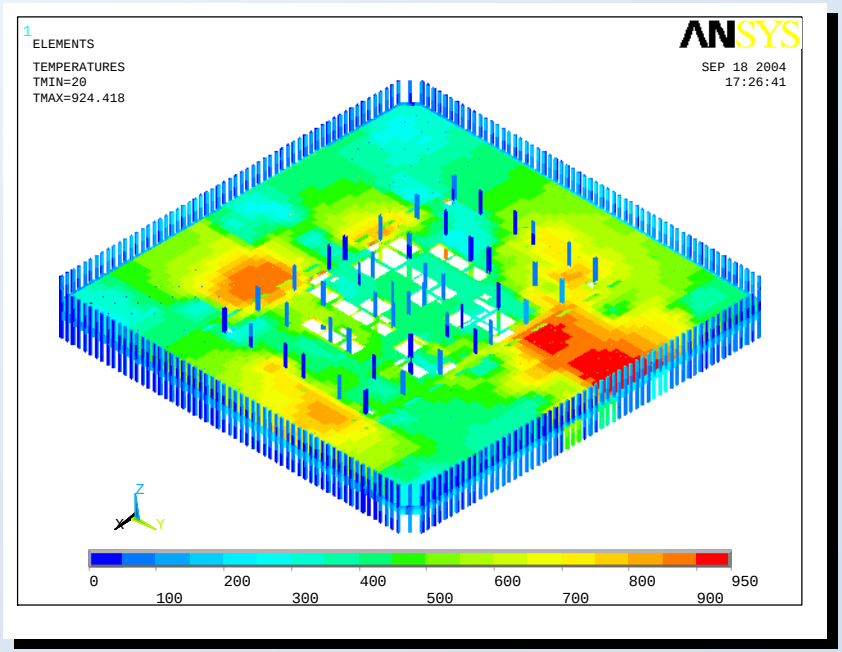
- Temperature-dependent mechanical properties of the steels, welds, and bolts used in the construction of the towers, including elastic, plastic, and creep properties from 20 ºC to 700 ºC

- NIST NCSTAR 1-3

Information/Data – Temperature Histories

- Time-temperature histories for structural components and connections for both standard fires (e.g., ASTM E 119) and actual fires based on fire dynamics simulations

- NIST NCSTAR 1-5G

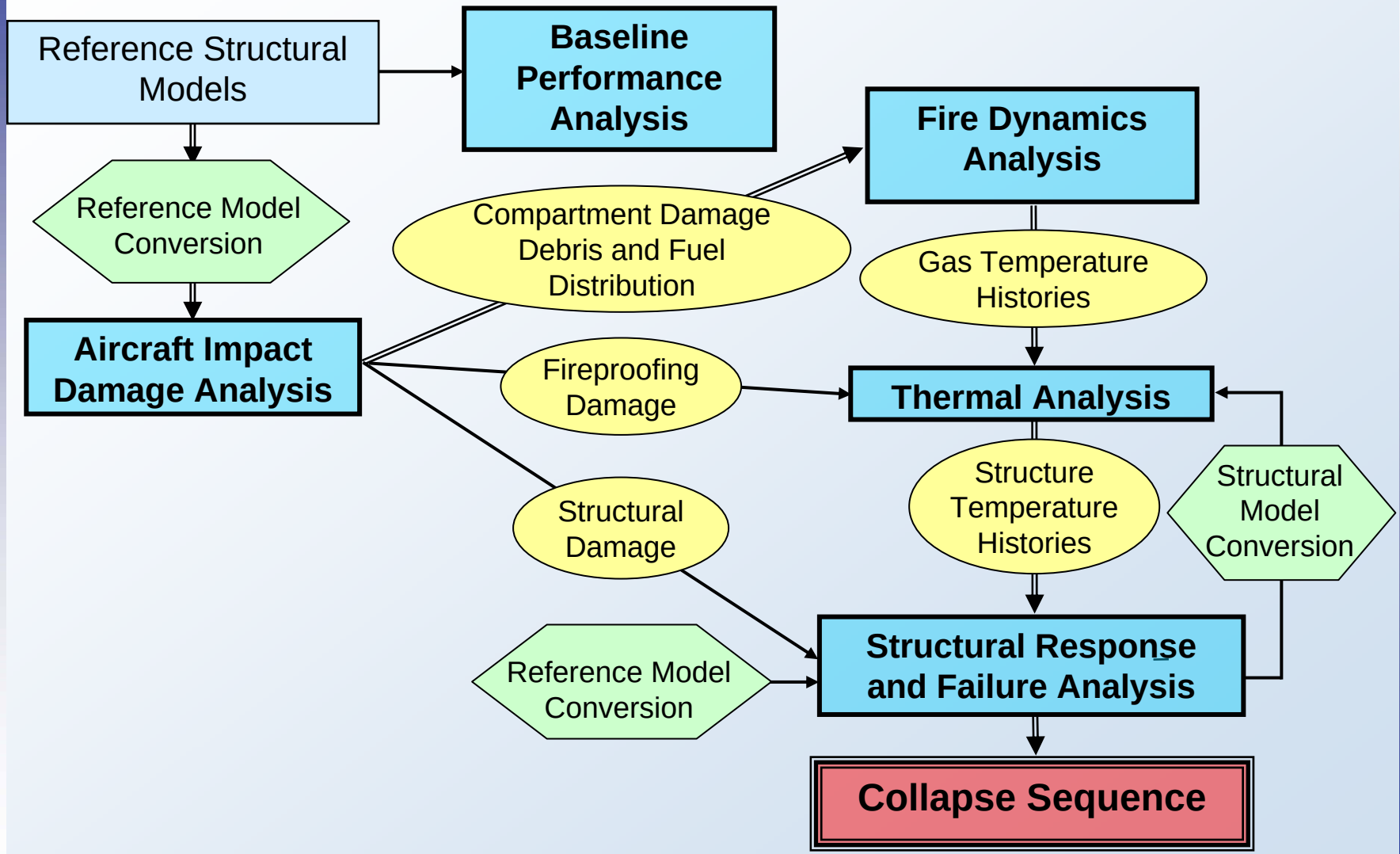


Information/Data - Observations

- Photographic and videographic records with time stamps that documented the observed sequence of events

- NIST NCSTAR 1-5A

Critical Analysis Interdependencies



Structural Analysis Progression

Component Analyses

- Knuckle
- Truss seat connections
- Single truss and concrete slab
- Full floor
- Column splice connection
- Single story column
- Nine story column
- Nine story-nine column exterior wall panel

Subsystem Analyses

- WTC 1
  - Isolated Core
  - South Exterior Face
  - Floors 93 to 99
- WTC 2
  - Isolated Core
  - East Exterior Face
  - Floors 78 to 83

Global Analyses

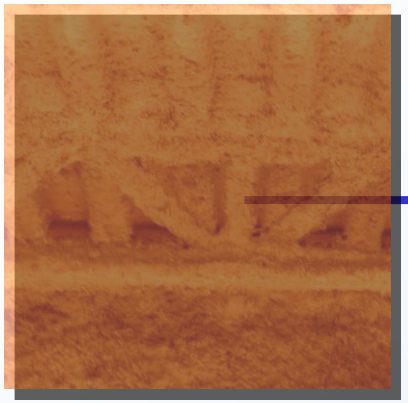
- WTC 1
- WTC 2

Detailed nonlinear analyses to determine component behaviors and failure mechanisms

Nonlinear analyses with component “simplifications” and failure mechanism “simplifications” to determine major subsystem behavior and sequential failure mechanisms.

Nonlinear analyses to determine global behavior and sequential failure mechanisms.

Organization of Session VI



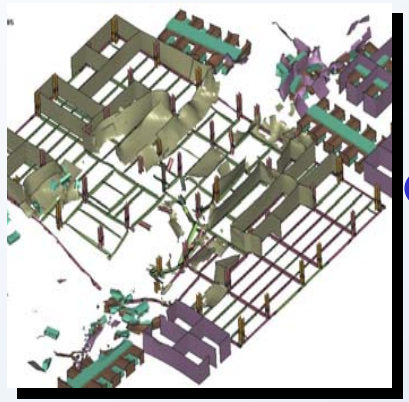
- Fire Endurance Testing of Floor Truss Assemblies

- Standard Fire Test Findings

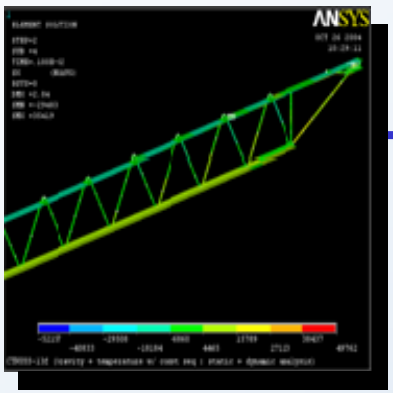
- Fire Protection of Steel

Organization of Session VI

- Observations for Structural Response



- Structural and Fire Protection Damage due to Aircraft Impact



- Structural Response to Impact and Fire

- Probable Collapse Sequences and Key Findings