NCST Investigation of the Champlain Towers South Collapse

Investigation Overview and Update

Judith Mitrani-Reiser
Lead Investigator

Glenn R. Bell
Associate Lead Investigator

NIST NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Champlain Towers South Investigation (CTS): Recent Activities

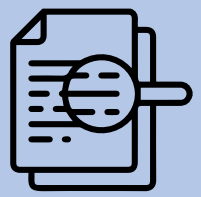
2023	JUNE	JULY	AUGUST	SEPTEMBER	2023

Champlain Towers South Investigation (CTS): June Activities

NCST Public Meeting
Invasive Testing Program
Collapse Anniversary

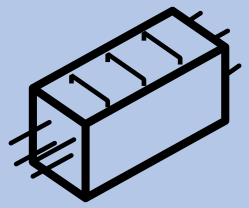
CTS Investigation: June 2023 Advisory Committee Meeting

Theme 1:
Evidence Collection, Measurements, and Visualization



Sissy Nikolaou, Christopher Segura, Jonathan Weigand, Emel Ganapati, Georgette Hlepas

Theme 2:
Materials, Geotechnical, and Structural Analysis and Testing



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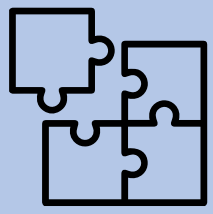
Theme 3:
Failure Hypotheses Development and Evaluation



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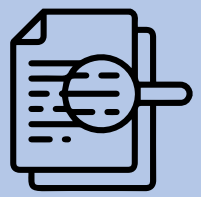

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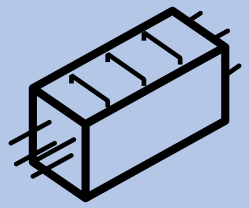

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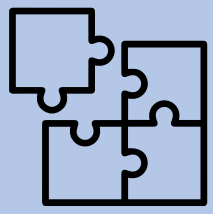

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CTS Investigation: June 2023 Advisory Committee Meeting

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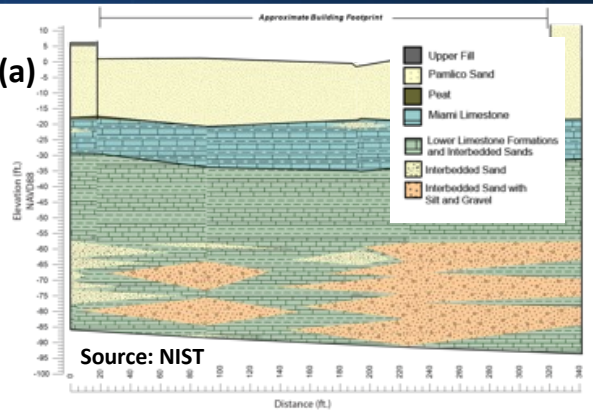

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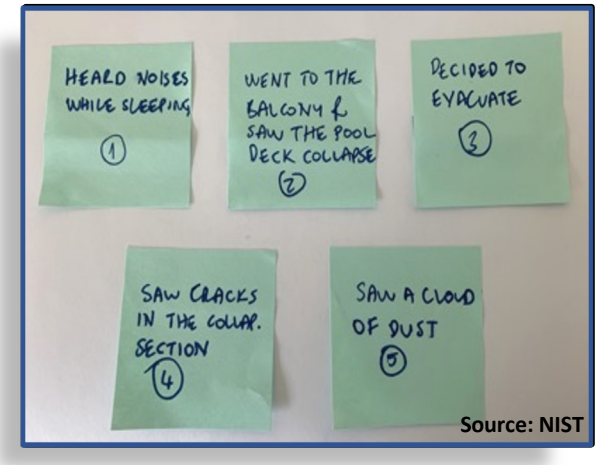

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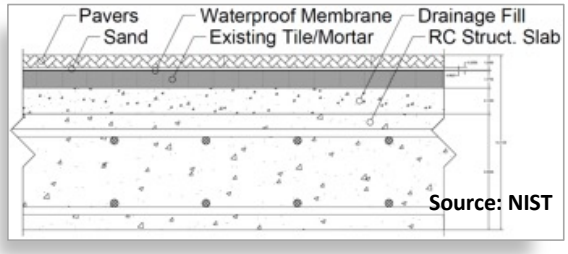

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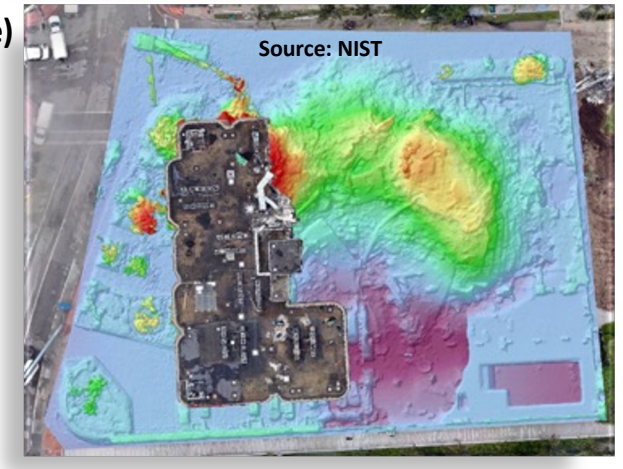

CTS Investigation: June 2023 Advisory Committee Meeting

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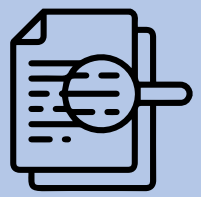

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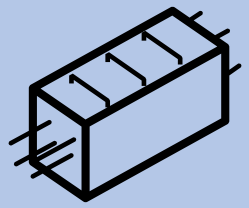

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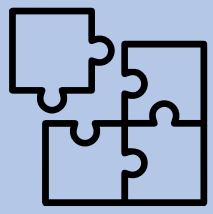

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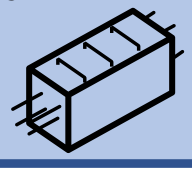

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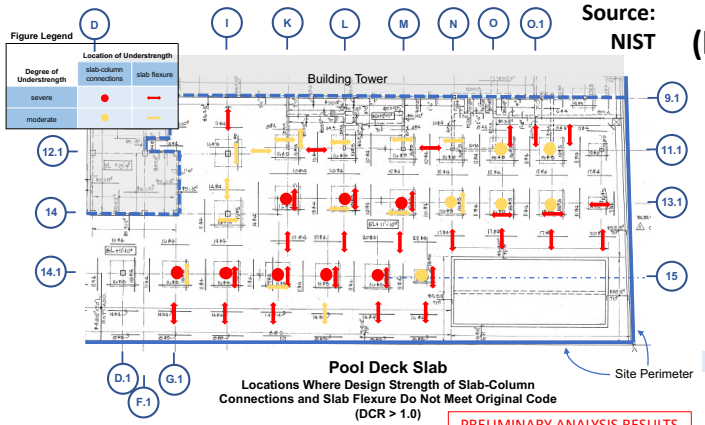
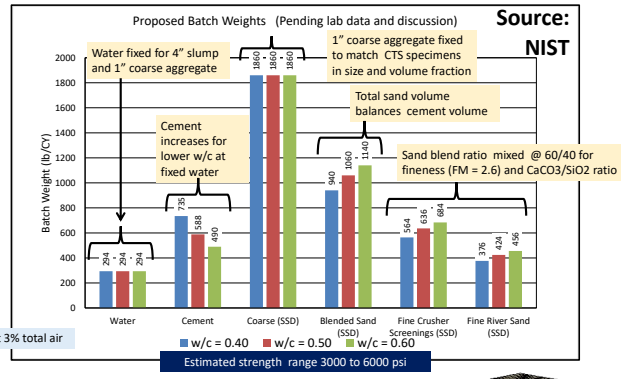
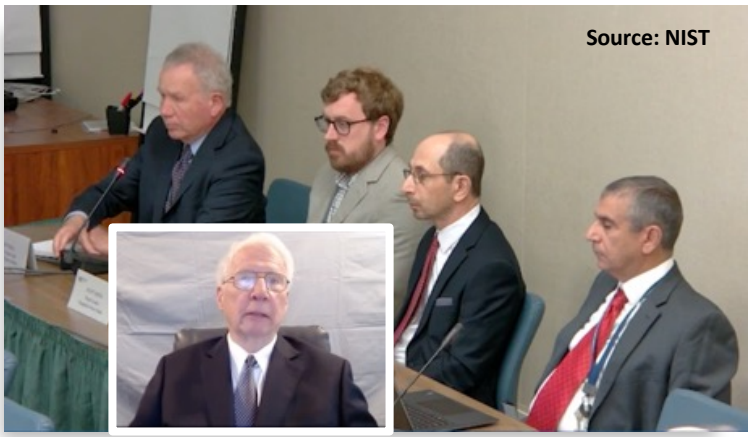


PRELIMINARY ANALYSIS RESULTS

(b)





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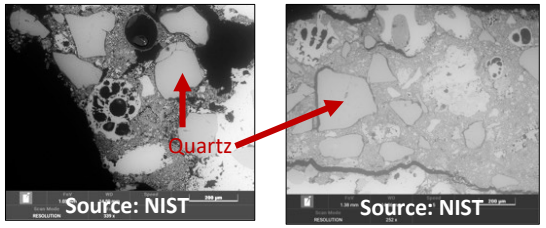

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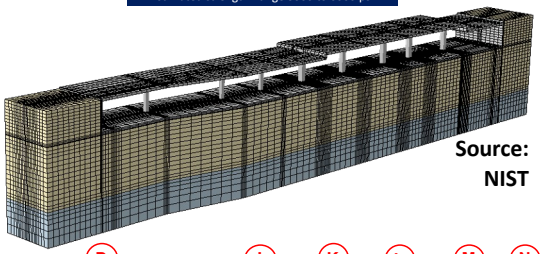

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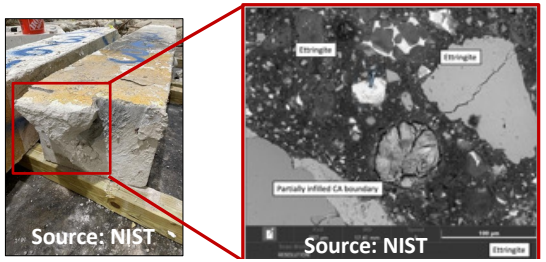

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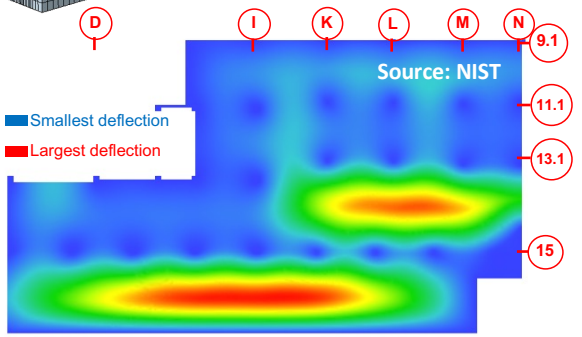

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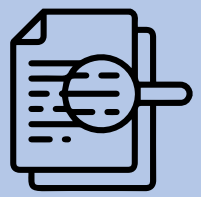

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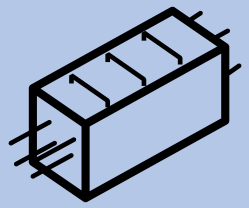

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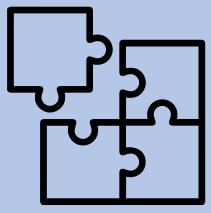

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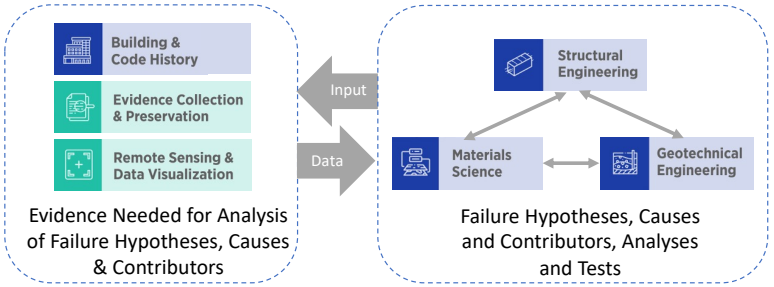

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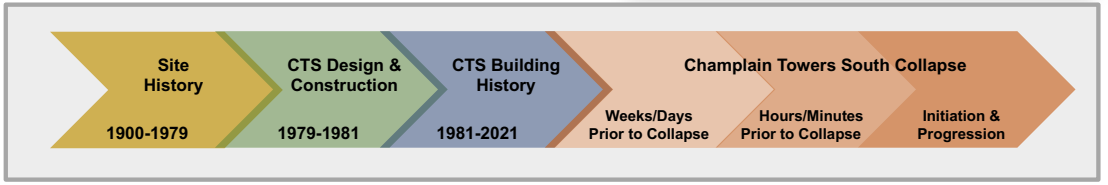

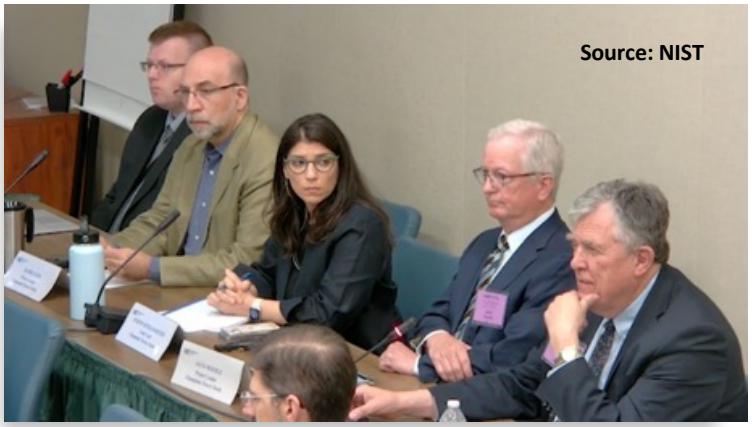

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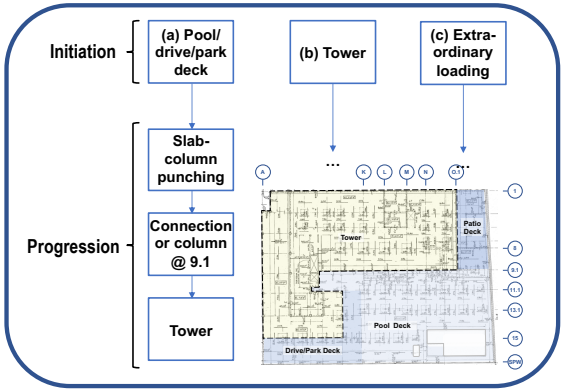

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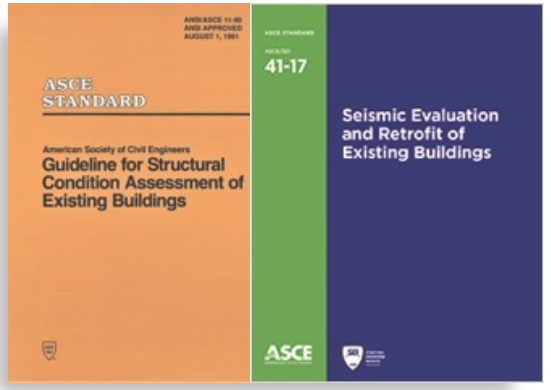


CTS Investigation: Invasive Extraction and Testing

Two Year Anniversary of CTS Collapse: June 24, 2023

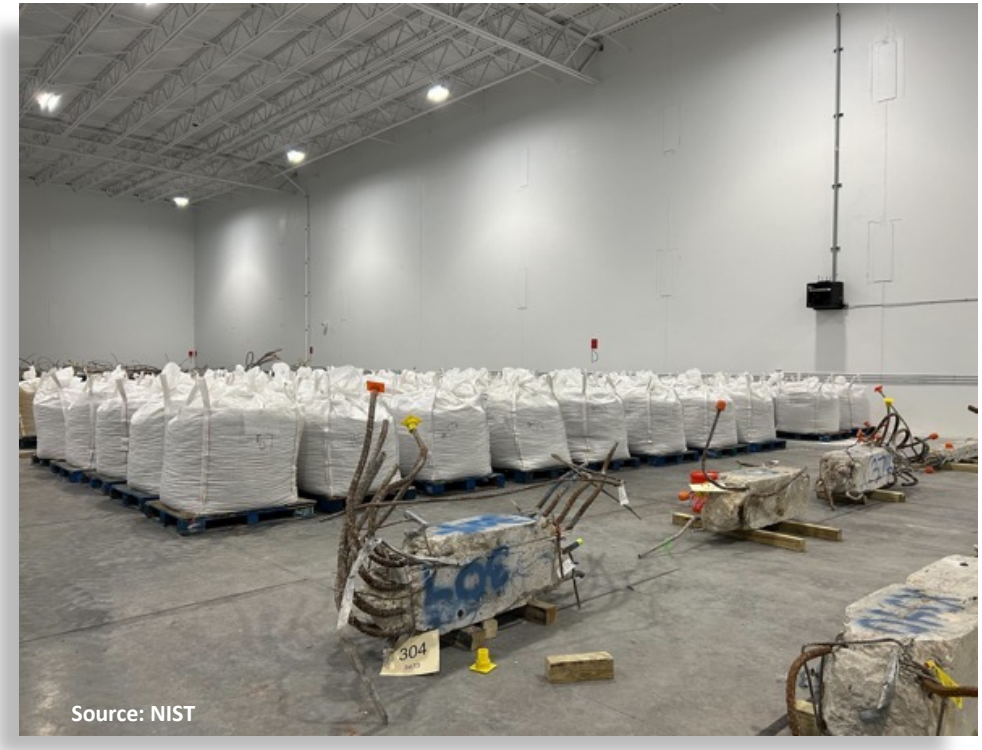
Source: NIST

Champlain Towers South Investigation: July Activities

NCST Public Meeting
Invasive Testing Program
Collapse Anniversary

Transport Structural Test Materials
Procurement & Contracts
Invasive Testing Program Support

CTS Investigation: Structural Test Materials



Source: NIST

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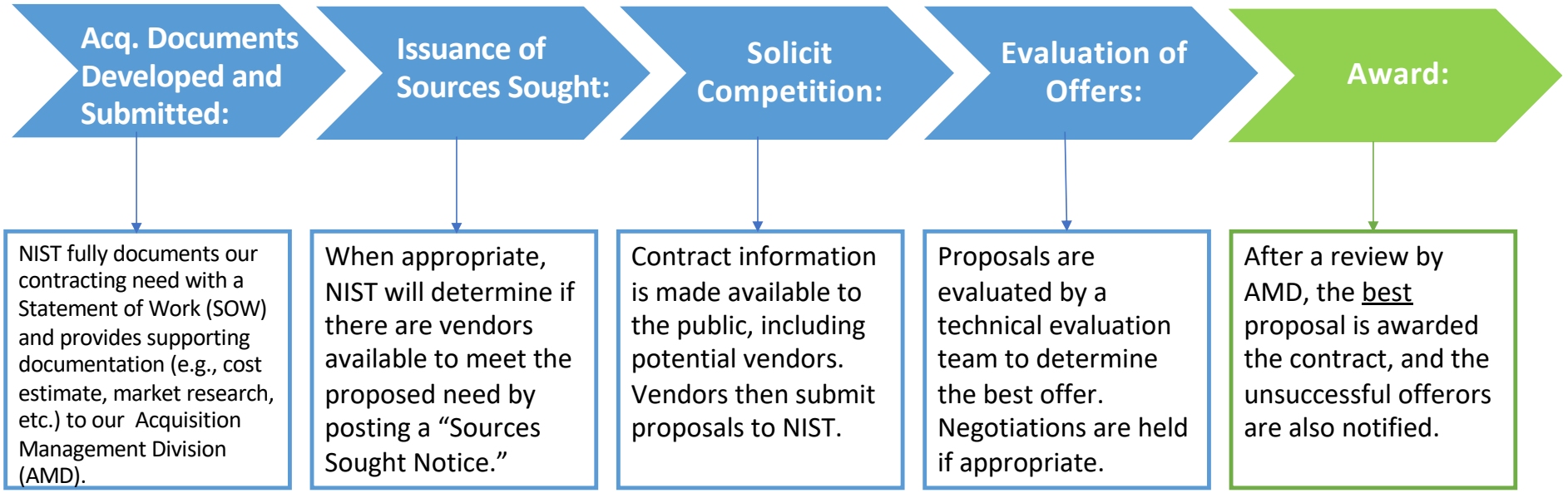
Champlain Towers South Investigation: Contracting

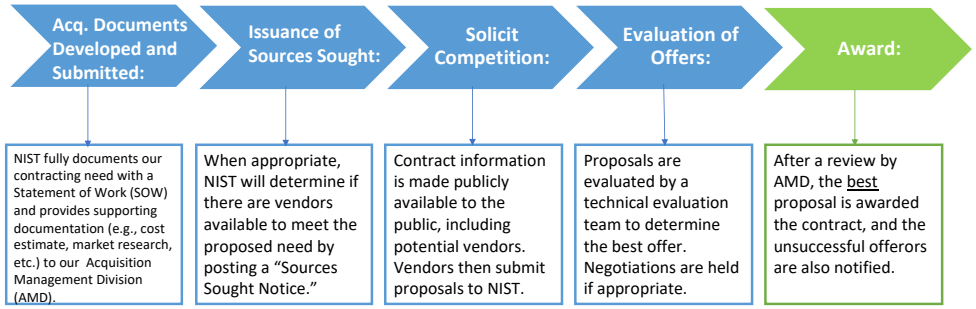
Contract Award Process Flow*



**Depending upon the type of acquisition (task order under an IDIQ or a new contract) and approach, some steps may vary. This is a high-level overview of the acquisition process followed by the CTS Investigation.*

Champlain Towers South Investigation: Contracting

Contract Award Process Flow*



To Ensure Efficiency in the Contract Process Flow:

- Tracking of contract status in spreadsheet shared across the Team, Divisions and Laboratory.
- Weekly meetings between the Division leadership, Lab contract specialists, and NIST's Acquisition Management Division.

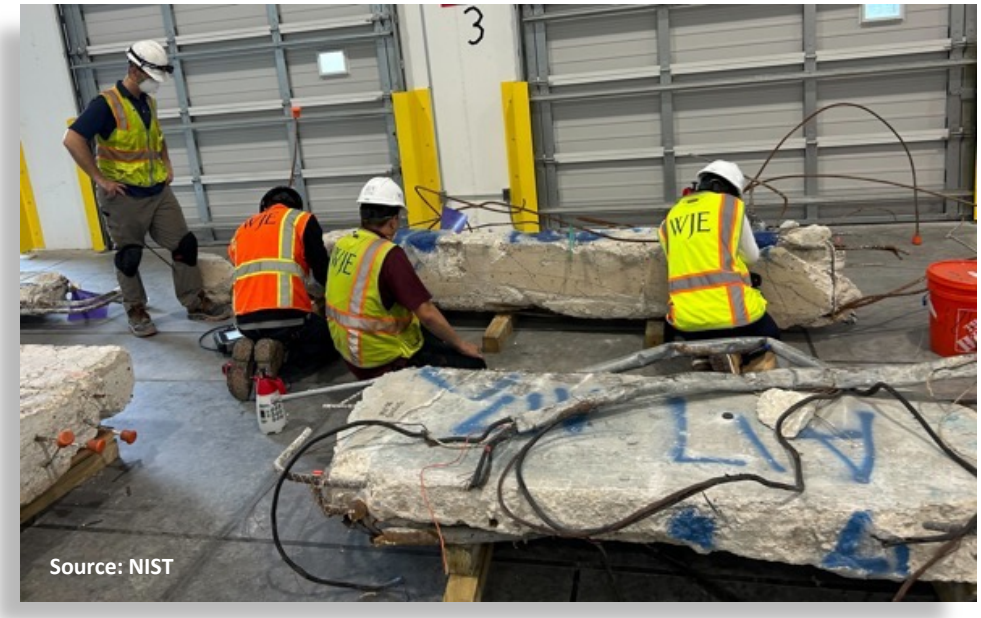
In the past three months, NIST has awarded:

- Three new work orders, under an existing interagency agreement, to support the invasive testing program and ongoing remote sensing and visualization leadership and support.
- One new contract to support the invasive testing program in Miami, FL.
- One new contract to investigate mechanisms of steel corrosion, test transport properties of concrete, and conduct service-life predictions.
- One new contract to provide leadership and technical expertise to the Building & Code History and Structural Engineering projects.
- Exercised contract options, and executed micro-purchases to generally support the investigation.

**Depending upon the type of acquisition (task order under an IDIQ or a new contract) and approach, some steps may vary. This is a high-level overview of the acquisition process followed by the CTS Investigation.*

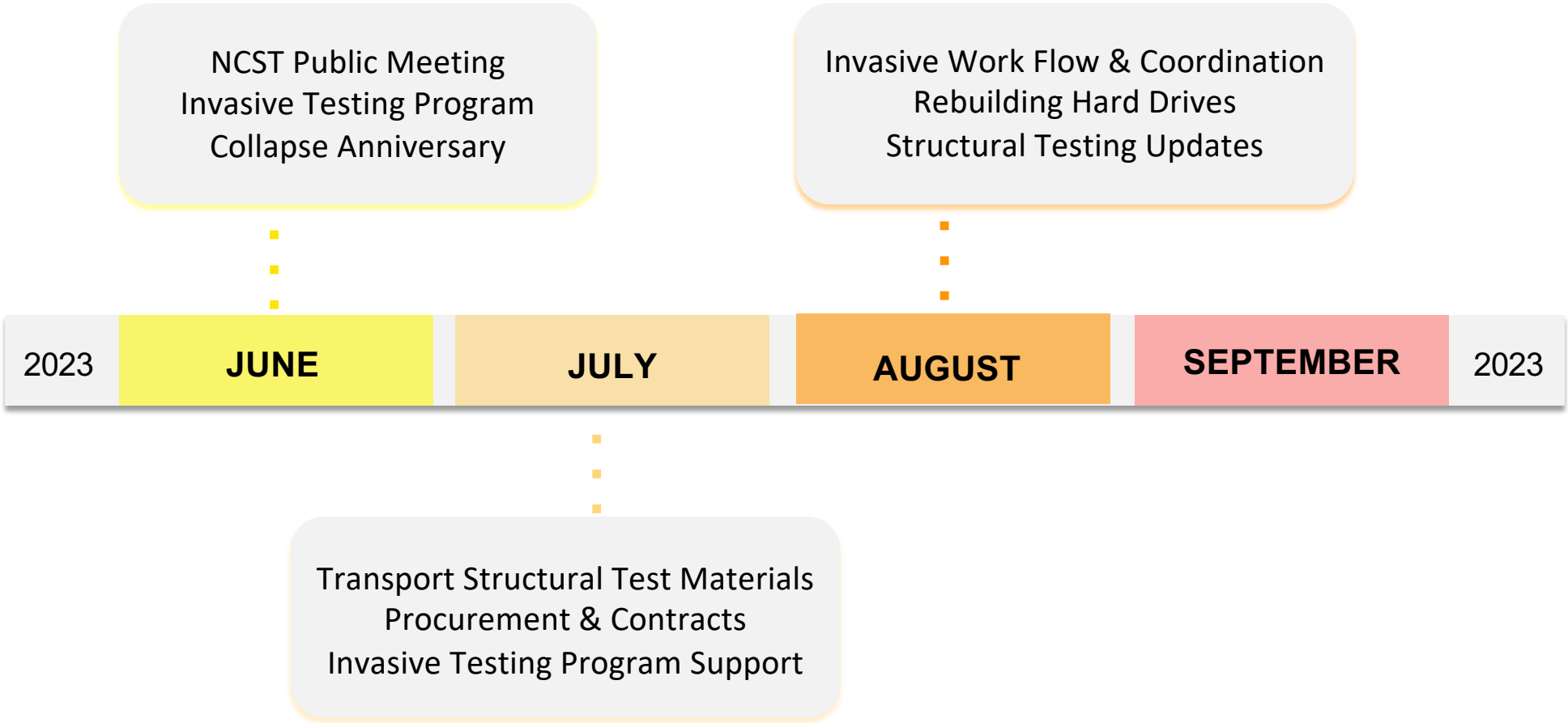
CTS Investigation: Invasive Testing Program Support

Source: NIST



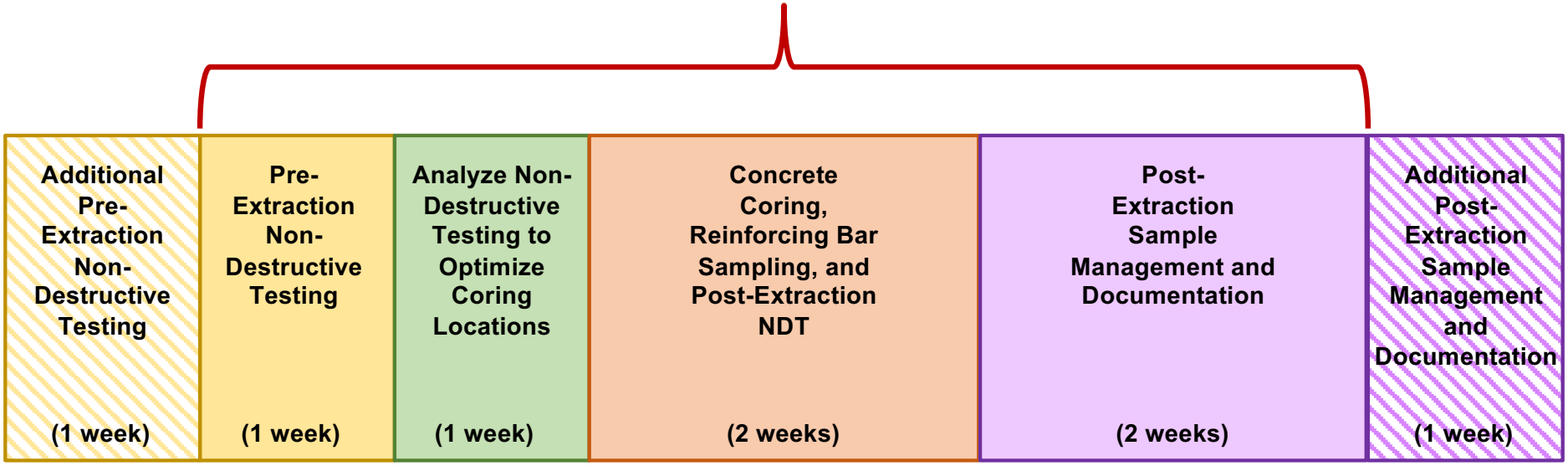
Source: NIST

Champlain Towers South Investigation: August Activities



CTS Investigation: Invasive Work Flow & Coordination

Typical Invasive Deployment Cycle (6 weeks)



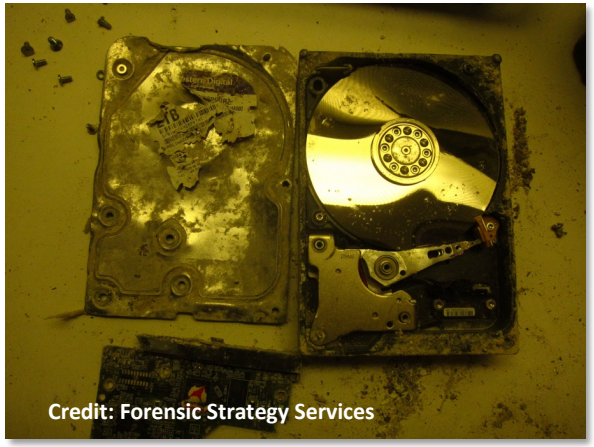
NIST's Coordination with Local Authorities:

- Weekly Meetings (45 min. in length)
- Weekly agendas, with priorities highlighted
- 50+ meetings to date in FY23
- Detailed plans for coring/testing shared
- Staggered deployments to increase efficiency
- Coordination on specimens with limited material

CTS Investigation: Search for Additional Footage


Source: NIST


Source: NIST


Credit: Forensic Strategy Services


Source: NIST

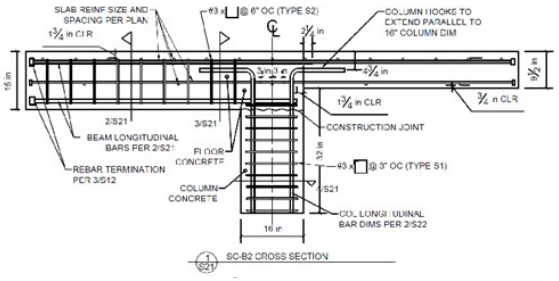

Source: NIST

- Conducted over 100 hours of searching
- Identified a total of 25 hard disk drives
- 14 drives identified as possibly from a DVR
- Forensic contractor may be able to recover 7 drives

CTS Investigation: Structural Testing Updates

Test Specimen Details

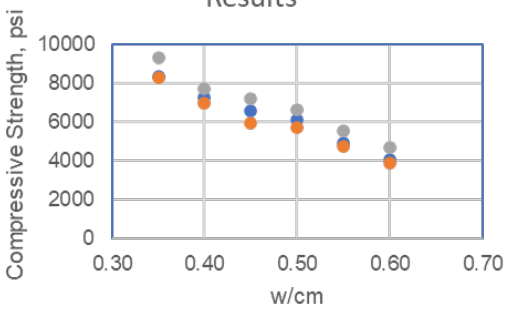
Details at slab w/ Beam A



- Detailed measurements from warehouse specimens
- NIST/Contractor agreement on details
- Reinforcement orders in progress

Material Properties

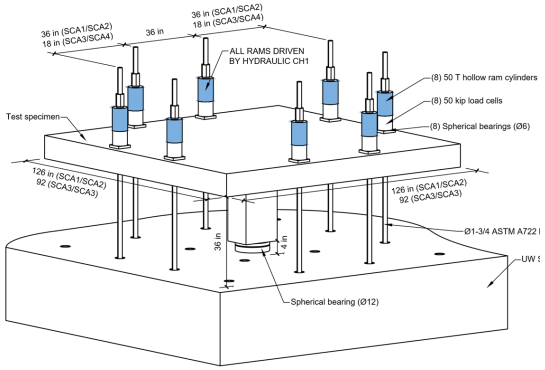
U. Florida 28-Day Trial Mix Results



- Core data used to establish target concrete strengths
- U. Florida concrete batching
- Materials and procedures transferred to contractors
- Contractor test batching in progress

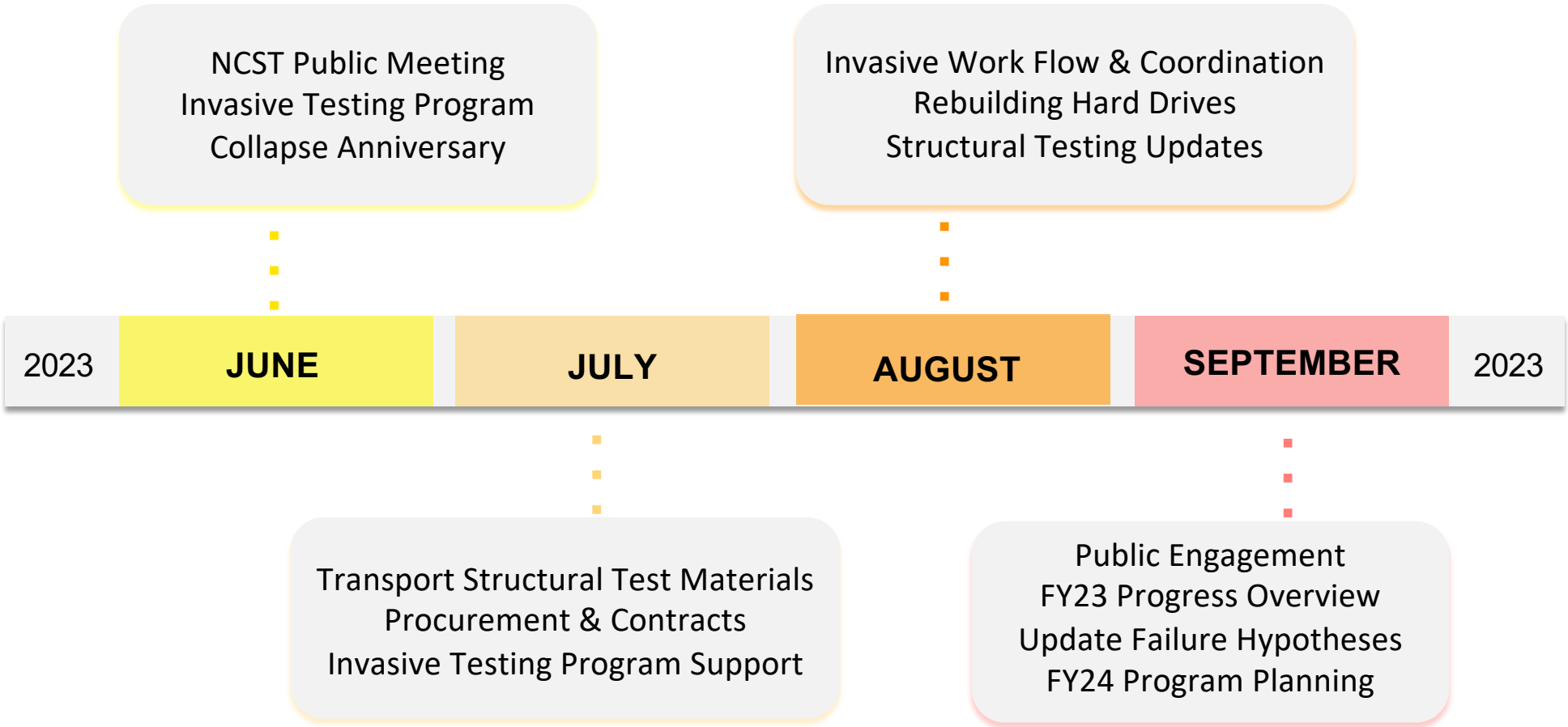
Testing Details

Slab-column test apparatus



- Detailed discussions about boundary conditions and instrumentation
- Test apparatus and instrumentation plans complete for slab-column testing.
- Discussions ongoing for slab-beam-column connection at L9.1

Champlain Towers South Investigation: September Activities

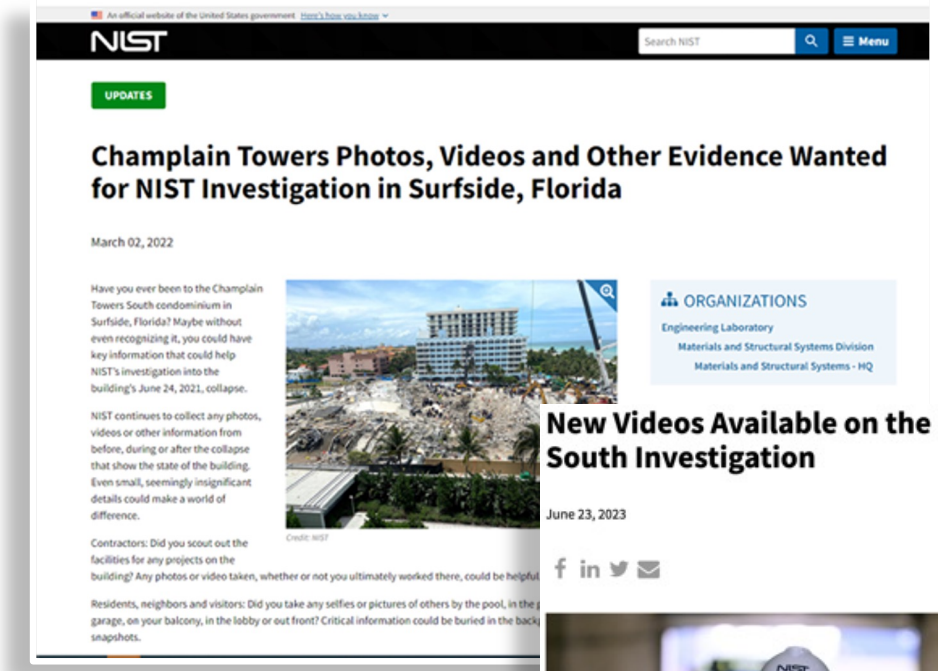


Champlain Towers South Investigation: Public Engagement

- Working with local partner to meet with families regularly
- Issued one news update since last meeting
- Released additional NCST videos, and recordings of the June committee meeting
- Review entries to the DFS portal
- Use multiple methods to communicate:

Video News releases

Blog Social media



NIST

UPDATES

Champlain Towers Photos, Videos and Other Evidence Wanted for NIST Investigation in Surfside, Florida

March 02, 2022

Have you ever been to the Champlain Towers South condominium in Surfside, Florida? Maybe without even recognizing it, you could have key information that could help NIST's investigation into the building's June 24, 2021, collapse.

NIST continues to collect any photos, videos or other information from before, during or after the collapse that show the state of the building. Even small, seemingly insignificant details could make a world of difference.

Contractors: Did you scout out the facilities for any projects on the building? Any photos or video taken, whether or not you ultimately worked there, could be helpful

Residents, neighbors and visitors: Did you take any selfies or pictures of others by the pool, in the garage, on your balcony, in the lobby or out front? Critical information could be buried in the back snapshots.

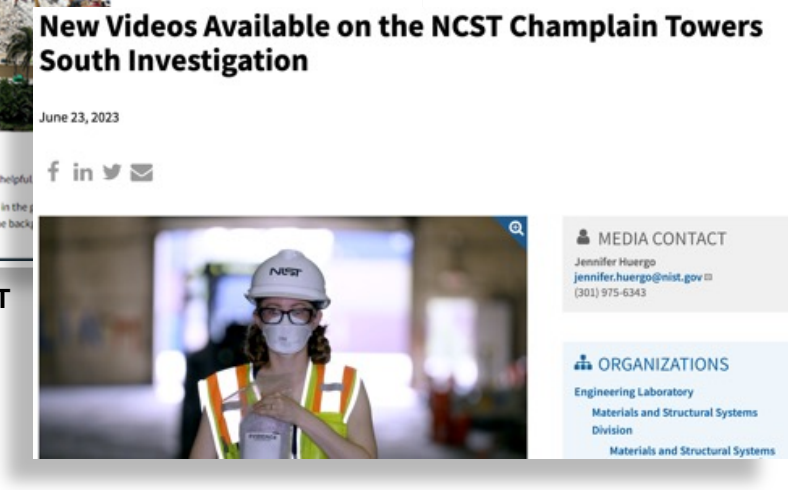
ORGANIZATIONS

Engineering Laboratory

Materials and Structural Systems Division

Materials and Structural Systems - HQ

Source: NIST



New Videos Available on the NCST Champlain Towers South Investigation

June 23, 2023

MEDIA CONTACT

Jennifer Huergo

jennifer.huergo@nist.gov

(301) 975-6343

ORGANIZATIONS

Engineering Laboratory

Materials and Structural Systems Division

Materials and Structural Systems

Source: NIST

Champlain Towers South Investigation: FY23 Progress Overview (by the numbers)

40+
NIST EMPLOYEES

600+
EVIDENCE SPECIMENS

15+
LOCAL AND FEDERAL AGENCIES

24+
FAILURE HYPOTHESES

25+
WORK ORDERS AND CONTRACTS AWARDED

3+ TB
PHOTOS AND VIDEOS

NCST Appropriated Funds:

49% Spent in FY22
Labor: $ 3.9M (37%)
Other Objects*: $ 6.8M (63%)

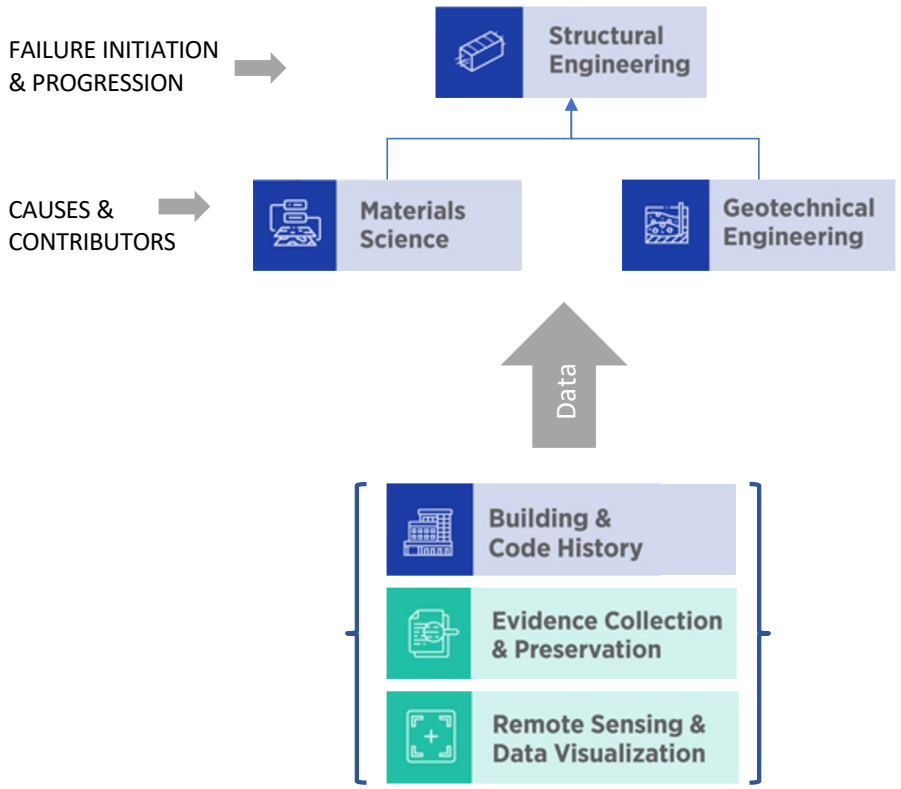
51% Spent/Planned in FY23
Labor: $ 3.2M (28%)
Other Objects*: $ 8.1M (72%)

NIST Disaster Supplemental:

~$ 1.0 M Spent in FY23
Labor: $ 30k (3%)
Other Objects*: $ 981k (97%)

**contracts, equipment, travel, misc.*

Champlain Towers South Investigation: Update Failure Hypotheses & FY24 Program Planning



1. Develop Project Objectives
2. Develop FY24 Milestones & Interdependencies
3. Develop Outyear Milestones
4. Identify Staffing and Equipment Needs
5. Identify Contract, Equipment, & Travel Needs
6. Implement FY24 Plans
7. Assess at Midyear & Update FY24 Plans
8. Develop FY25 Plans
9. Assess FY24 Accomplishments & Update FY25 Plans

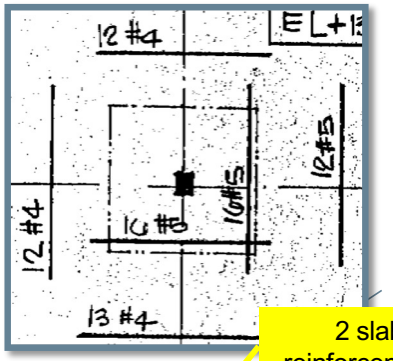
Presentation of Preliminary Data & Analysis

⚠ IMPORTANT: ALL DATA ARE PRELIMINARY

- This presentation describes 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 cause of the collapse – and NIST's findings and recommendations.
- Preliminary data and analyses in these presentations are not to be used to form recommendations at this time.

CTS As-Built Conditions

Typically fewer than the specified number of column strip top reinforcing bars are centered over the column in the pool deck slab.



Slab Top Reinforcement at Example Column Location

Example Column Specimen

At this location, only 2 rather than 4 top bars were centered over the column in each direction.

The measured spacing of the top reinforcing bars in the column strips of the pool deck slab specimens commonly ranges from about 20 % to 40 % wider than required by the structural design drawings, resulting in less reinforcing in the column strips than required by the design.

Sources: Photographs – NIST; Drawing Excerpts from Original Structural Design Drawings

Building & Code History

Records Located to Date

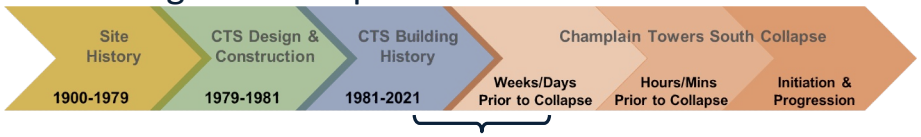
Champlain Towers South:

- Resident complaints of pool deck slab's condition causing potential falling hazards, damage to vehicles
- Construction of the beach access and related condition of the south perimeter wall
- Condition assessments done in preparation for building's 40-year recertification
- Photos of the underside of the pool deck slab, garage columns, and pool foundation

87 Park:

- Measurements of vibration and noise monitoring
- Communications, daily site reports, logs of work done, photos, sheeting plans showing temporary and permanent installations, proposals and contracts
- Records related to beach access walk construction
- Information on dewatering and site drainage

CTS Investigation Collapse Timeline



Source: NIST

Evidence Collection & Preservation + Materials Science

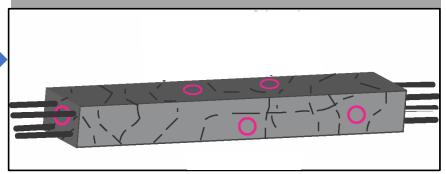
NIST

Source for All Images: NIST

1. Identify Specimens for Subsampling

		Compressive ASTM C39/42	MOE ASTM C469	Tensile Strength ASTM C39/42
Columns		Qty. Planned	Qty. Planned	Qty. Planned
C01	Collapsed - Patio/Parking, Basement	15	5	7
C02	Collapsed - Tower, Basement	15	5	7
C03	Collapsed - Tower, Level 1-3	15	5	7
C04	Collapsed - Tower, Level 4-7	7	0	0
C05	Collapsed - Tower, Level 8+	7	0	0
Slabs				
S01	Collapsed - Patio/Parking Deck, Level 1	25	6	8
S02	Collapsed - Interior, Level 1	20	5	7
S03-A	Collapsed - Interior, Level 2+	20	0	7
S03-B	Collapsed - Exterior, Level 2+	15	0	5
Beams				
B01	Patio/Parking Deck, Level 1	6	0	2
Walls				
SW01	East or West Shear Wall	6	0	0

2. Crack Mapping & NDT

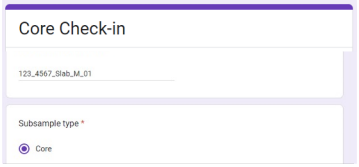


3. Mark Planned Core Locations

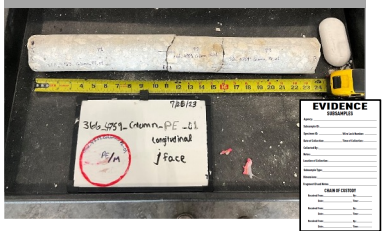
4. Specimen Preparation

5. Coring

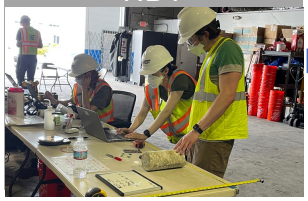
6. Subsample Check-In



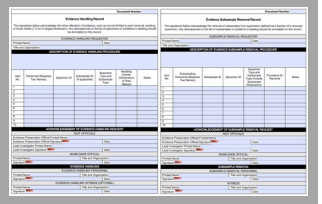
7. Core Documentation



8. Post-Extraction NDT

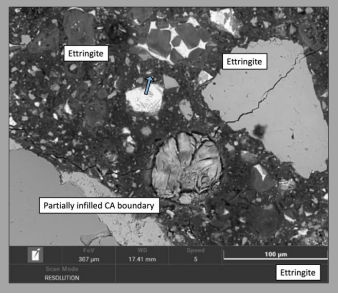


9. Prepare for Testing



Evidence Forms

10a. Materials and Petrographic Laboratory Examination and Testing

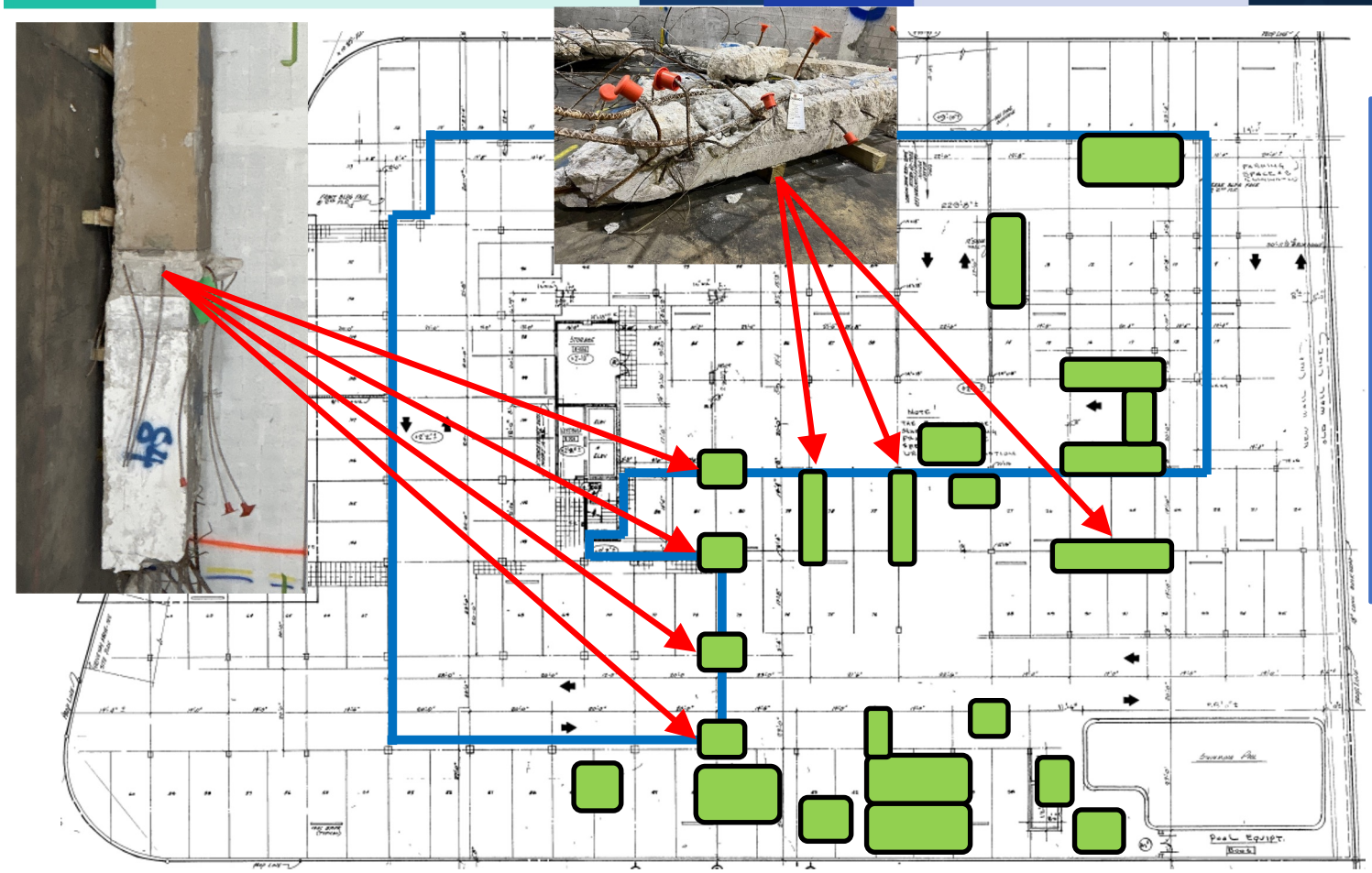


10.b Mechanical Testing

Evidence Collection & Preservation

Materials Science

NIST's invasive extraction program is being conducted in coordination with investigations by local authorities.



Source of Photographs and Annotations to Original Architectural Design Drawings: NIST

Phases 1 & 2A

Focus on pool deck slab & tower column concrete for structural modeling and the structural test program concrete mix design

Extraction

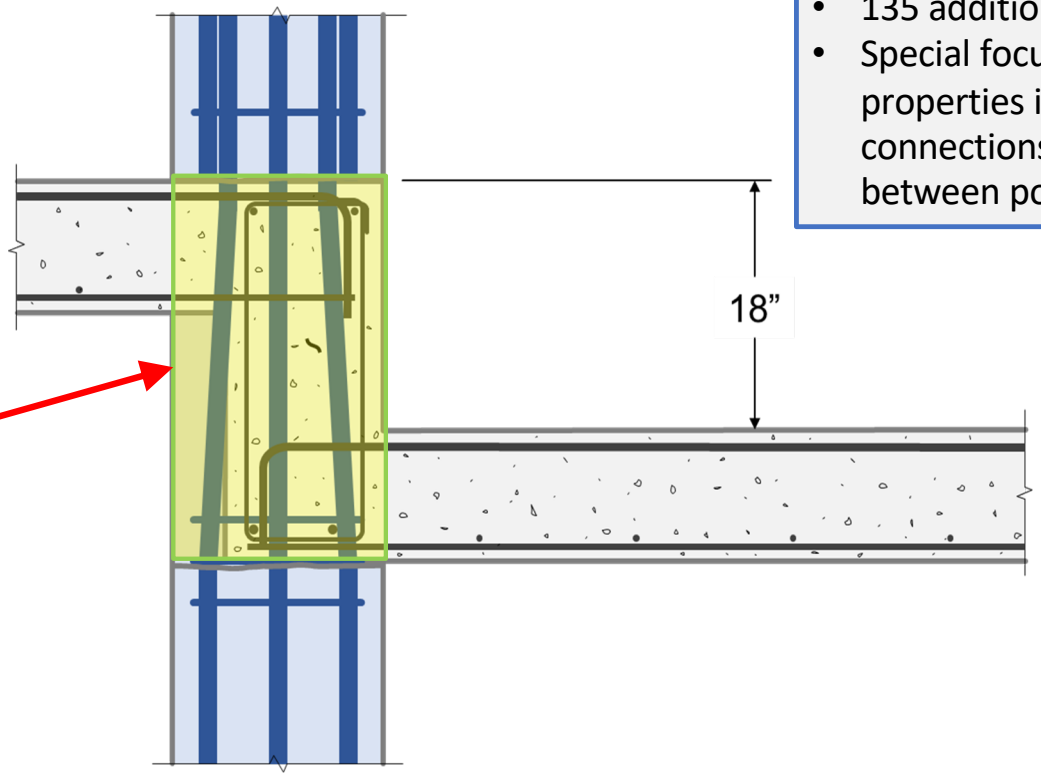
- 127 concrete cores and similar subsamples
- 10 reinforcing bar subsamples

Evidence Collection & Preservation

Materials Science

NIST's invasive extraction program is being conducted in coordination with investigations by local authorities.

NIST



Phase 2B

- 135 additional cores
- Special focus on concrete properties in slab-column connections at interface between pool deck & tower

Source for All Images: NIST

Evidence Collection & Preservation

Materials Science

NIST's invasive extraction program is being conducted in coordination with investigations by local authorities.

NIST

Summary of Invasive Extraction and Testing to Date

- 301 cores and other concrete subsamples extracted
- 77 cores tested for compressive strength

  Average strengths for structural element type populations exceed specified design strength*
- 8 cores tested for modulus of elasticity**
- 16 cores currently being subjected to materials-related tests**
- 10 reinforcing bar subsamples extracted and tested for tensile properties**

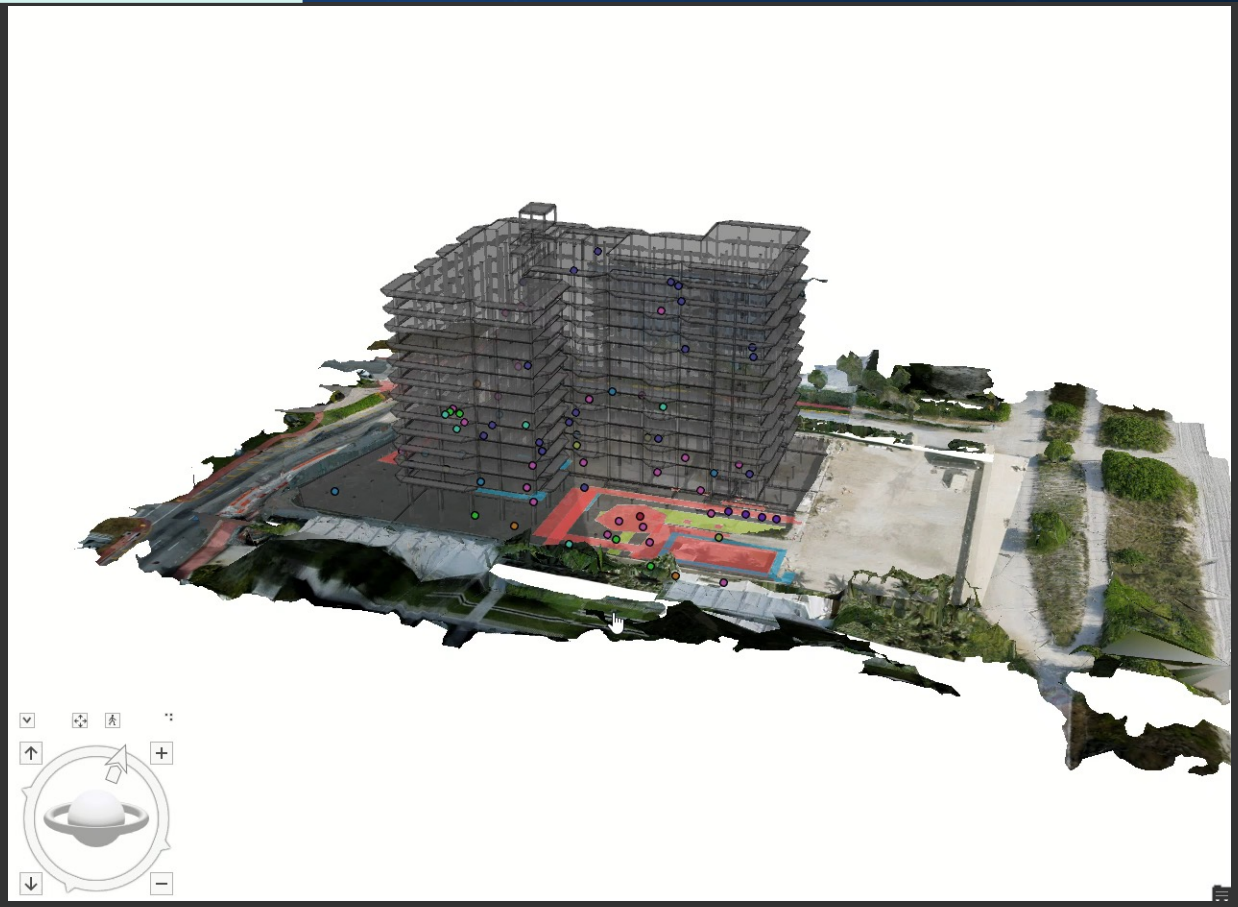
* No conclusions on the impact of these results are drawn pending consideration of spatial variability, quantification of uncertainty, consideration of any sampling biases, and continued materials analyses.

** Results not yet available.

Remote Sensing & Data Visualization

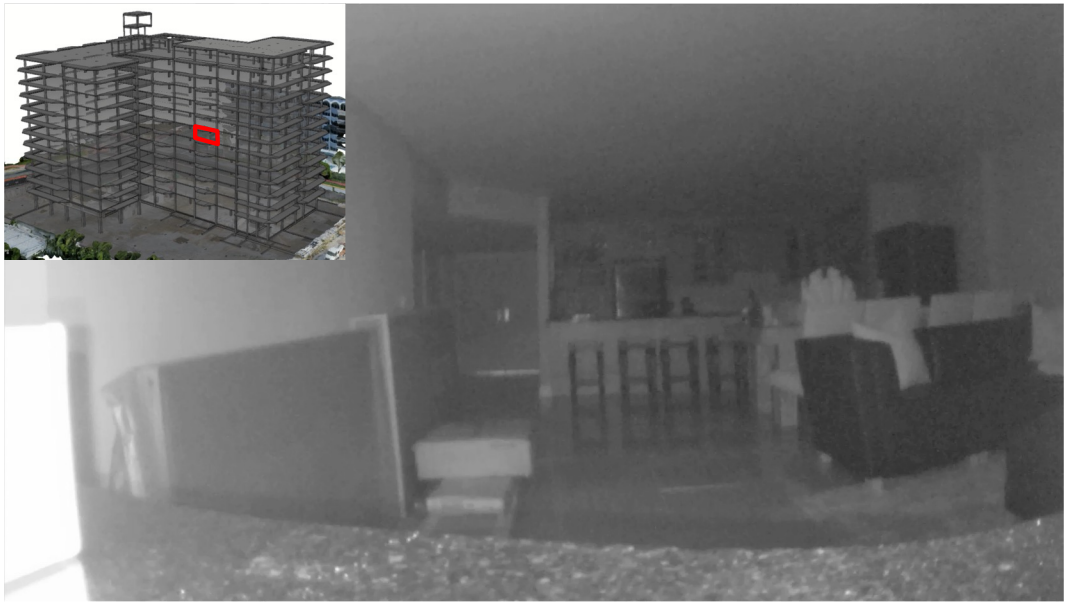
3D Site Information Model

NIST



Remote Sensing & Data Visualization

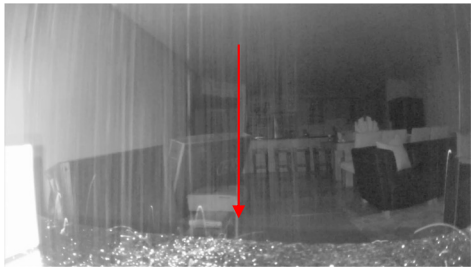
Analysis of Motion-Activated Camera Recording



- Unit 711 video (looking north) captured movement during the collapse.
- Evaluating motion in video to aid in determining initiation and progression of tower collapse.

Initial event triggers recording but does not capture any motion.

Second event triggers recording. Material from above falls straight down.



As video progresses, material from above falls at an angle; features in the background become distorted.

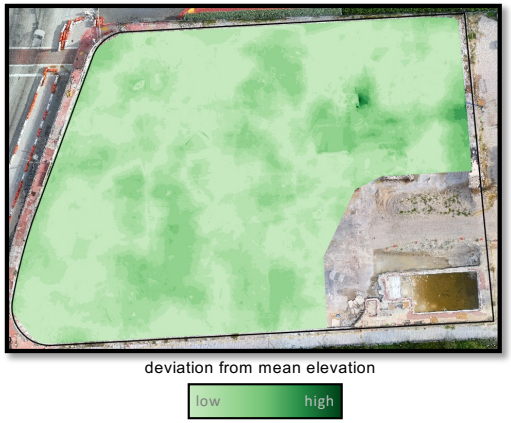
Geotechnical Engineering

Karstic Features - Sinkholes

Were there large voids in the ground underneath CTS that impacted the CTS foundations ?

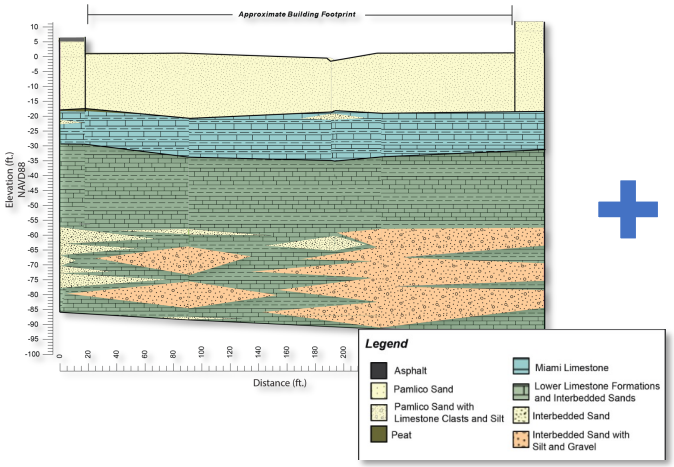
Source for All Images: NIST

Surveys of Basement Slab



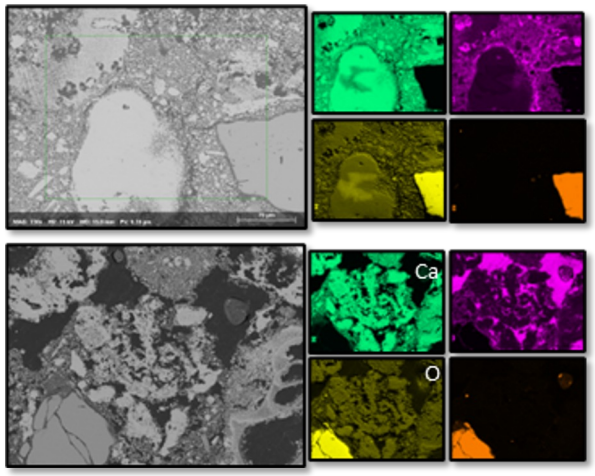
Post-collapse surveys of basement slab indicate differential settlements were small or absent.

Subsurface Investigation of Site



Boreholes, cone penetration tests, and geophysical testing at the CTS site completed to date, and subsurface information regarding the 87 Park site show no evidence of large karstic voids.

Specialized Laboratory Testing



Specialized mineralogy, imaging, and laboratory testing of limestone and sand samples show that soil and limestone were not susceptible to formation of karstic features.

Preliminary Evaluation: No evidence, to date, of large karstic voids that impacted the CTS foundations.

Geotechnical Engineering ⇒

Potential Differential Settlements

Were there large settlements of the CTS pile foundations that contributed to the CTS partial collapse ?

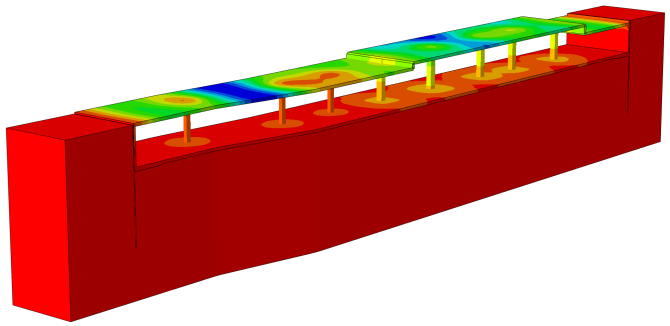
Site-Specific Pile Testing

In two post-collapse load tests of piles in pool deck area, piles performed well and demonstrated adequacy to carry estimated design loads. Results are in agreement with literature for regional load tests with similar Franki piles, subsurface conditions, and load conditions.

Source for All Images: NIST

+

Pile Settlement Evaluation



Preliminary numerical analyses and calculations using empirical methods estimate settlements consistent with the site-specific pile load testing.

Created by NIST using Abaqus Software

Preliminary Evaluation: Estimated potential settlements under structural loading are small - on the order of 1/4 inch.

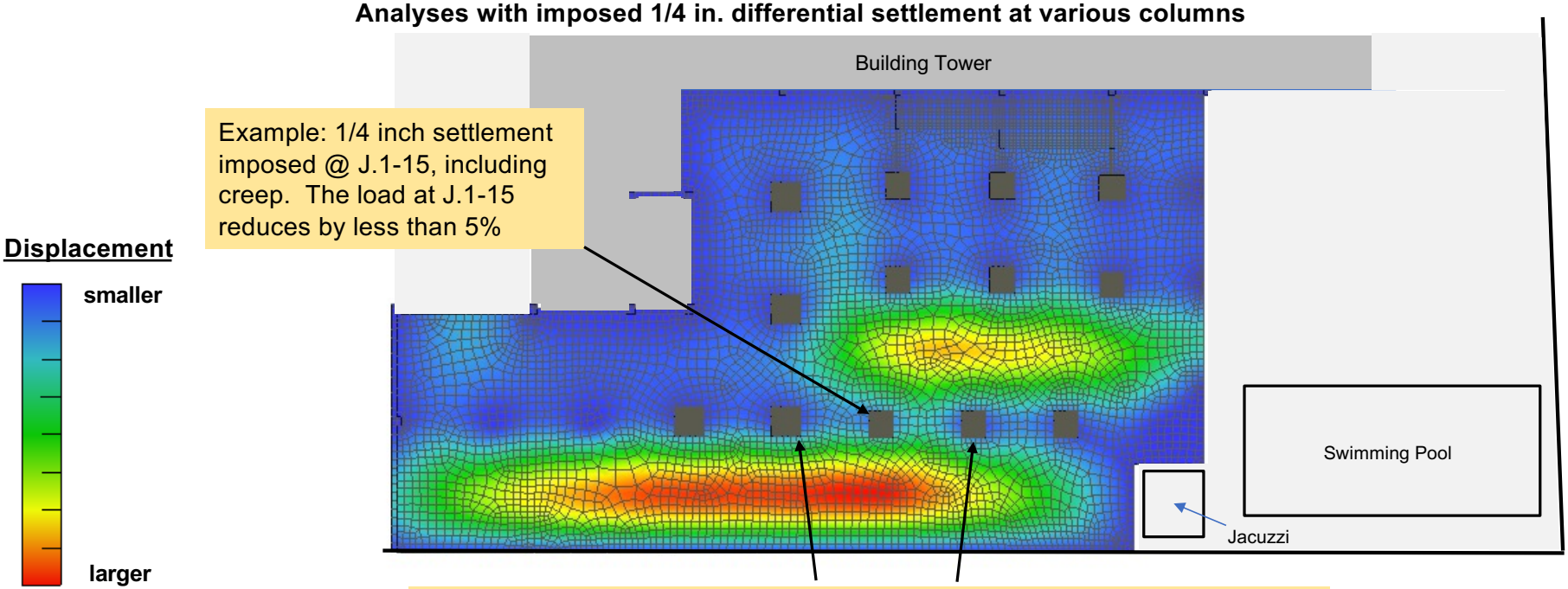
(evaluation of impact of settlements on the pool deck described in the following slide)

Structural Impact of Differential Settlement

Pool/Drive/Park Deck Collapse Model

Analyses with imposed 1/4 in. differential settlement at various columns

Example: 1/4 inch settlement imposed @ J.1-15, including creep. The load at J.1-15 reduces by less than 5%



The loads at adjacent locations I-14.1 and K.1-15 increase by less than 5%.

Source: NIST using ATENA software

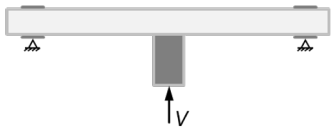
Preliminary Evaluation: 1/4 in. differential settlement has minimal impact on pool deck structure.

Structural Engineering

Structural Laboratory Tests & Collapse Modeling

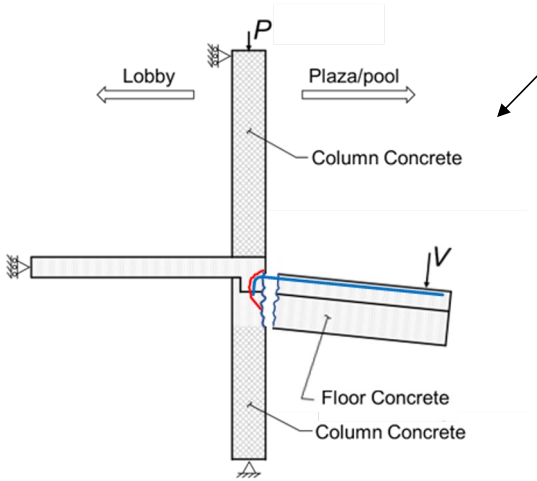
NIST

Structural Laboratory Tests

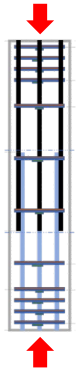


(a) Elevation: Slab-column tests

- *Representative materials shipped from South Florida*
- *Trial batches in progress*
- *Reinforcement and test apparatus approvals in progress*



(b) Elevation: Connections along line 9.1



(c) Elevation: Column splice tests

All Images: NIST

Collapse Modeling

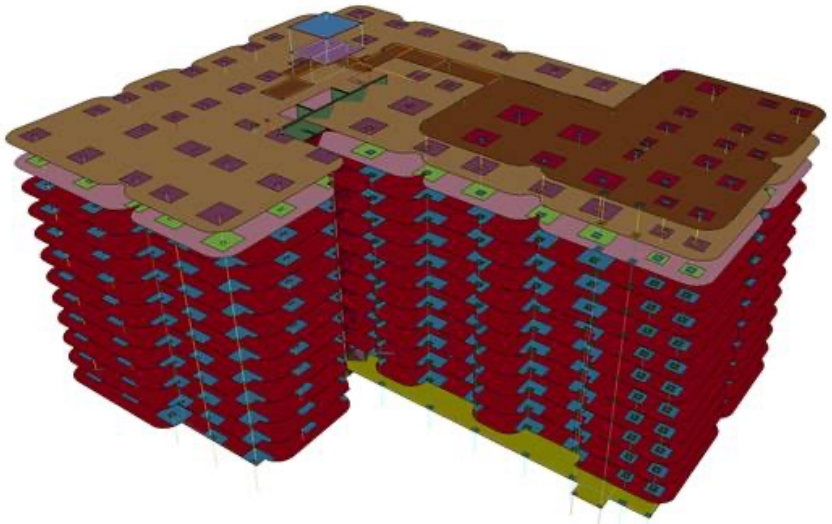


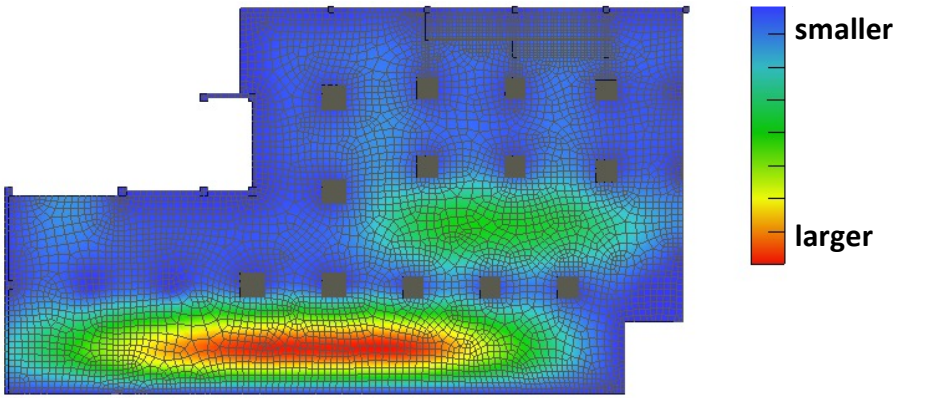
Image created by NIST with LS-DYNA software

CTS NCST Investigation

Integration of Evidence and Analyses in Collapse Modeling

NIST

Pool/Drive/Park Deck Collapse Model



Source: NIST using ATENA software

Project 1: History

- Loads
- Historic detailing practices
- Reinforcement detailing, cover, and spacing

Project 2: Evidence

- Reinforcement detailing, cover, and spacing
- Other as-built conditions
- Eyewitness accounts

Project 3: RSVP

- Details and measurements from photographs and Lidar

Project 4: Mat-Sci

- Concrete and steel material properties
- Degree of corrosion

Project 5: Geotechnical

- Soil-spring stiffness
- Pile-column eccentricity effects
- Settlement effects

Next Six Months - Highlights

CTS NCST Investigation

- Advance analysis of failure hypotheses: Initiation & progression of partial collapse
- Prepare for recommendations & report writing

Building & Code History

- Complete wind load history study
- Finalize pre-collapse conditions
- Analyze data from civil litigation

Materials Science

- Support extraction at PEFs and testing of materials at NIST's and outside labs
- Analyze concrete durability and aging
- Analyze reinforcement corrosion

Evidence Collection & Preservation

- Complete invasive extraction of concrete cores and rebar
- Track evidence during invasive testing
- Start Phase 2 interviews

Geotechnical Engineering

- Geotechnical support services contract
- SSI analysis with Structural Engineering
- Analysis of potential geotechnical contributors to failure hypotheses

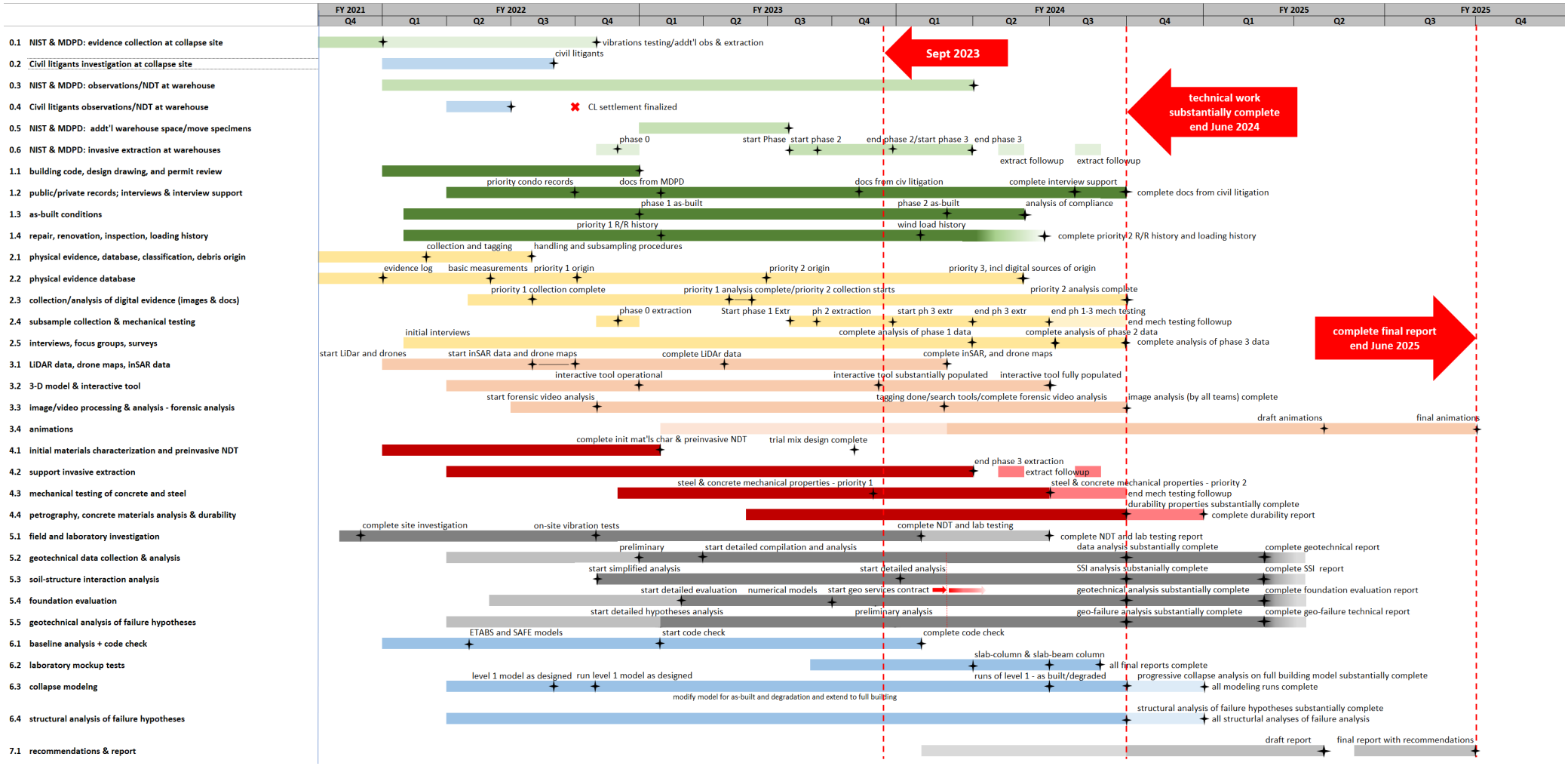
Remote Sensing & Data Visualization

- Complete InSAR study
- Analysis of building security hard drives
- Continue to populate data visualization tool

Structural Engineering

- Conduct structural laboratory tests
- Incorporate as-built data into models
- Extend collapse models

Investigation Schedule



NCST Investigation of the Champlain Towers South Collapse

Investigation Overview & Update

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NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

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