

# NCST Investigation of the Champlain Towers South Collapse

## Investigation Overview and Update

Judith Mitrani-Reiser  
*Lead Investigator*

Glenn R. Bell  
*Associate Lead Investigator*

# CTS Investigation: Years 1-3+ Activities



- Collected Physical Evidence
- Subsurface Investigation
- Created Investigation Plan
- Established Team Leaders
- Developed Failure Hypotheses
- Created Collapse Timeline
- Received Congressional Funds

- Received Court-Transferred Specimens and Test Records
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- Summarized Preliminary Observations from Code Checks

- Cast Specimens for Full-Scale Structural Tests
- Enhanced/Analyzed Videos
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- Continued Mechanical Testing of Concrete Cores & Steel Reinforcing Bars

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YR 1

Jun-Dec  
2021

Jan-Jun  
2022

YR 2

Jul-Dec  
2022

Jan-Jun  
2023

YR 3

Jul-Dec  
2023

Jan-Mar  
2024

Mar-Apr  
2024

May-Jun  
2024

YR 3

Jul-Aug  
2024

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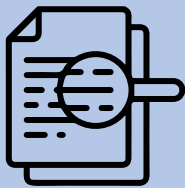
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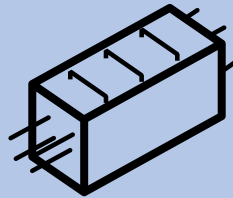
# CTS Investigation: March 2024 Advisory Committee Meeting

## **Theme 1: *Timeline and Evidence Collection***



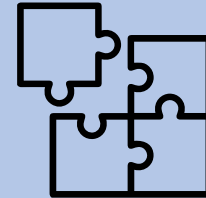
*Judith Mitrani-Reiser,  
N. Emel Ganapati, David Goodwin,  
Christopher Segura,  
Jonathan Weigand, Kam Saidi,  
Jack Moehle*

## **Theme 2: *Analysis and Testing Updates***



*Fahim Sadek, James Harris,  
Christopher Segura,  
Kenneth Hover, Jack Moehle,  
Sissy Nikolaou,*

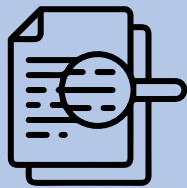
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*Glenn Bell, Fahim Sadek,  
Georgette Hlepas,  
Scott Jones, James Harris,  
Youssef Hashash*

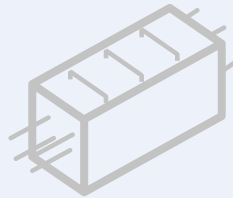
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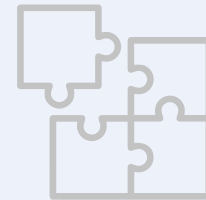
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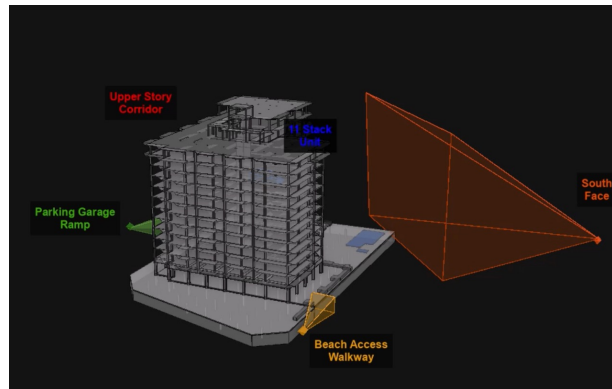
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# CTS Investigation: March 2024 Advisory Committee Meeting **NIST**

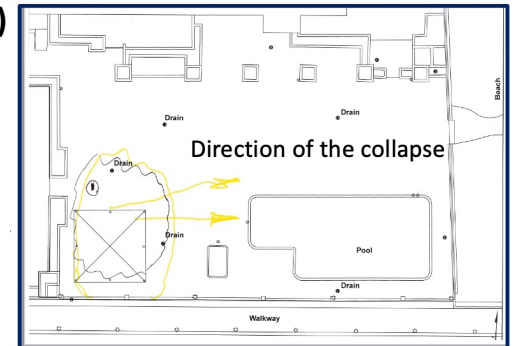
## Theme 1: *Timeline and Evidence Collection*



(a)



(b)



**Drawing Annotations by CTS Resident**

(Original Drawing Source: CTS Receiver)



(c)



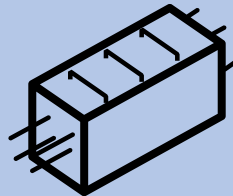
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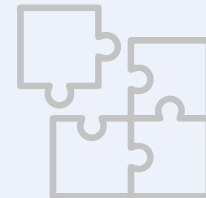
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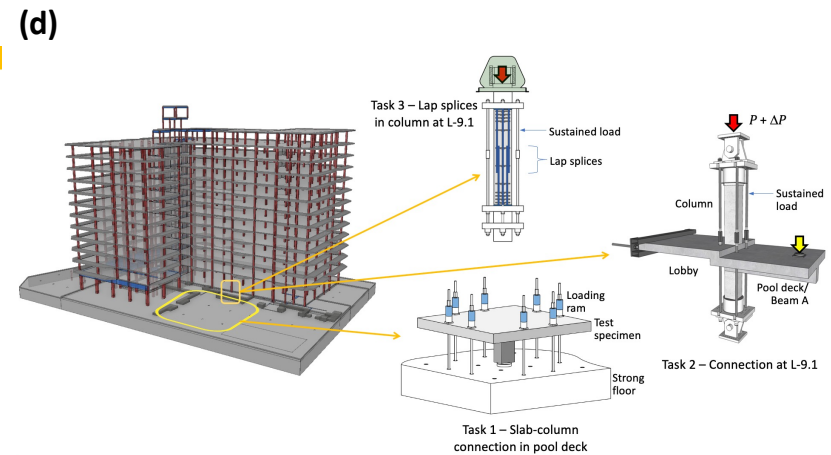
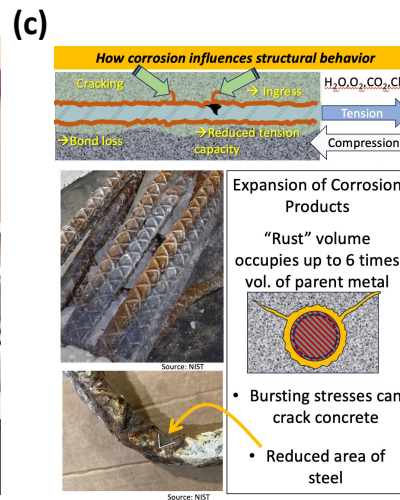
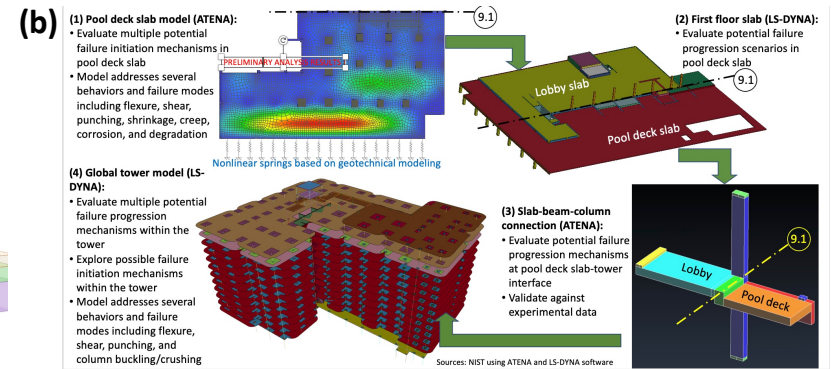
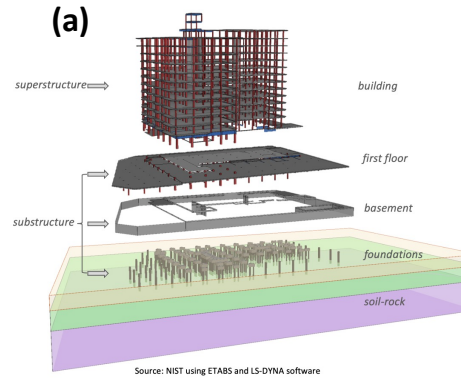
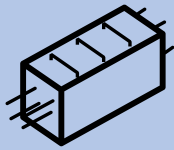
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*Glenn Bell, Fahim Sadek,  
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# CTS Investigation: March 2024 Advisory Committee Meeting **NIST**

## Theme 2: Analysis and Testing Updates





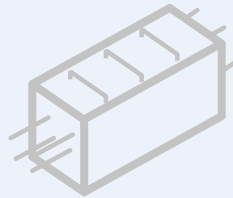
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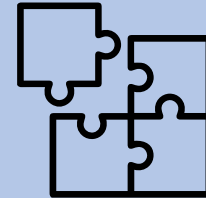
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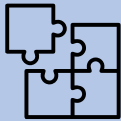
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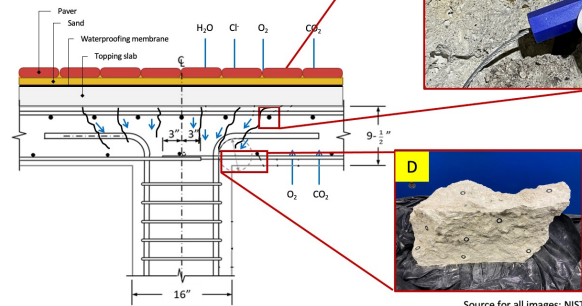
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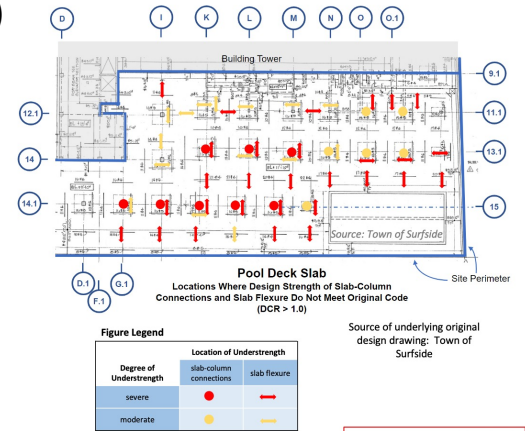
### (a) Degradation Mechanisms

1. Cracking creates a "highway" for Cl<sup>-</sup>, H<sub>2</sub>O, and CO<sub>2</sub> to reach reinforcing bar causing corrosion
2. Concrete microstructure altered by the environment, changing mechanical properties



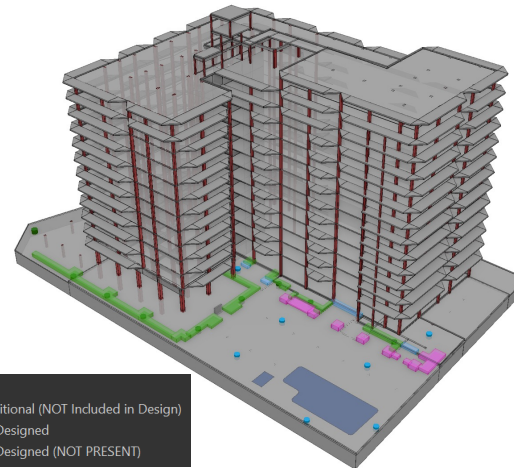
Source for all images: NIST

### (b)

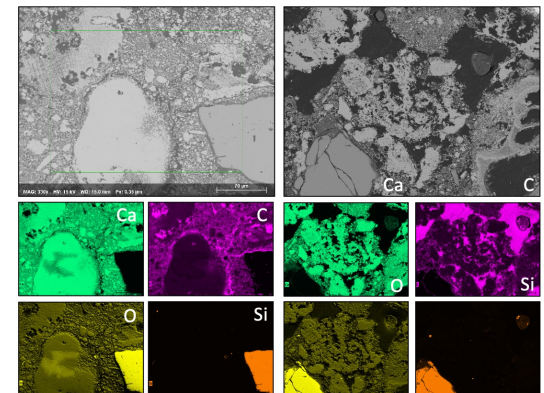


PRELIMINARY ANALYSIS RESULTS

### (c)



### (d) Sample depth range 25 ft-26 ft      Sample depth 36 ft



Source all images: NIST

PRELIMINARY ANALYSIS RESULTS

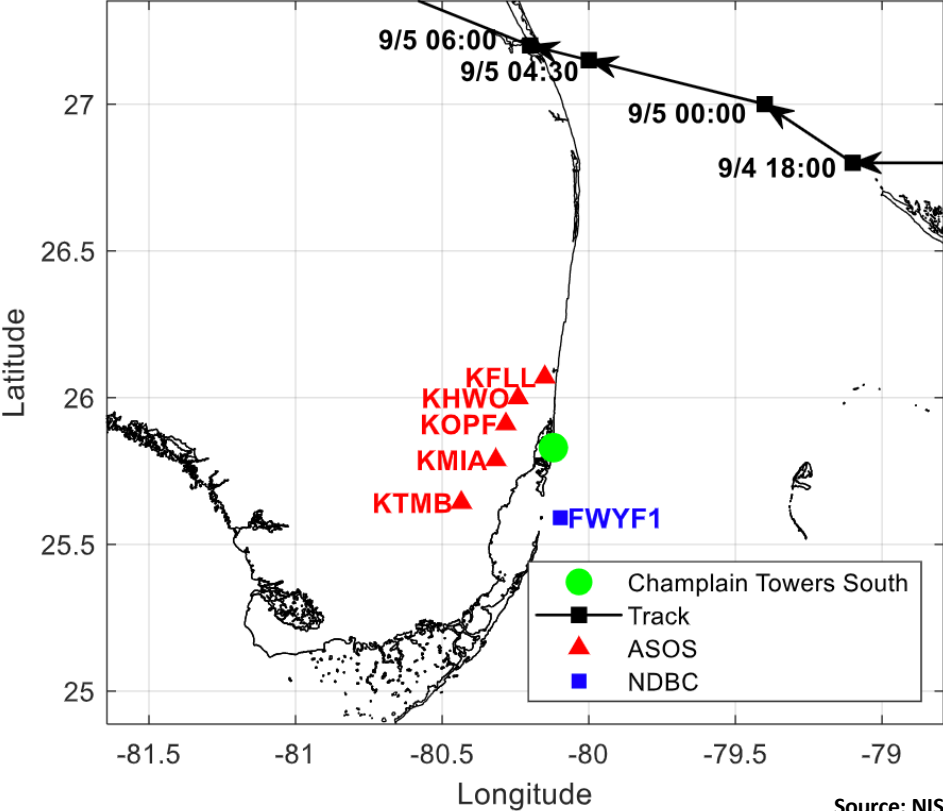


Source: NIST

# CTS Investigation: April 2024 Historical Wind Study



Source: NIST



Source: NIST

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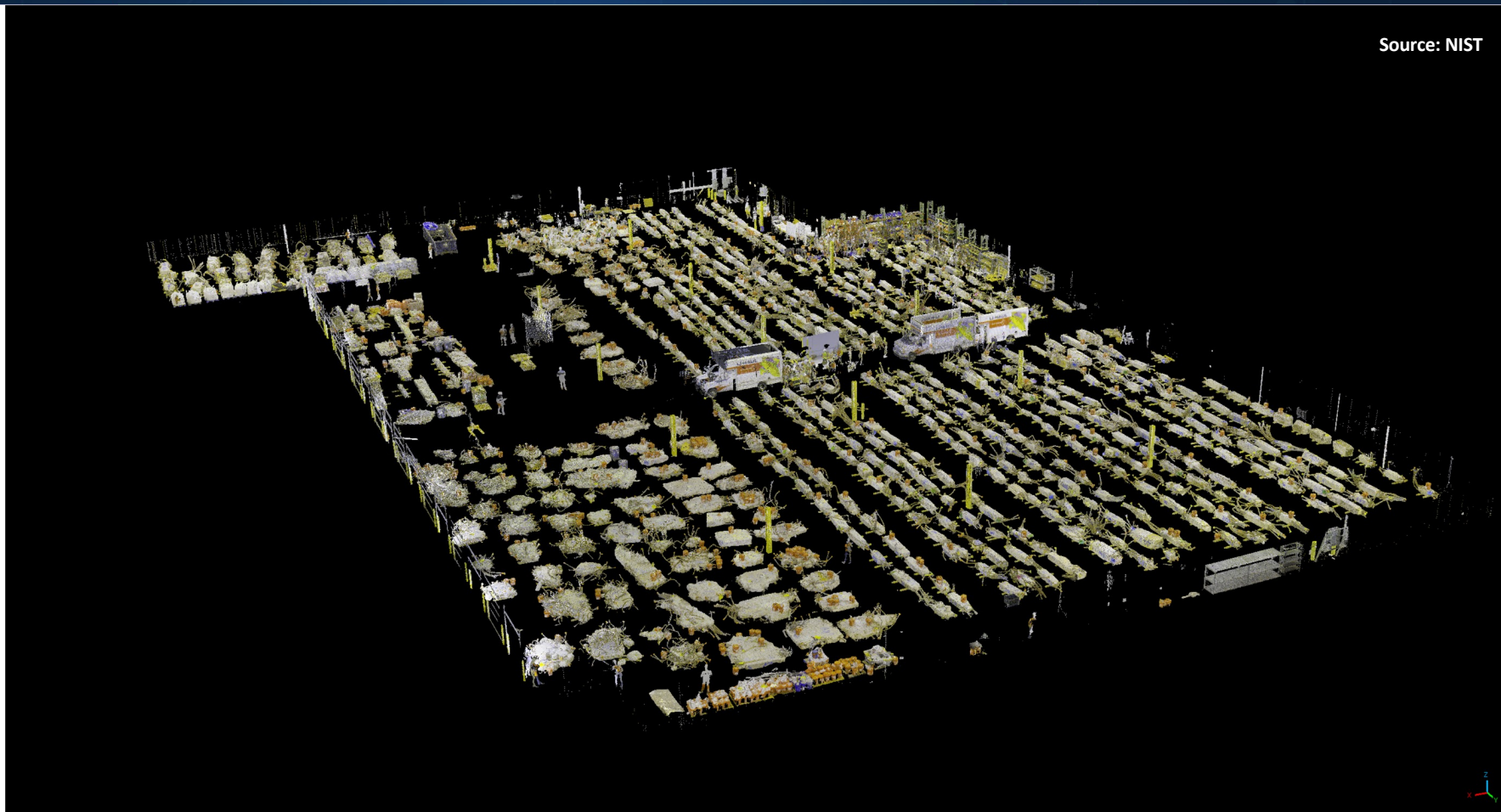
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# CTS Investigation: May 2024 Evidence/Warehouse Scans

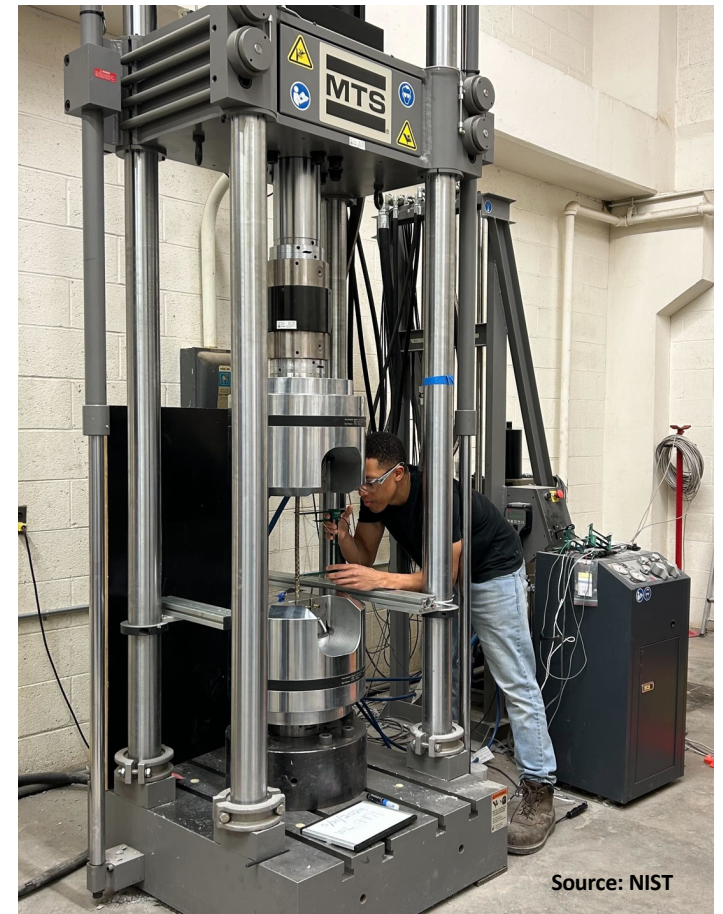
NIST

Source: NIST



# CTS Investigation: June 2024 Mechanical Tests

NIST



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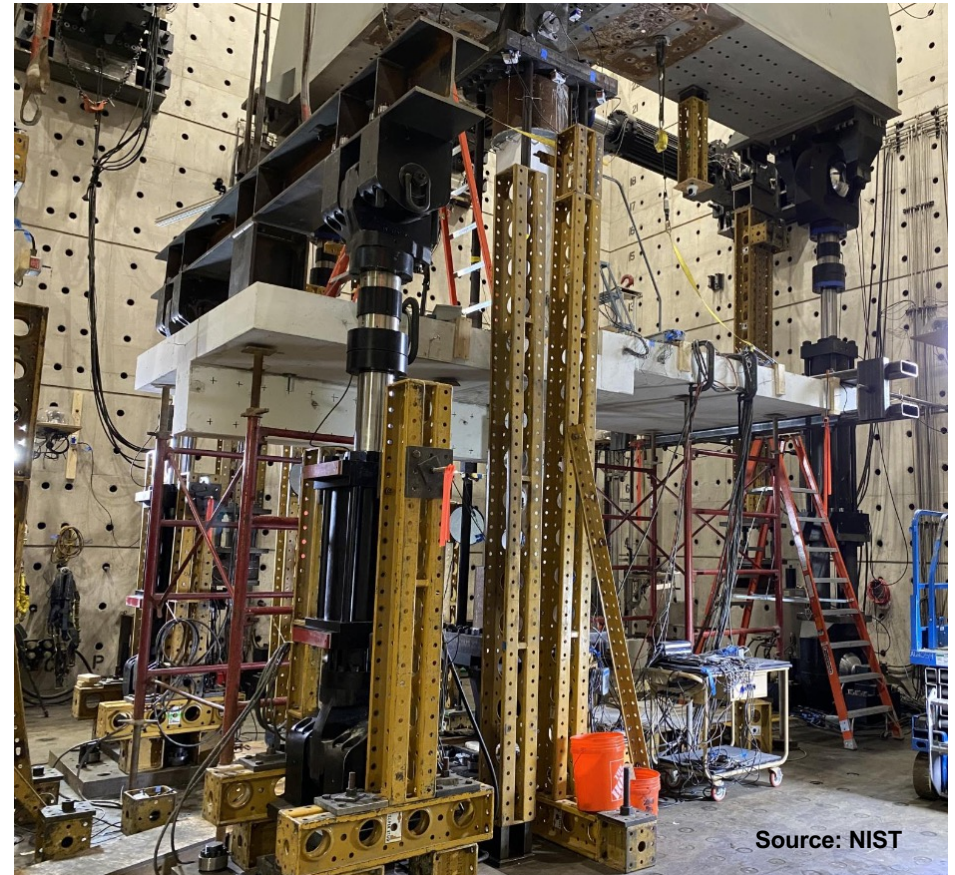
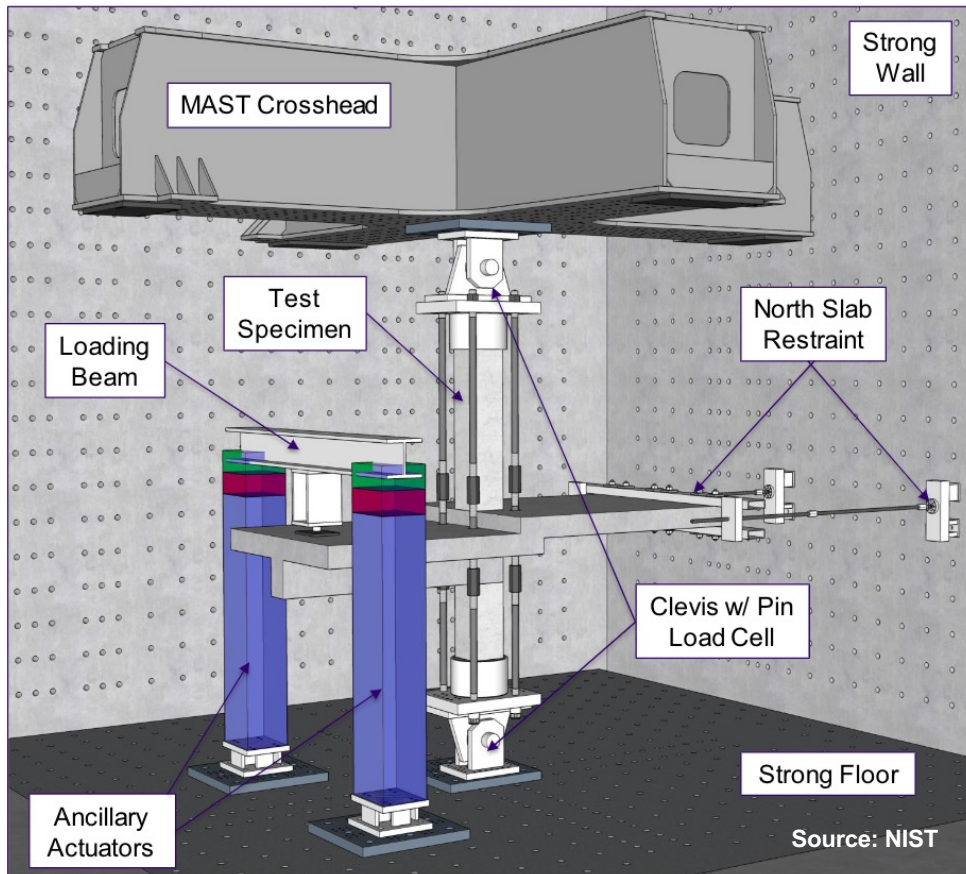
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- NCST Public Meeting
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- Relunched Interviews
- Completed Column Tests & Mechanical Tests of Concrete Cores
- Conducted First Beam-Slab-Column Joint Test
- Evaluated Hard Drives

# CTS Investigation: July 2024 Structural Tests at UMN

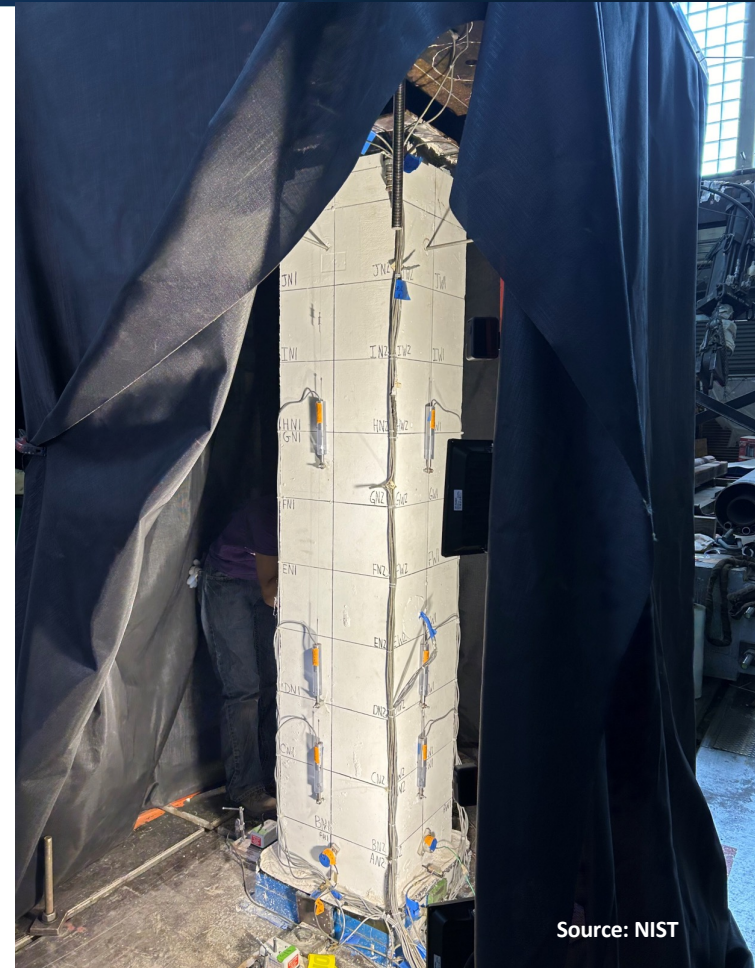
NIST





# CTS Investigation: August 2024 Structural Tests at UW

NIST



**Collaborate  
Coordinate  
Cooperate**

**NIST Engineering Laboratory (EL)**

Structures Group (MSSD)  
Infrastructure Materials Group (MSSD)  
Earthquake Engineering Group (MSSD)  
Community Resilience Group (MSSD)  
Disaster Statutory Programs (MSSD)  
Intelligent Systems & Fire Research Divisions  
EL's Data, Security, Technology Group  
EL's Applied Economics Office

MSSD = Materials and Structural Systems Division

**NIST**

Physical Measurement Laboratory  
Materials Measurement Laboratory  
Public Affairs Office  
Office of Chief Counsel  
Program Coordination Office  
Management and Organization Office  
Acquisition & Agreements Mgmt. Office  
ITL's Statistical Engineering Division

ITL = Information Technology Laboratory

**Federal**

Federal Emergency Mgmt. Agency  
U.S. Army Corps of Engineers  
U.S. Geological Survey  
National Science Foundation  
Federal Bureau of Investigation  
Department of Defense  
NOAA's National Weather Service  
Bureau of Reclamation

NOAA = National Oceanic and Atmospheric Administration

**Local and State**

Miami-Dade County Mayor's Office,  
Fire, Police, and Building Departments  
Town of Surfside  
City of Miami Beach  
Florida Division of Emergency Mgmt.  
Florida DOT and State Attorney's Office  
Virginia Beach Fire Department  
USAR Task Forces

DOT = Department of Transportation

USAR= Urban Search & Rescue

# CTS Investigation: FY22-24 Budget & Contracts Overview



Status	Contract	Contractor(s)	Project(s) Supported
Modification (3/2024)	Evidence Collection Leadership & Support	Florida International University (FIU)	<ul style="list-style-type: none"> <li>Co-leadership for P2</li> <li>P1, P2, P3, P4, P5, P6, P7</li> </ul>
Modification (4/2024)	Invasive Testing Support	Applied Research Associates (ARA)	<ul style="list-style-type: none"> <li>P2, P4</li> </ul>
Modification (5/2024)	Full-Scale Structural Testing	University of Washington (UW)	<ul style="list-style-type: none"> <li>P6</li> </ul>
Modification (5/2024)	Geotechnical Engineering Project Leadership	University of Illinois, Urbana-Champaign (UIUC)	<ul style="list-style-type: none"> <li>Co-leadership for P5</li> </ul>
Modification (5/2024)	Evidence Storage Management & Protection	Miami-Dade County	<ul style="list-style-type: none"> <li>P7</li> </ul>
New Contract (7/2024)	Geographic Information System Software	ArcGIS	<ul style="list-style-type: none"> <li>P3</li> </ul>
New Contract (7/2024)	Building & Site History Support	J.R. Harris & Company	<ul style="list-style-type: none"> <li>Co-leadership for P1</li> <li>P6</li> </ul>
Modification (8/2024)	Steel Corrosion Expertise	Tourney Consulting Group	<ul style="list-style-type: none"> <li>P4</li> </ul>
Modification (8/2024)	Geotechnical Engineering Support	Geocomp	<ul style="list-style-type: none"> <li>P5</li> </ul>
New Contract (9/2024)	Create 3-D building information model	Fluency Architecture & Design	<ul style="list-style-type: none"> <li>P3</li> </ul>

**FY22-FY23  
CTS Investigation  
Appropriated Funds Spent**

Labor: \$ 7.5M (34%)  
Other Objects\*: \$ 15.5M (66%)

*\*contracts, equipment, travel, misc.*

**FY23-24  
Disaster Supplemental Funds  
Spent to Date**

Labor: \$ 3.1M (32%)  
Other Objects\*: \$ 6.5M (68%)

*\*contracts, equipment, travel, misc.*

# NIST Seeks Additional Data

NIST

Search NIST



Menu

Resilience

<https://www.nist.gov/disaster-failure-studies/data-submission-portal>

## DISASTER & FAILURE STUDIES

### About the Disaster & Failure Studies Program

National Construction Safety Team (NCST) +

Champlain Towers South Collapse NCST Investigation

Hurricane Maria Program

Joplin Tornado NCST Investigation

World Trade Center NCST Investigation

Studies by Hazard Types +

Impacts & Recommendations

**Data Submission Portal**

Data Archive +

Recent Activities

FAQs

## Data Submission Portal

### General Overview

[Traducción al español](#)

Disasters and failure events provide important opportunities for scientists and engineers at the National Institute of Standards and Technology (NIST) to learn how we can improve the safety of buildings, their occupants, and emergency responders. NIST has studied and investigated more than 50 earthquakes, hurricanes, building and construction failures, tornadoes, and fires since 1969. The goal for these post-event assessments is to recommend improvements to building codes, standards, and practices. The Disaster and Failure Studies Program provides leadership, coordination and management for all disaster studies at NIST.

To fully understand a damaging event, NIST must gather all possible evidence, including photos, videos, or other documentation that may be owned and held by the public that contain clues about the event, the buildings affected, or the emergency response. For this purpose, NIST established the NIST Disaster Data Portal to serve as an entry point for the general public and other stakeholders to upload files for investigations and studies of disaster and failure events. The Portal helps ensure that this valuable information is organized and maintained to enable study, analysis, and comparison with subsequent severe disaster and failure events.

Click on the button below to submit data including photos, video, and other documentation associated with a disaster or failure event. Submitters will be asked to complete a form for each submission that includes a description of the data, credits, and permissions.

[Access the Data Portal](#)



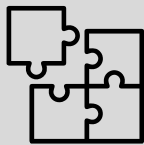
# Disclaimers for Presentations

**⚠ IMPORTANT: ALL DATA ARE PRELIMINARY**

- These presentations describe preliminary data gathered to date as well as preliminary analyses of these data. Data and analyses are subject to change.
- Once all data are finalized and analyzed, they will inform a broader understanding of the likely technical cause or causes of the collapse – and NIST’s findings and recommendations.
- These presentations do not constitute NIST findings or recommendations.
- All survey and interview data collection included a consent process that specifies the allowable uses of data and protections of respondents.
- Copyrighted content (such as photographs) appearing in these presentations is used with permission; reproduction, redistribution or reuse may require copyright holder permission, including for content with anonymous attribution/credit.
- Every reasonable effort has been made to identify copyright holders for content (such as photographs) appearing in these presentations.

# Champlain Towers South Investigation Failure Analysis by the Numbers (investigation to date)

NIST



**300+**

POTENTIAL STRUCTURAL FAILURE POINTS  
BEING ANALYZED FOR 25 FAILURE HYPOTHESES



**58**

INTERVIEWS COMPLETE

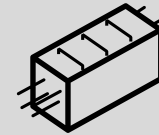
Created by Ifanicon  
from Noun Project

92 MORE INTERVIEWS + 10 FOCUS GROUPS PLANNED



**20,000+**

RECORDS USED  
TO ESTABLISH THE BUILDING'S HISTORY AND PRECOLLAPSE  
CONDITIONS



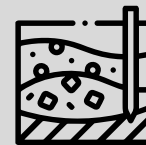
**~1,080**

STRUCTURAL MATERIALS TESTS COMPLETED  
ON CONCRETE AND REINFORCEMENT SAMPLES  
EXTRACTED FROM THE BUILDING



**Tens of 1000's**

OF ADDITIONAL CIVIL LITIGATION RECORDS  
RECEIVED SINCE MARCH 2024



**108**

GEOTECHNICAL MATERIALS TESTS COMPLETED  
OR UNDERWAY  
ON SOIL/ROCK, FOUNDATION, AND GROUNDWATER SAMPLES



**~60**

GIGABYTES OF DATA  
REVIEWED IN ARCHIVAL RESEARCH



**14**

FINITE ELEMENT MODELS  
IN ACTIVE USE FOR STRUCTURAL AND GEOTECHNICAL ANALYSES

Created by symbolic  
from Noun Project

# Champlain Towers South Investigation Schedule Impacts

NIST

1. Programmatic Challenges

2. Technical Challenges

# Champlain Towers South Investigation Schedule Impacts



## 1. Programmatic Challenges

### Structural Laboratory Slab-Column Tests

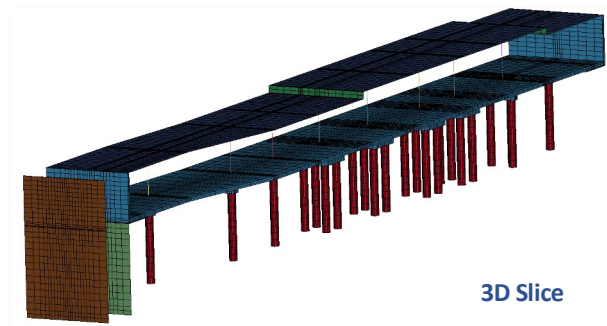
- Time in working through challenges of a complex, large scale test program



Post-test condition of slab-column connection tested, with corroded reinforcement.

### Geotechnical Program

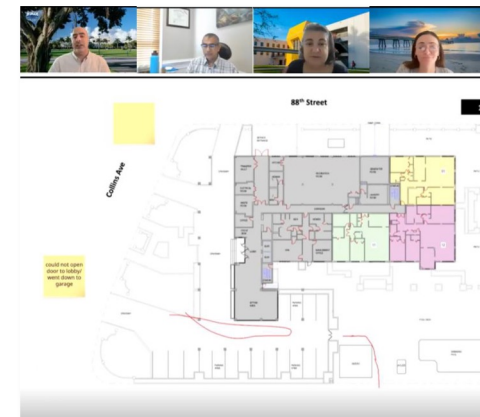
- Loss of NIST key geotechnical staff member



Computational model with substructural parameters (soil, rock, foundation) updated with input and uncertainties from lab tests.

### Social Sciences Program

- Extended time required to customize the interview instruments for each stakeholder and have them approved
- Interviews paused for the six weeks surrounding the collapse anniversary
- Extended time to access local government records for archival research



Interview in progress.



# Champlain Towers South Investigation Schedule Impacts

## 2. Technical Challenges

### Low Strength Test Results



Example foundation pile-shaft core with a low compressive strength test result.

### Uncertainty Quantification



Compression strength tests of concrete cores with variable moisture content.

### Specimen Collection Bias



Sample of concrete reported to be “crumbly” by personnel working at collapse site.

# Champlain Towers South Investigation Schedule

FY 2021				FY 2022				FY 2023				FY 2024				FY 2025				FY 2026																		
J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Q4				Q1				Q2				Q3				Q4				Q1				Q2				Q3				Q4						

March 2024 estimate for release of draft report for public comment

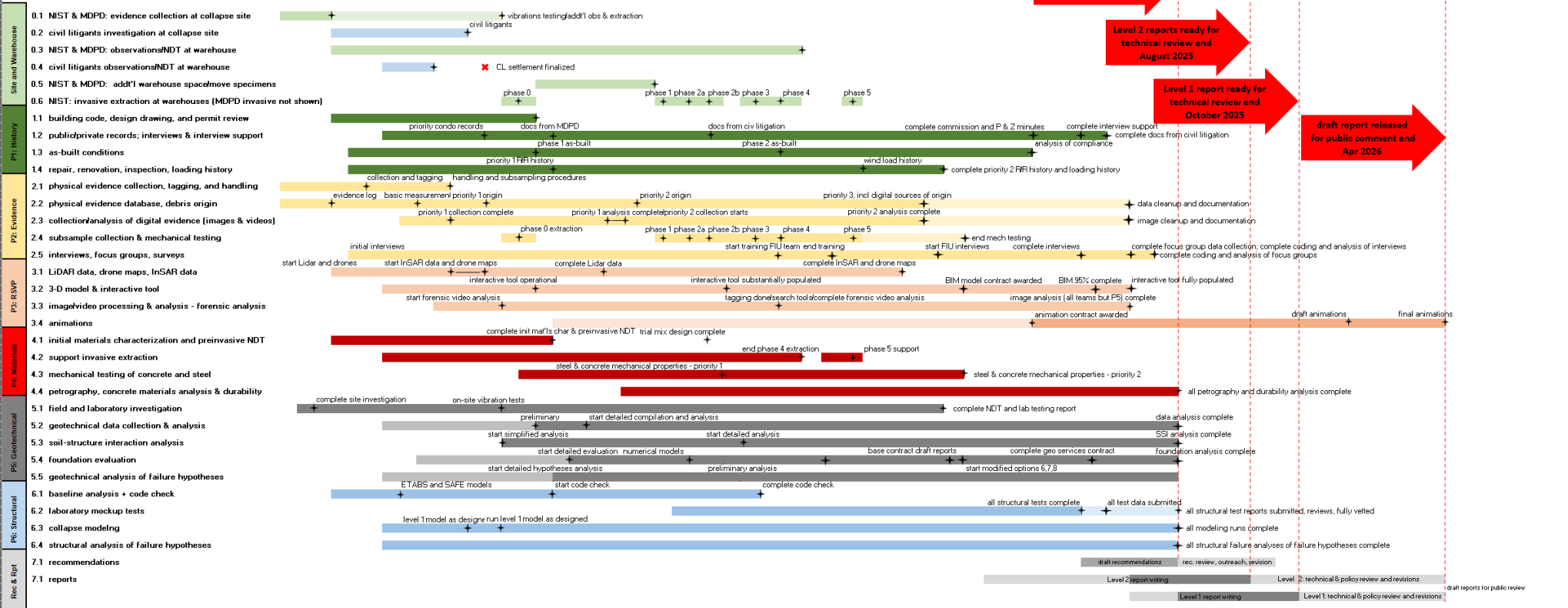
11 month delay in draft report for public comment

complete technical work end May 2025

Level 2 reports ready for technical review end August 2025

Level 1 report ready for technical review end October 2025

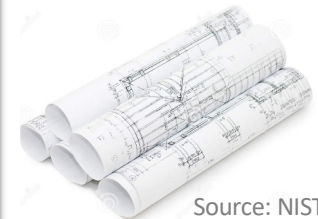
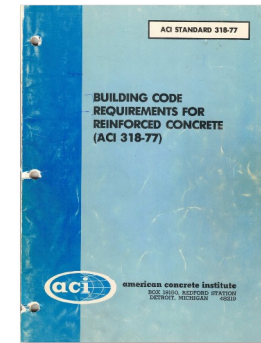
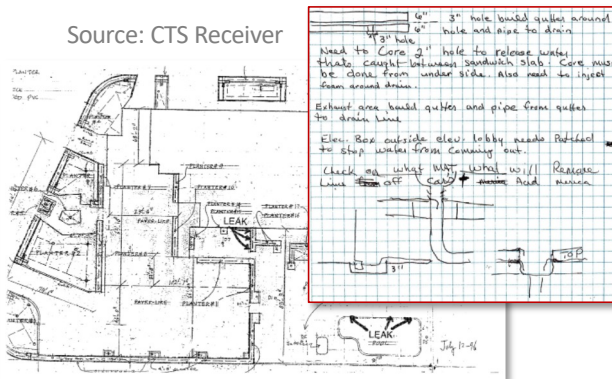
draft report released for public comment end Apr 2026



# Champlain Towers South Investigation



## Building & Code History



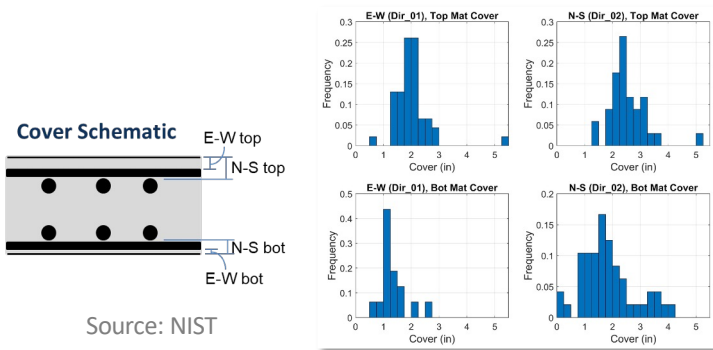
Source: American Concrete Institute

Source: NIST

Tens of thousands of additional civil litigation files transferred to NIST since March 2024.

New digital evidence contributed to mapping of construction joints in pool deck.

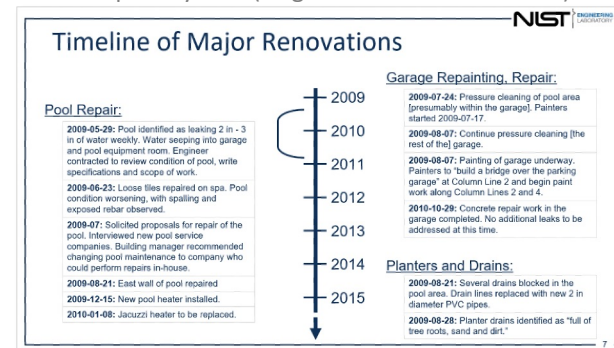
Technical inquiries and archival research shed light on 1980s design/construction practice in South Florida.



Detailed measurements used to analyze compliance.

Preliminary Analysis Results

Adapted by NIST (Original Source: CTS Receiver)



Records used to populate timeline of pool deck renovations.

# Champlain Towers South Investigation

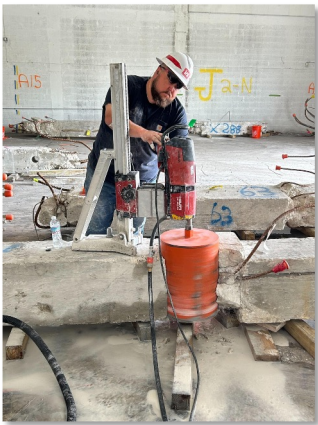


## Evidence Collection & Preservation

NIST

### Phase 5 Extraction

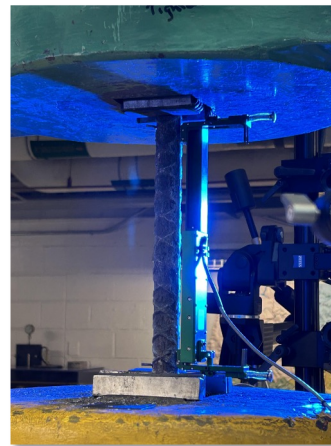
187 cores extracted since March 2024 resulting in 235 testable samples.



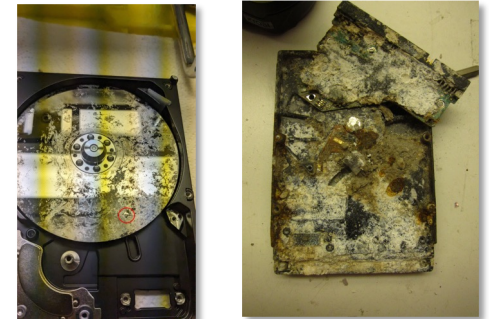
### 593 Tests Completed for Mechanical Properties of Concrete



### 183 Tests Completed for Mechanical Properties of Reinforcing Steel



### Completed Forensic Analysis of Hard Drives



### Identified Additional Security Cameras in Proximity of CTS



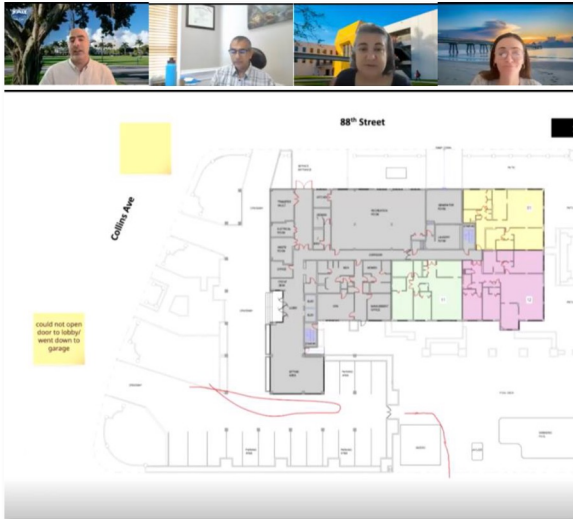
# Champlain Towers South Investigation



## Evidence Collection & Preservation

NIST

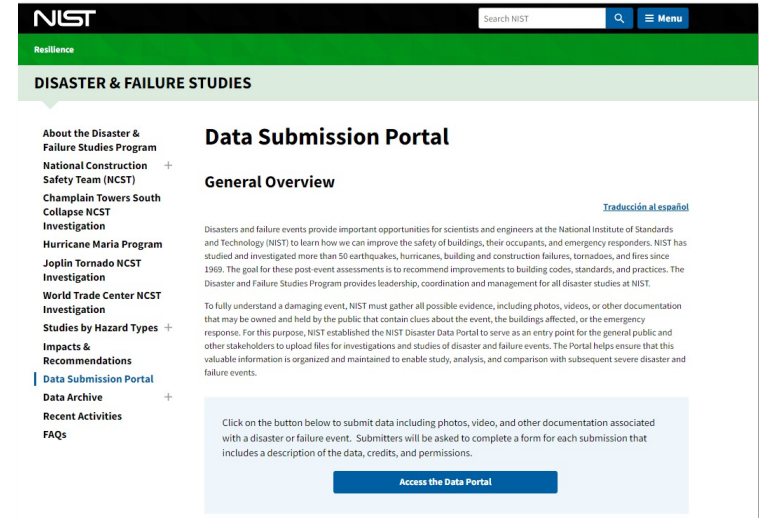
### Interviews Resumed by FIU Social Science Team



### Archival Research



### Recent Uptick in Submissions to NIST's DFS Data Submission Portal



Source all images: NIST

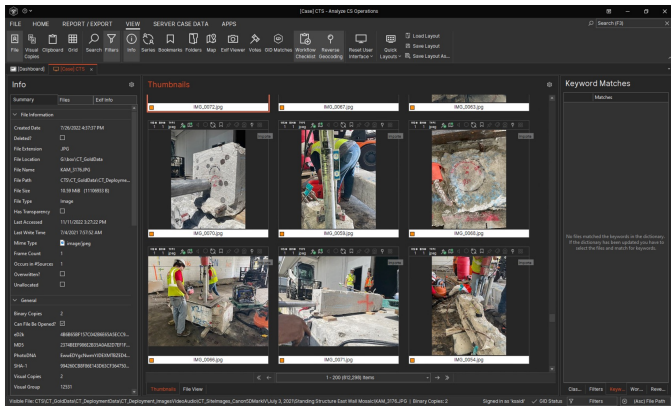
# Champlain Towers South Investigation



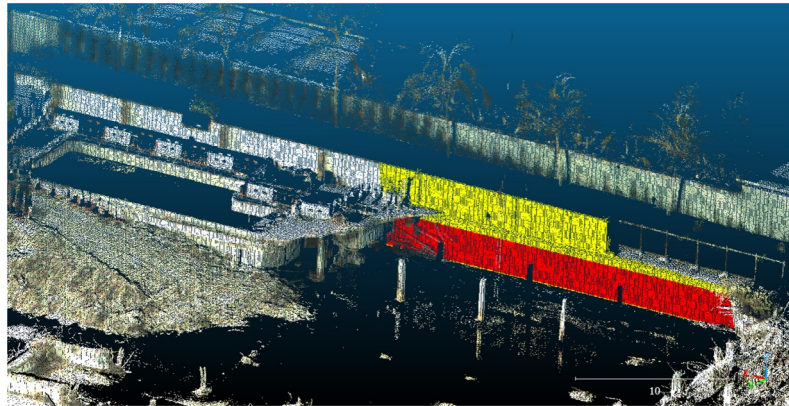
## Remote Sensing & Data Visualization

NIST

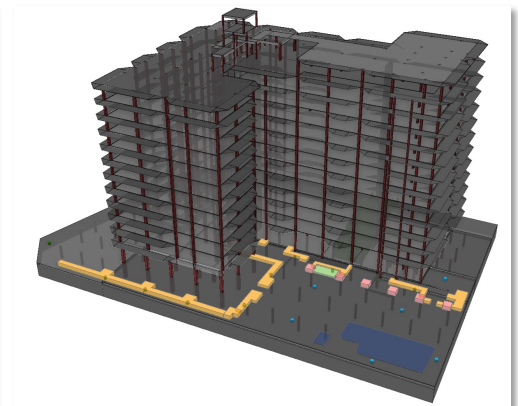
15,035 Images & Videos Tagged  
in Griffeye Database



LiDAR Scan of South Basement Wall



Continued Population of Data  
Visualization Tool



Source all images: NIST

# Champlain Towers South Investigation



Materials  
Science

NIST

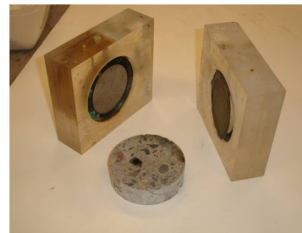
## Phase 5 Extraction

187 cores extracted since March 2024 resulting in 235 testable samples.

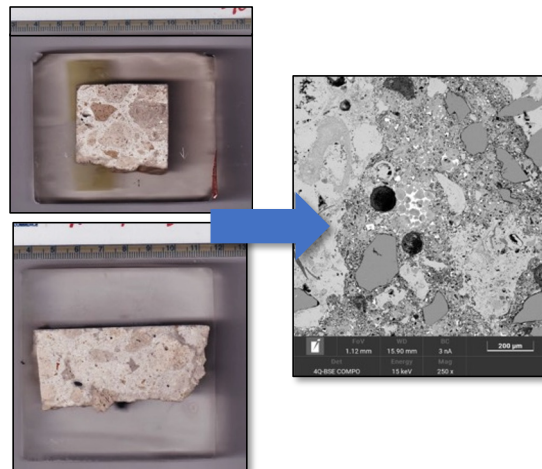


Core check-in and NDT.

## Approx. 300 Petrographic, Chemical, and Durability Related Property Tests of Structural Concrete

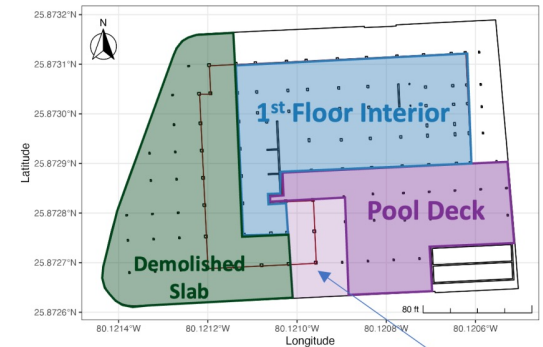


Test for resistance to chloride ion penetration.



Concrete petrography.

## Geospatial Mapping of Concrete Properties



Portion of slab that collapsed under building. Treated as **Pool Deck**

Concrete mapping zones.

Source all images: NIST

# Champlain Towers South Investigation



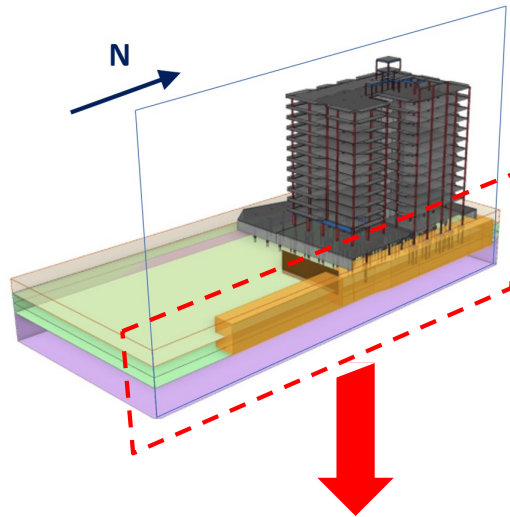
## Geotechnical Engineering



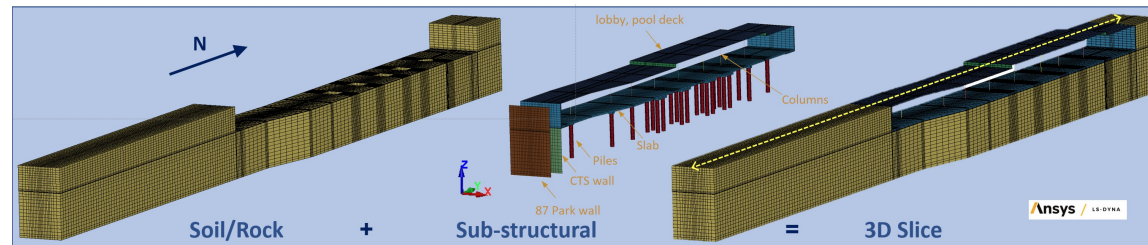
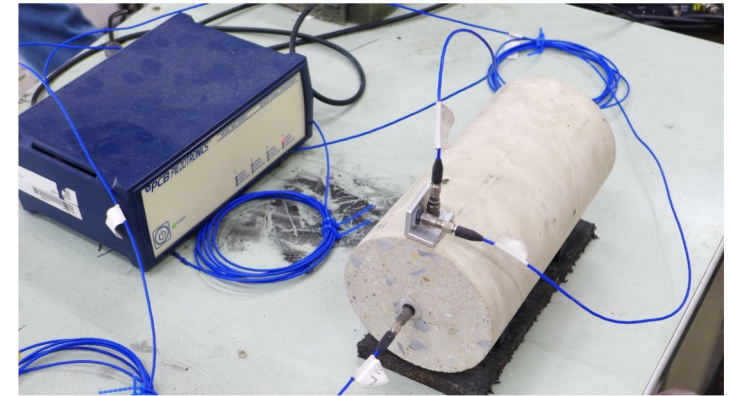
### Pile Core Strength



### Soil-Structure Computer Simulation



### Pile Core Elastic Parameters



Source all images: NIST



# Champlain Towers South Investigation



## Structural Engineering



### Structural Laboratory Tests



Laboratory slab-beam-column tests.  
(1 of 2 tests in progress)

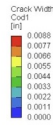


Laboratory column tests,  
(3 of 3 complete)

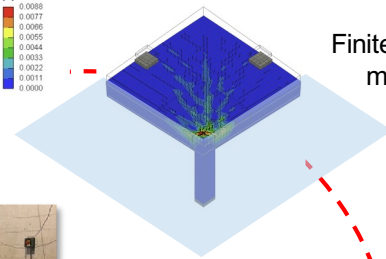


Laboratory slab-column  
connection test.  
(3 of 8 complete)

larger  
**Crack width**  
smaller

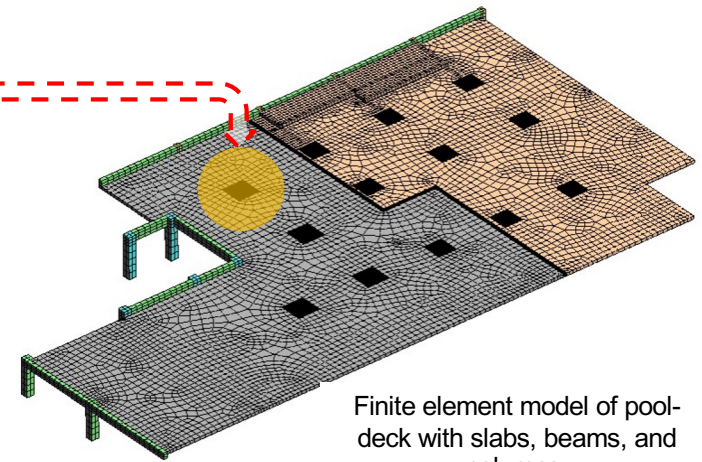


### Modeling Slab-Column Connection Failures in the Pool Deck



Finite element  
models.

**Critical Shear  
Crack Theory**



Finite element model of pool-  
deck with slabs, beams, and  
columns.

Source all images: NIST

# Champlain Towers South Investigation Next Six Months



## CTS NCST Investigation

- Advance analysis of failure hypotheses: Initiation & progression of partial collapse
- Start drafting recommendations



## Building & Code History

- Complete review of local gov't docs
- Complete review of civil litigation docs
- Finalize analysis of compliance



## Materials Science

- Assess geospatial distribution of material properties, including UQ
- Analyze concrete durability and aging
- Analyze reinforcement corrosion



## Evidence Collection & Preservation

- Finalize data processing for report
- Finalize image processing for report
- Complete interviews / start focus groups



## Geotechnical Engineering

- Complete Geotechnical Interpretative Report
- SSI analysis with Structural Engineering
- Analyze potential geotechnical contributors to failure hypotheses



## Remote Sensing & Data Visualization

- Significantly complete BIM model
- Analyze images for failure hypotheses
- Continued population of data visualization model



## Structural Engineering

- Complete structural laboratory tests
- Incorporate as-built and pre-collapse data into models
- Use collapse models to analyze failure hypotheses

# NCST Investigation of the Champlain Towers South Collapse

## Investigation Overview & Update



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Submit relevant information to NIST:  
disaster@nist.gov  
<https://www.nist.gov/disaster-failure-studies/data-submission-portal>