NCST Investigation of the Champlain Towers Collapse

Investigation Update

Glenn Bell
Associate Lead Investigator

Source: NIST

CT NCST Investigation Update: Agenda

1. **Investigation objectives**
2. Investigative approach and flow
3. Recent accomplishments
4. Project plans
5. Project management and budget
6. Next steps

CT NCST Investigation Update: Investigative Objectives

National Construction Safety Team Act

Technical Cause(s) + Recommendations

SEC. 8. NATIONAL CONSTRUCTION SAFETY TEAM REPORT.

Not later than 90 days after completing an investigation, a Team shall issue a public report which includes—

(1) an analysis of the likely technical cause or causes of the building failure investigated;

(2) any technical recommendations for changes to or the establishment of evacuation and emergency response procedures;

(3) any recommended specific improvements to building standards, codes, and practices; and

(4) recommendations for research and other appropriate actions needed to help prevent future building failures.

CT NCST Investigation Update: Investigative Approach and Flow

1. Investigation objectives
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CT NCST Investigation Update: Failure Cause(s)

Analysis of Demand and Capacity

1. Initiation of failure (demand exceeds capacity)
2. Progression of failure (progressive collapse analysis)

seek a match

Analysis of Failure Data

1. Videos of failure
2. Eyewitness accounts
3. Analysis of debris pile (photos, scans, videos, etc.)
4. Observation of individual pieces of physical evidence

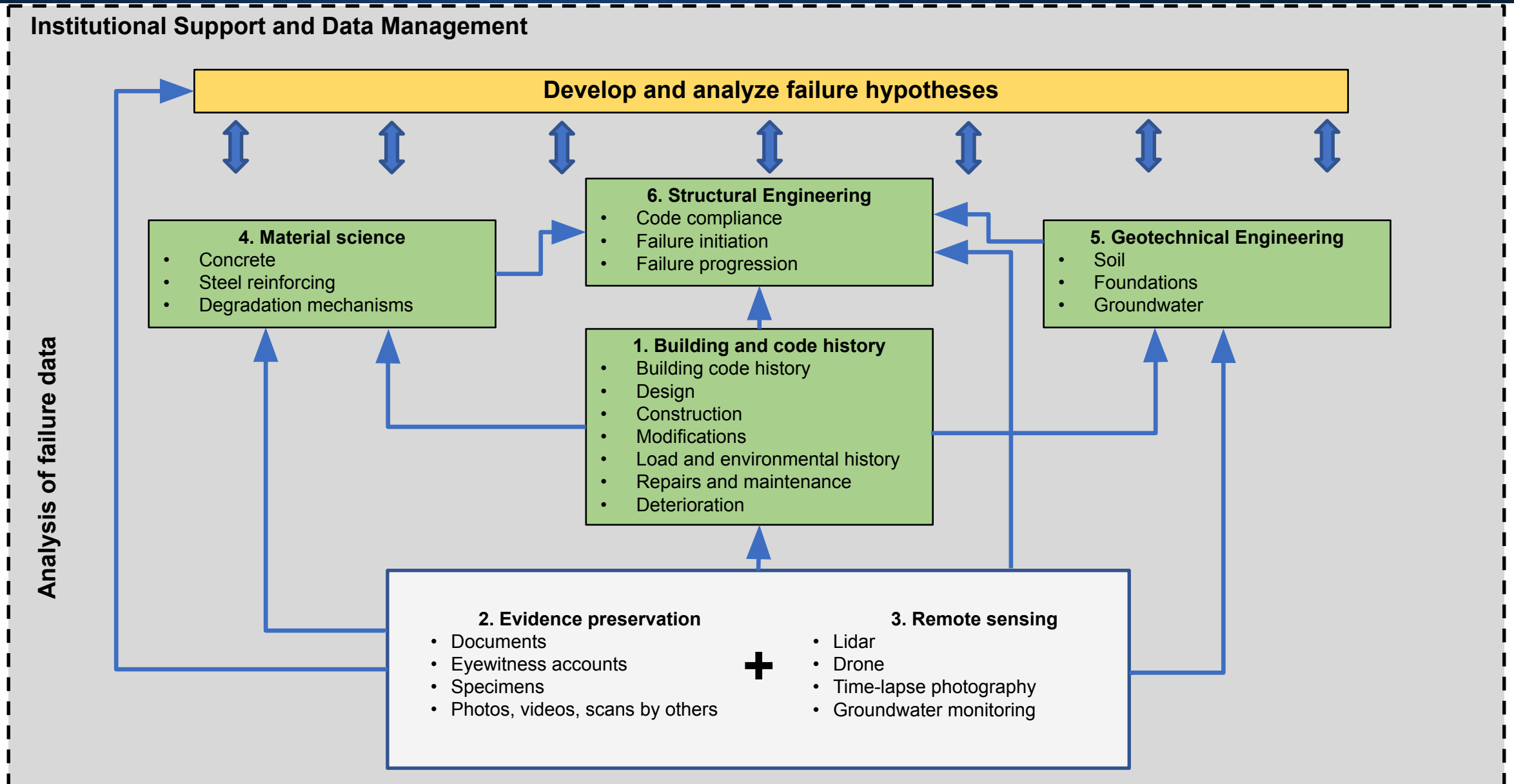
Analysis of Demand: What loads and environmental conditions were acting on the structure at the time of failure?

- Dead
- Live
- Wind
- Thermal and shrinkage
- Extraordinary conditions (e.g., blast, vehicle impact, flooding)
- Vibrations

Analysis of Capacity: What were the ultimate strengths of elements of the structure and structure as a whole at the time of failure?

- Original design
- Original construction (configuration, details, materials)
- Modifications made over time
- Deterioration
  - Material (concrete and steel)
  - Fatigue
  - Soil conditions and foundation settlements
  - Previous loadings

CT NCST Investigation Update : Development and Analysis of Failure Hypotheses



CT NCST Investigation Update

1. Investigation objectives
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CT NCST Investigation Update: Recent Accomplishments

- ❑ **Physical evidence**
- ❑ Data processing, curation, IT infrastructure
- ❑ Recruiting/onboarding project teams
- ❑ Develop failure hypotheses
- ❑ Geotechnical laboratory work
- ❑ Structural modeling
- ❑ Codes, standards, reference docs
- ❑ Interviews
- ❑ Project planning

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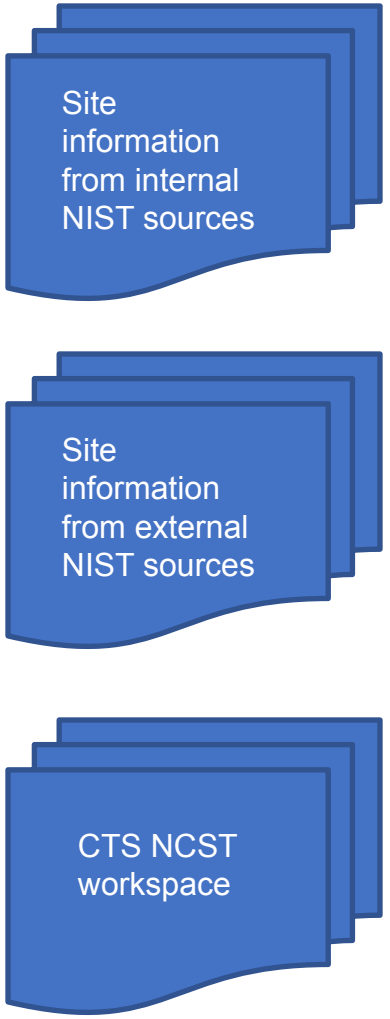

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Judith Mitrani-Reiser, Lead Investigator
Glenn Bell, Associate Lead Investigator
David Goodwin, NCST Investigator
James Harris, NCST Investigator
Youssef Hashash, NCST Investigator
Georgette Hlepas, NCST Investigator
Ken Hover, NCST Investigator
Scott Jones, NCST Investigator
Jack Moehle, NCST Investigator
Sissy Nikolaou, NCST Investigator
Fahim Sadek, NCST Investigator
Kamel Saidi, NCST Investigator
Chris Segura, NCST Investigator
Jonathan Weigand, NCST Investigator

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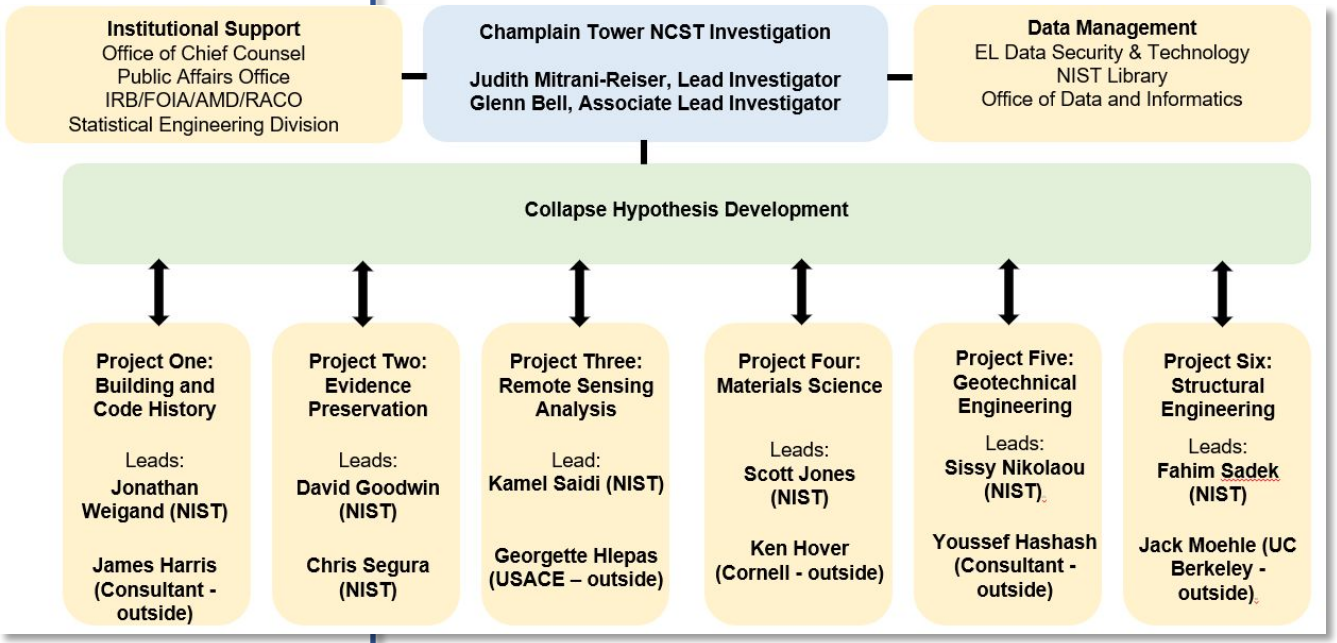

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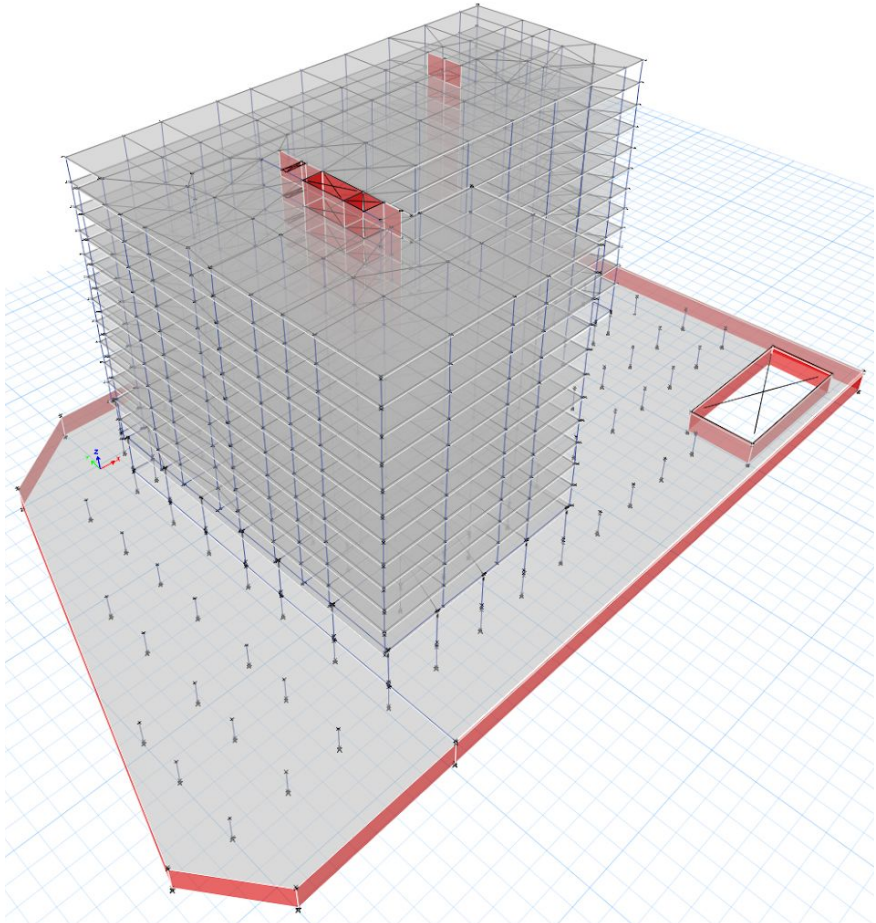

Source: NIST, using ETABS® software

CT NCST Investigation Update: Recent Accomplishments

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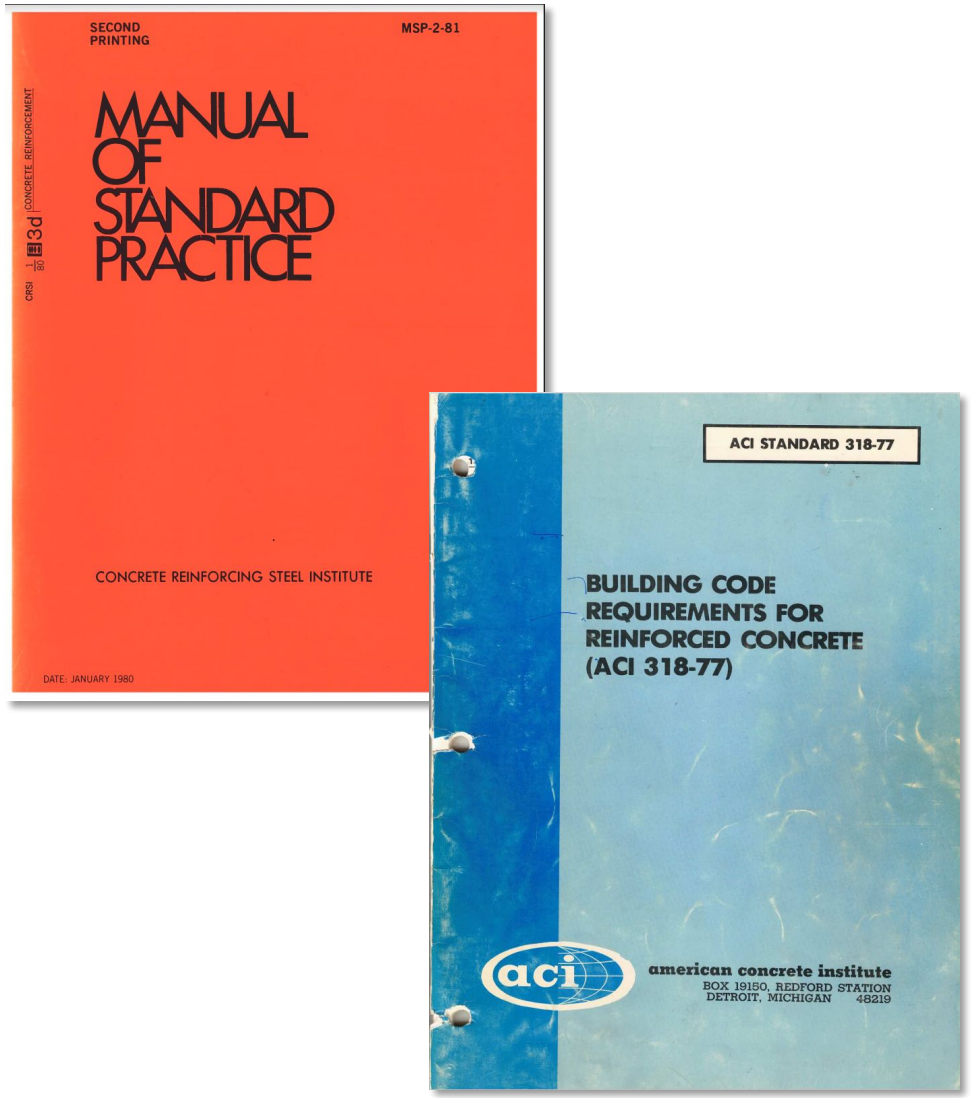

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Source: NIST

CT NCST Investigation Update: Recent Accomplishments

- Physical evidence
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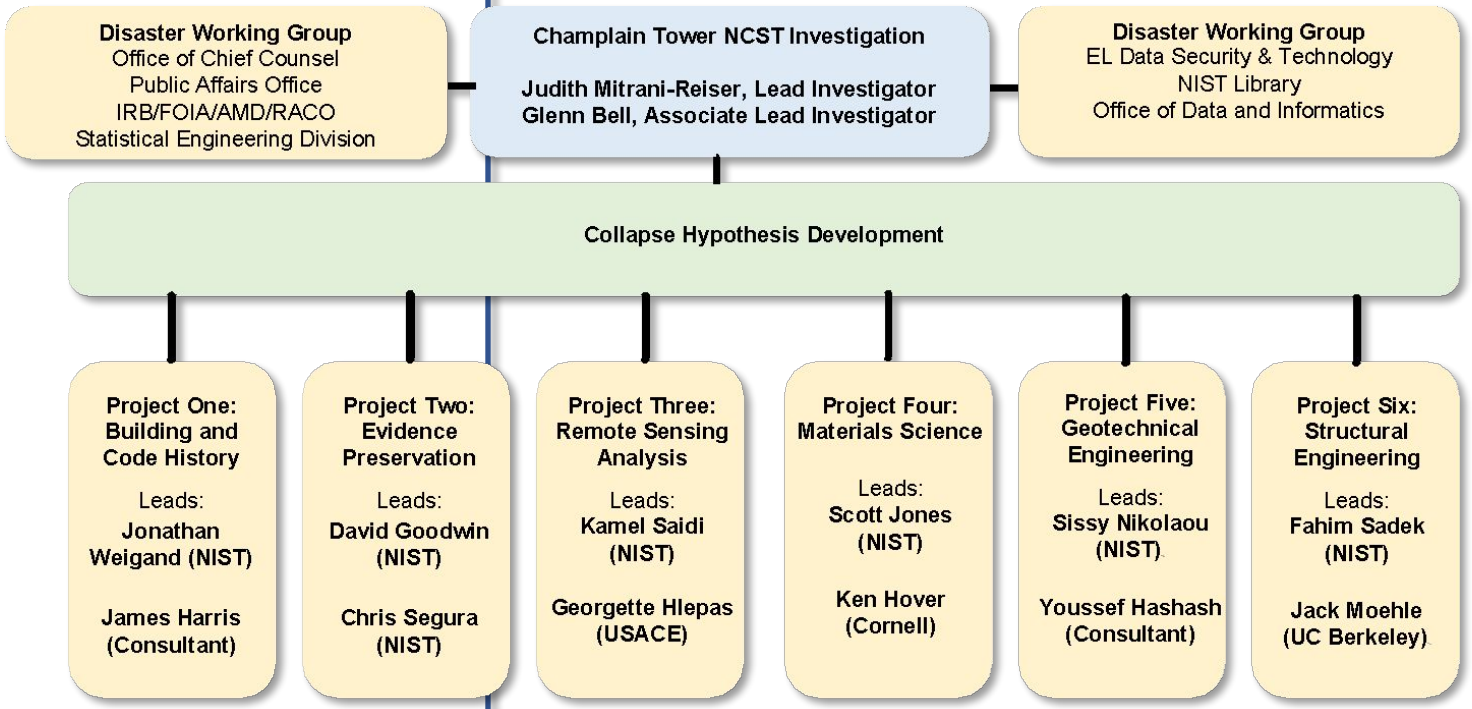
- Structural modeling
- External data collection
- Interviews
- **Project planning**



Building and Code History

The **objective** of this project is to assess the entire history of the building from original design through the partial collapse, including relevant codes and standards, design drawings and other documents, construction records, inspections, maintenance, renovations, and loads and environmental conditions.

Champlain Towers South Collapse: History

Principal project tasks

- Study site history, design and construction considerations to establish the as-built condition of CTS
- Determine what maintenance, repairs and renovations occurred over the life of the structure
- Study the history of site, loading, and environmental conditions affecting the condition of CTS

Next steps

- Continue reviewing and summarize currently available documentation for design, construction, and maintenance/repairs/renovations of CTS
- Continue interviewing people with historic knowledge of construction in the South Florida area

Source: Google Earth
Data: SIO, U.S. Navy, NGA, GEBCO

Evidence Preservation

The **objective** of this project is to use innovative tagging and data collection methods to catalog and organize evidence and ensure the integrity of its origin through proper storage, handling and sampling. This project will also include interviews of residents, first responders, family members or others with knowledge of the building condition and collapse events.

Champlain Towers South Collapse: Evidence Preservation

Principal project tasks

- Create an evidence database to catalog and classify physical specimens from CTS
- Store, manage, and preserve physical specimens. Manage the process of subsample collection and destructive testing
- Collect and analyze non-physical evidence

Next steps

- Determine original locations of specimens in CTS
- Develop protocols for detailed documentation of the specimens

Source: NIST

Remote Sensing & Visualization

The **objective** of this project is to provide a comprehensive 3D geospatial data management solution to compile, organize, visualize, and communicate the surface and subsurface data from the Champlain Towers South building collapse investigation.

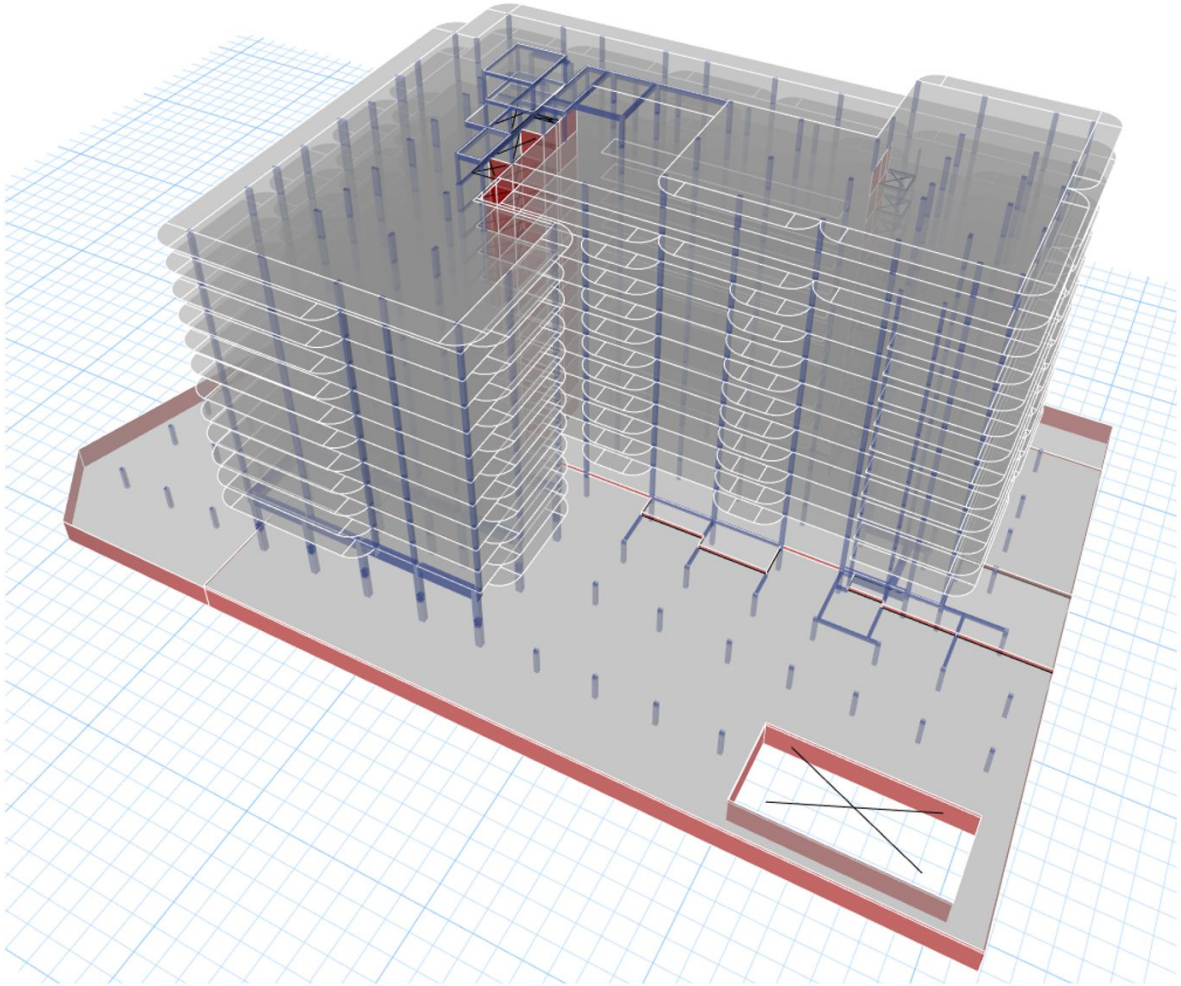
Champlain Towers South Collapse: Sensing & Visualization

Principal project tasks

- Create a three-dimensional model of CTS including the superstructure, foundation and geotechnical conditions, and relevant features of surrounding site
- Work with project teams to define nature and sources of data to be contained in the building information model
- Provide project teams with a comprehensive 3D geospatial data management solution

Next steps

- Establish desired data structure based on needs of project teams
- Create building information model and begin to populate database



Source: NIST, using ETABS® software

Materials Science

The **objective** of this project is to evaluate materials used in specific building features and at different locations in the building for their initial mechanical properties and durability and how those properties may have changed over time as a result of service, exposure, maintenance, and repair. This project will compare these to design specifications and guidelines for monitoring, maintenance, and repair. Data will be used in analyses and simulations of the partial collapse.

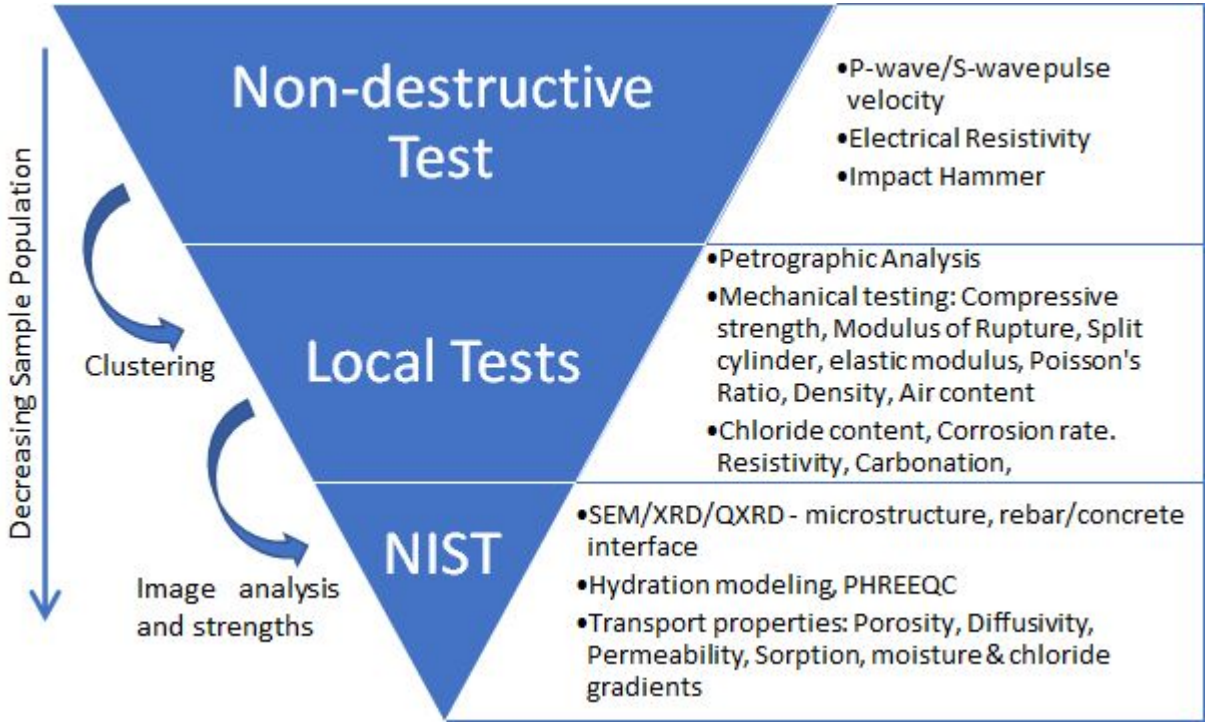
Champlain Towers South Collapse: Material Science

Principal project tasks

- Use material-level NDT to rapidly characterize properties of building debris
- Conduct a comprehensive program of subsample testing (microscopic to mechanical) to characterize relevant structural elements, including concrete and steel reinforcing components
- Identify concrete and steel degradation mechanisms

Next steps

- Continue NDT on specimens
- Develop initial sampling and destructive testing plan for material subsamples



Geotechnical Engineering

The **objective** of this project is to evaluate the foundation's design, its as-built construction and its current condition. It will also assess geotechnical and soil factors that may have affected the foundation.

Champlain Towers South Collapse: Geotechnical Engineering

Principal project tasks

- Characterize the site history and geologic development
- Conduct a comprehensive subsurface investigation. Determine properties of the subsurface materials and foundations
- Analyze and evaluate the subsurface and substructure performance

Next steps

- Process data collected in site investigation
- Complete laboratory testing of specimens retrieved from site

Source: NIST

Structural Engineering

The **objective** of this project is to use evidence collected from the collapse site, the results of the other projects, and structural engineering and reinforced concrete design knowledge to generate computer models that will simulate the failure initiation and progression.

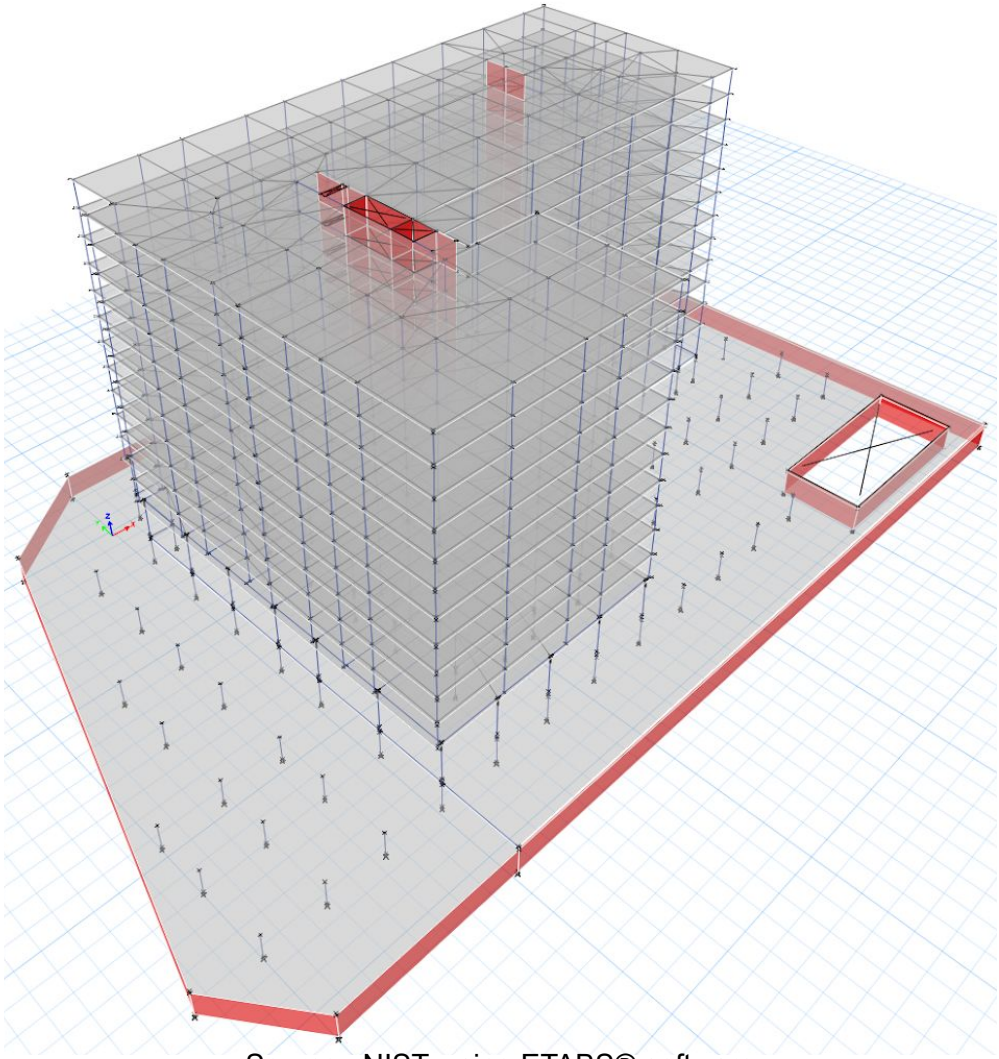
Champlain Towers South Collapse: Structural Engineering

Principal project tasks

- Develop validated models of building structure and components to understand performance characteristics and use in global collapse analysis
- Conduct testing of selected building components to understand performance characteristics and use in global collapse analysis
- Simulate global collapse of the structure

Next steps

- Complete baseline analysis to assess design of structure under design gravity and wind loading
- Develop laboratory testing program



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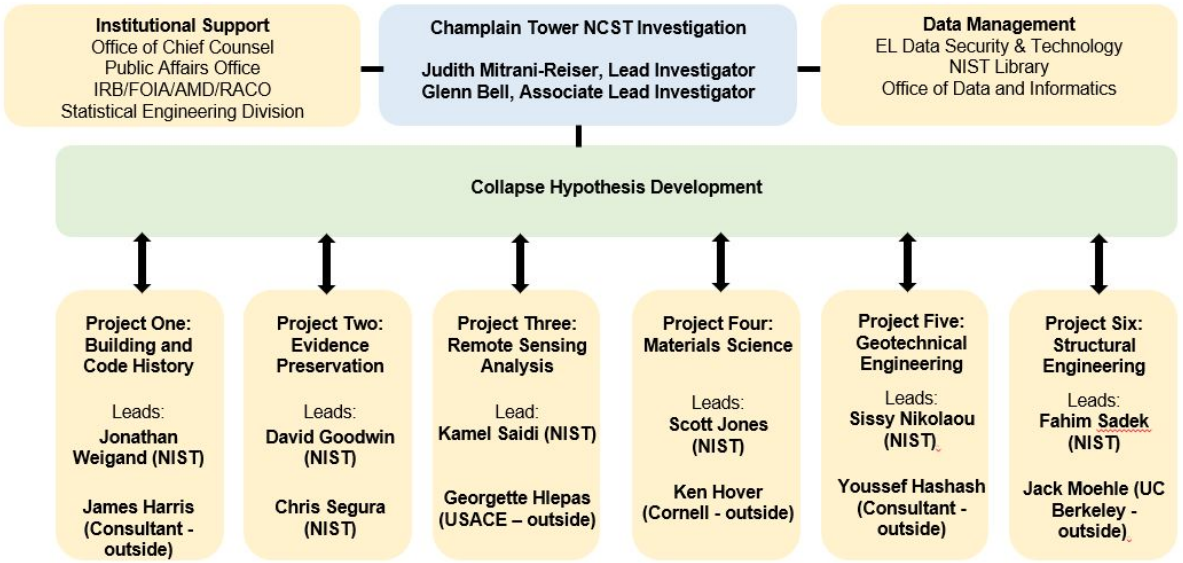
CT NCST Investigation Update: Project Management



1. Individual project teams meet weekly
2. Collective project teams meet weekly, alternating team leadership only and full team membership
3. Lead investigator and Associate Lead Investigator meet weekly
4. Investigation leaders meet with DFS Director and Division and Engineering lab leadership approximately biweekly

CT NCST Investigation Update: Project Budget

TITLE II

DEPARTMENT OF COMMERCE

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

SCIENTIFIC AND TECHNICAL RESEARCH AND SERVICES

For an additional amount for "Scientific and Technical Research and Services" for necessary expenses to carry out investigations of building failures pursuant to the National Construction Safety Team Act of 2002 (15 U.S.C. 7301), $22,000,000, to remain available until September 30, 2023.

H.R. 5305, Division B

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CT NCST Investigation Update: Next Steps

- Protocols for evidence management and sharing
- Process field data collected through site work
- Refine project plan and budget
- Round out project team members and onboarding
- Eyewitness accounts
- Acquire external information: documents, photos, videos

Thank you

Glenn R. Bell
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Associate Lead Investigator, Champlain Towers NCST Investigation
National Institute of Standards and Technology
U.S. Department of Commerce