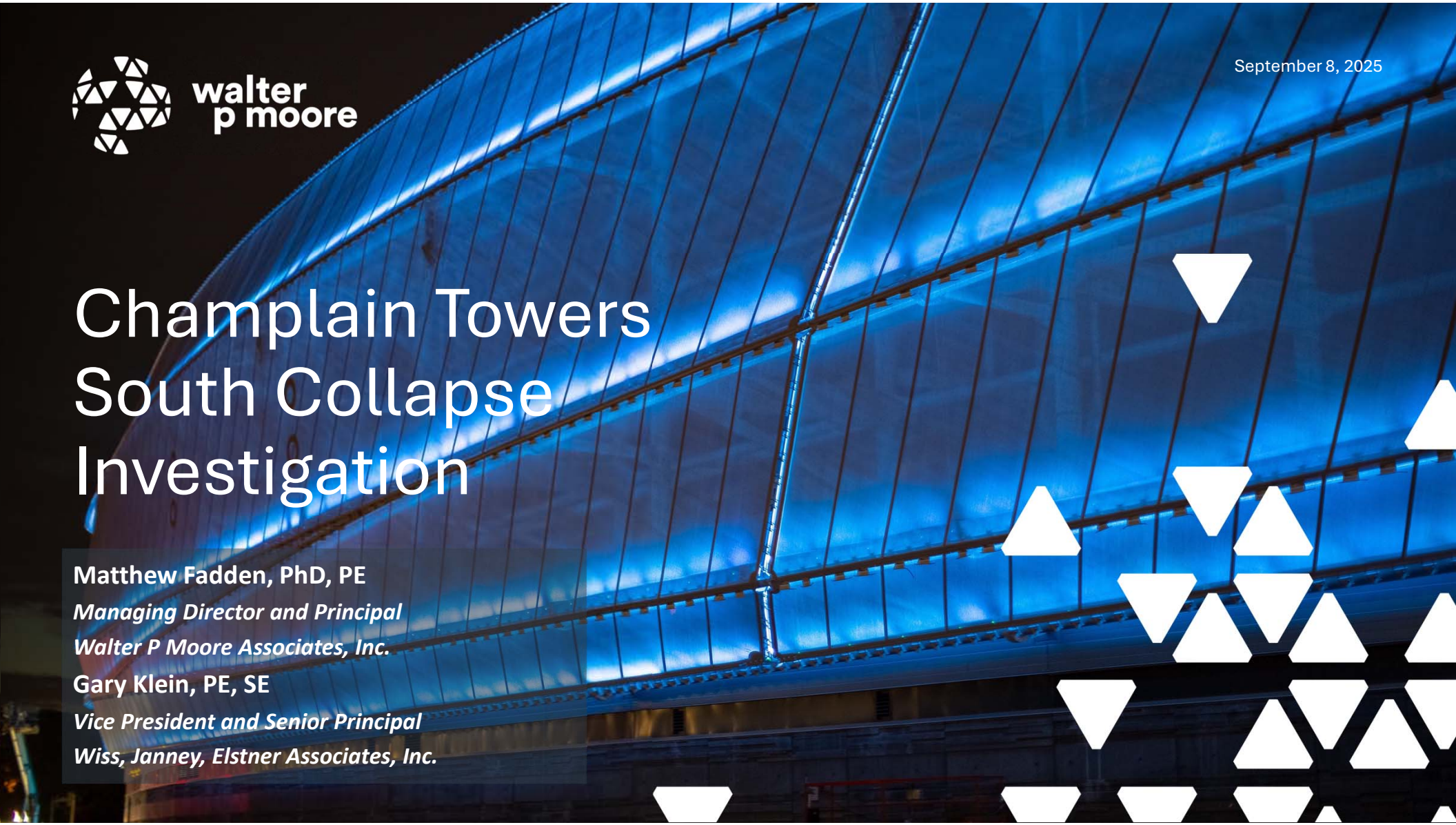


September 8, 2025

Champlain Towers South Collapse Investigation

Matthew Fadden, PhD, PE
Managing Director and Principal
Walter P Moore Associates, Inc.
Gary Klein, PE, SE
Vice President and Senior Principal
Wiss, Janney, Elstner Associates, Inc.

Presentation Outline

1. Champlain Towers South Collapse

- Document Review
- Site Investigation
- Laboratory Studies
- Structural Analyses

→ Collapse Theory

2. State of Structural Assessments in Florida

Findings & Observations

Document Review

What we knew June 24, 2021 – Surfside, FL

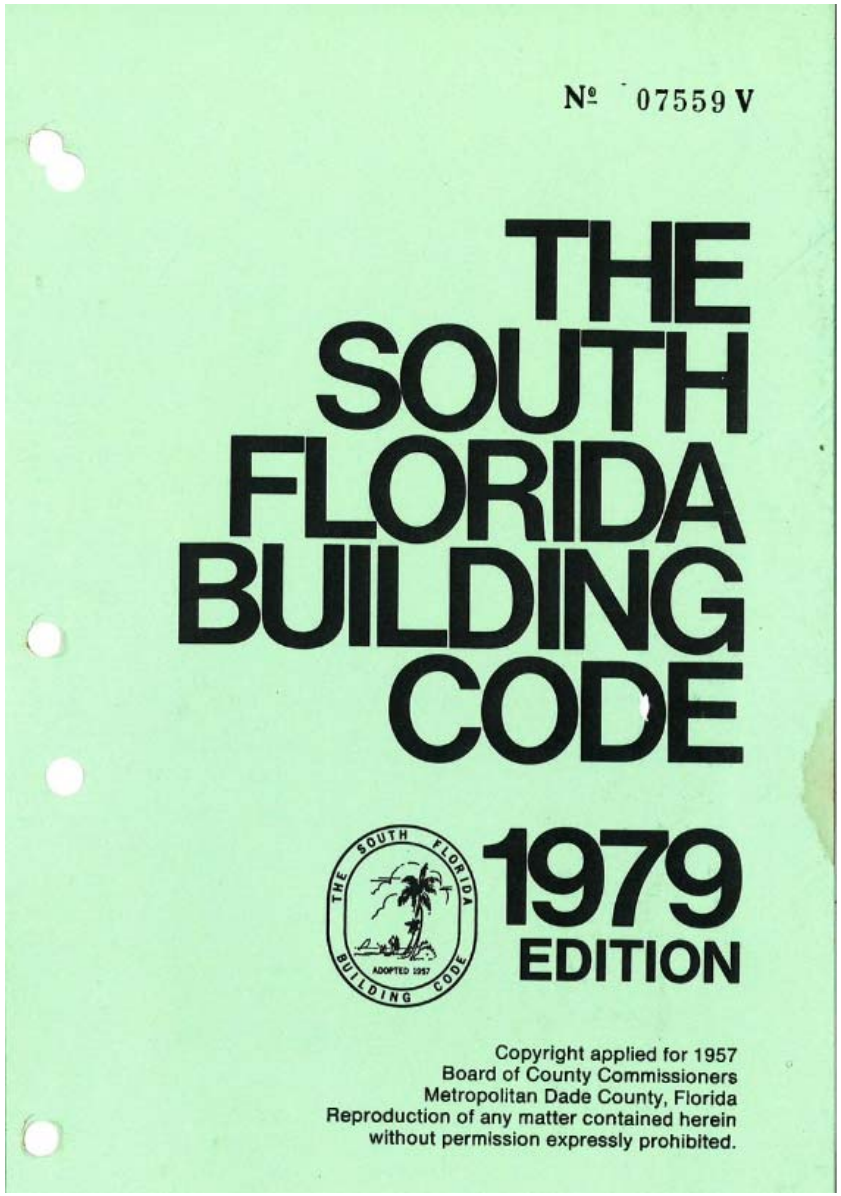
- A building had partially collapsed at ~1:30 am
- 100+ people were feared missing or dead
- The cause was unclear
- Initial information via:
  - Social media
  - News
  - Photos
  - Videos

Building Description

- 12-story L-shaped structure with 136 units built in 1981
- Reinforced concrete flat plate construction
- Parking on the lobby level and the basement garage
- Pool deck terrace on the south side of the buildings

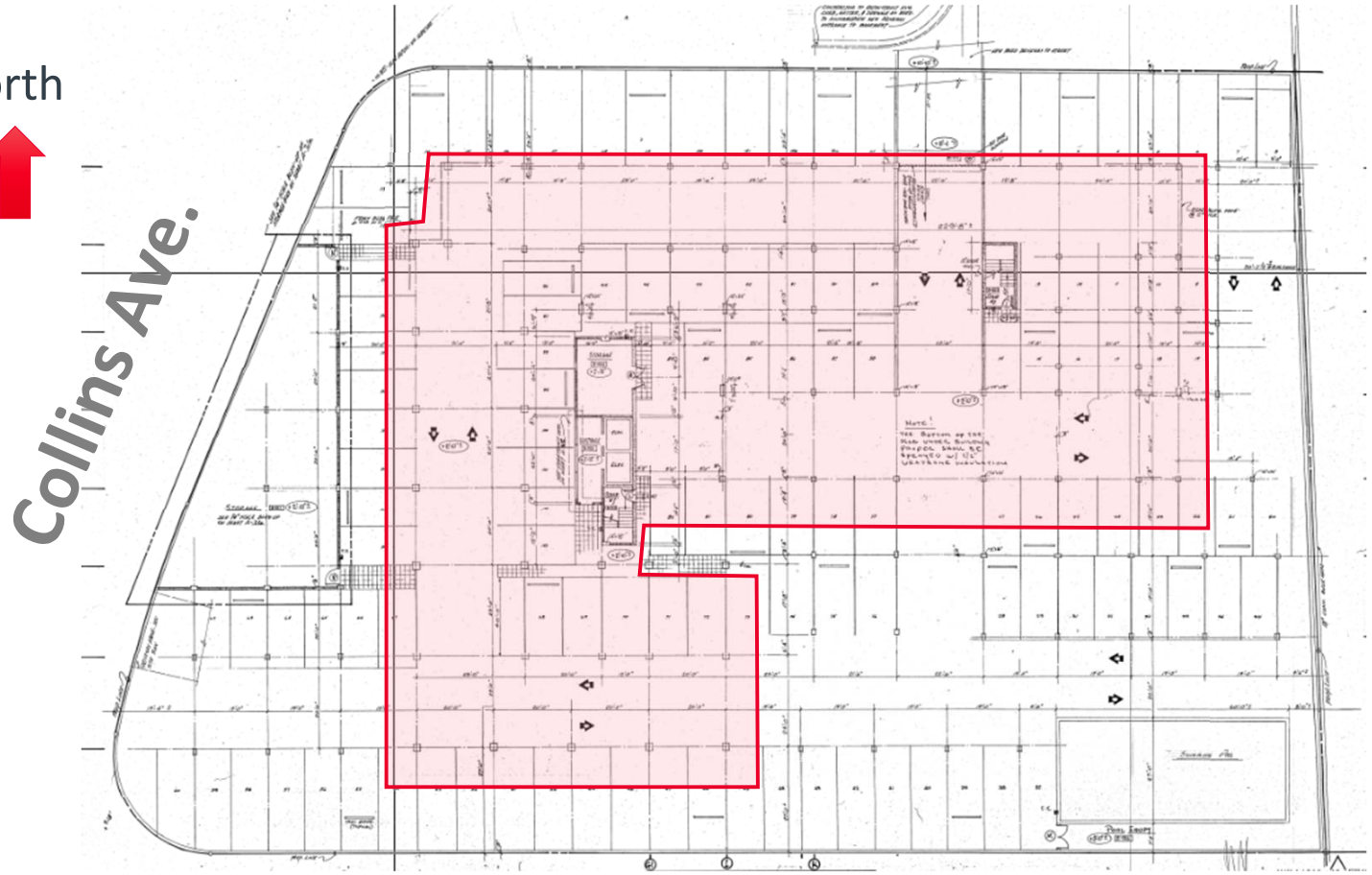
Codes and Design Standards (1981)

- South Florida Building Code 1979
- ACI 318-77: Building Code Requirements for Reinforced Concrete




North
Collins Ave.
K/13.1
L/13.1
Atlantic Ocean

North

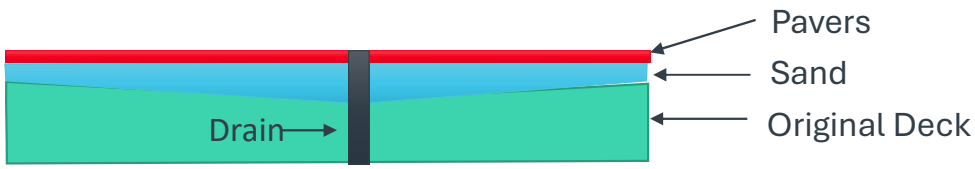


Atlantic Ocean

1996 Retrofit: Pool Deck & Garage

Under the supervision of a licensed Florida professional engineer, a repair contractor performed:

- Planter waterproofing
- Paver installation
- Concrete structural repairs



March 22, 1996

Thomas Conway
Building Manager
Town of Surfside
9293 Harding Avenue
Surfside, FL 33154

Dear Mr. Conway,

[redacted] will be starting a project at Champlain Towers South located at 8777 Collins Avenue, Surfside FL. Included in the scope of work will be concrete structural repair in the parking garage. This type of repair entails removing loose concrete overhead, treating steel rebar with rust inhibitive coating and patching back with repair mortar. Also included in the garage will be urethane foam injection in ceiling cracks (approximately 500 lineal ft.).

The condo has retained the services of [redacted] 5100 West Copans Road, Margate, FL 33063 to do the inspections and supervise the project.

Please feel free to contact me with any questions.

Sincerely,

[redacted]
Sales Manager

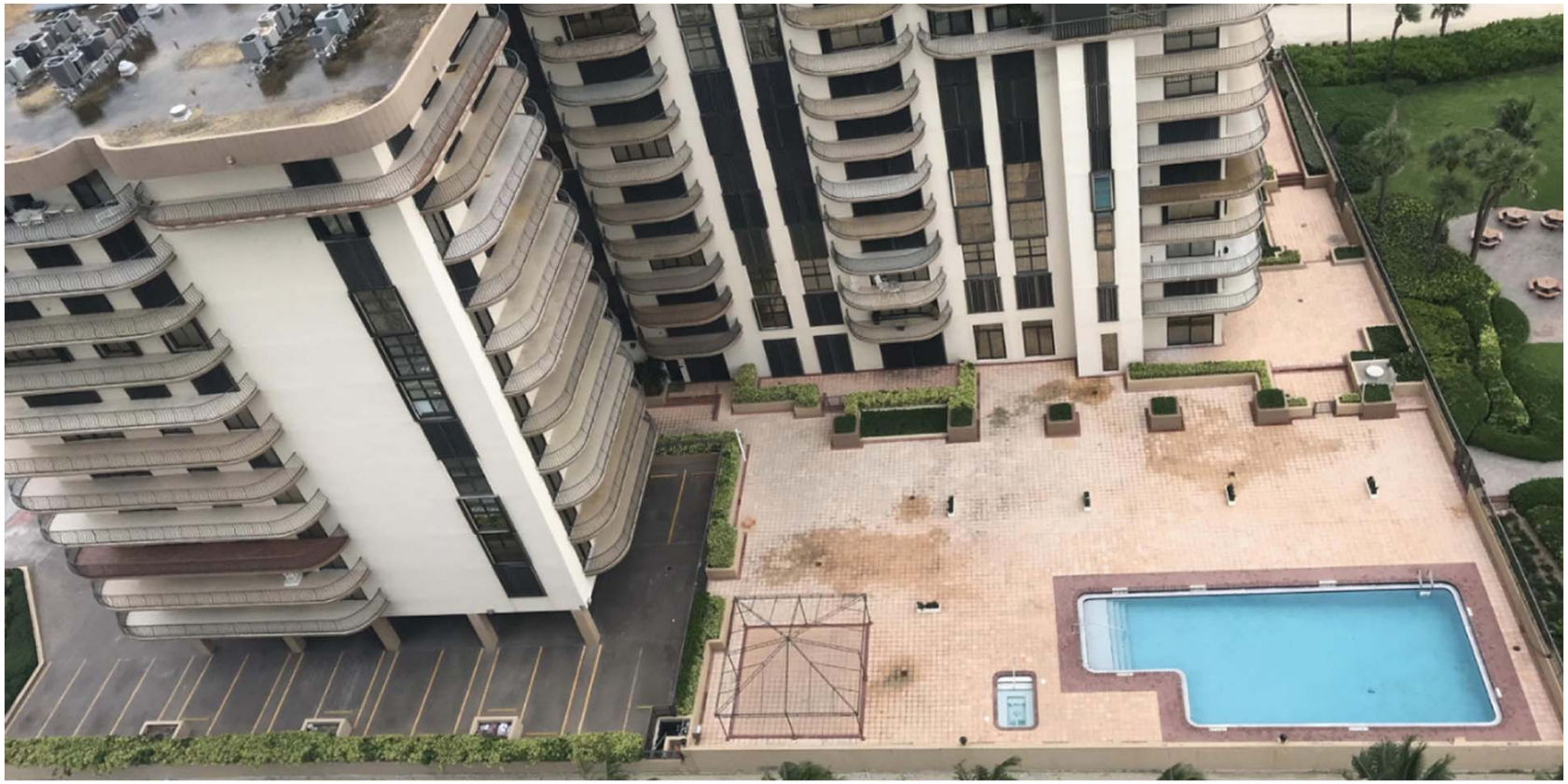
2018 Recertification Report

- Abundant cracking and spalling in garage with calcium carbonate leaching
- Previous repairs failing due to poor workmanship
- Concrete repair recommended following standard practices
- Recommend that the entrance and pool decks slabs showing distress be removed and replaced

Figure J1: Typical cracking and spalling at parking garage columns

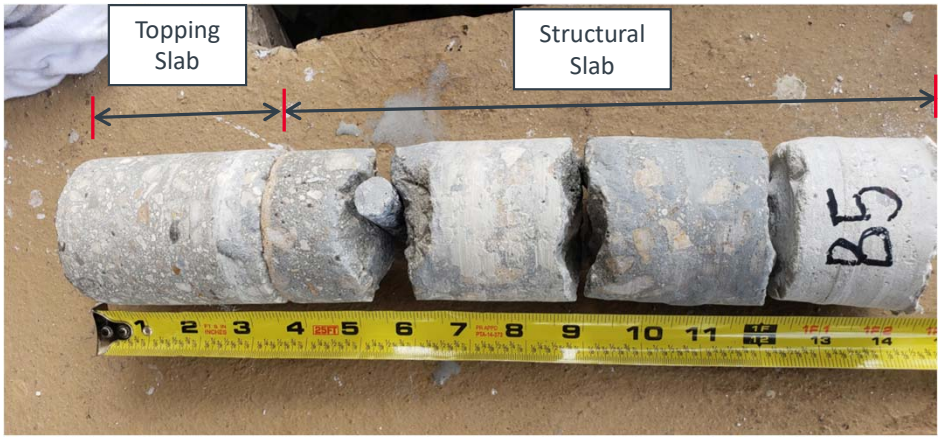
Figure J2: Spalling with exposed steel reinforcement at topside of garage deck.

Recertification Investigation – Deck Finish

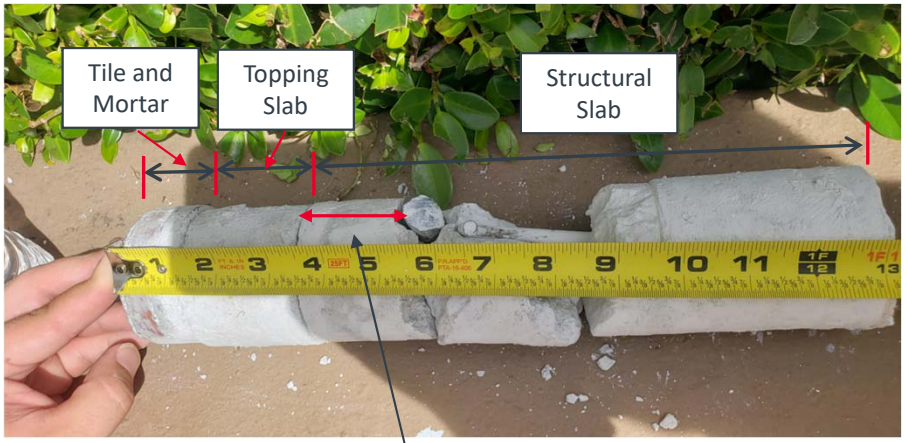


Recertification Investigation – Concrete Core Samples

Parking Deck

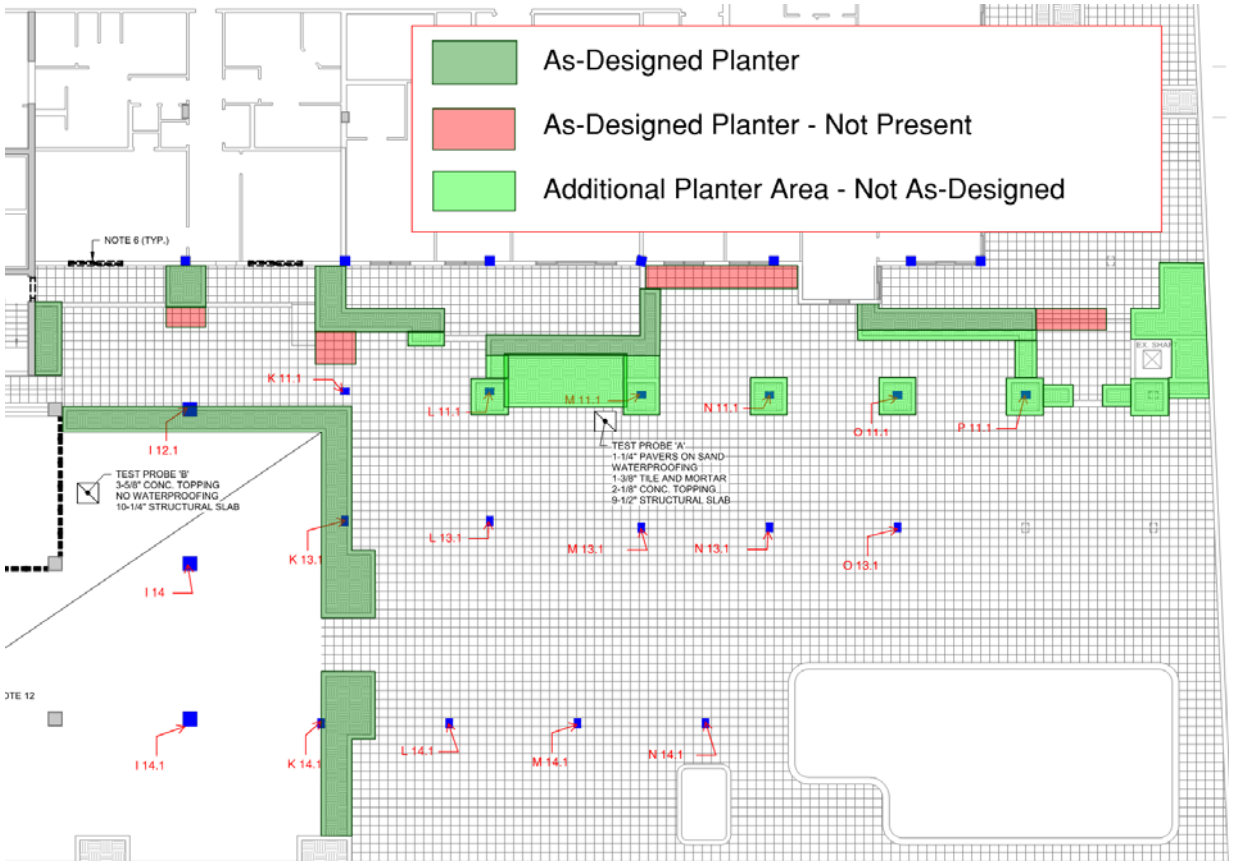


Pool Deck

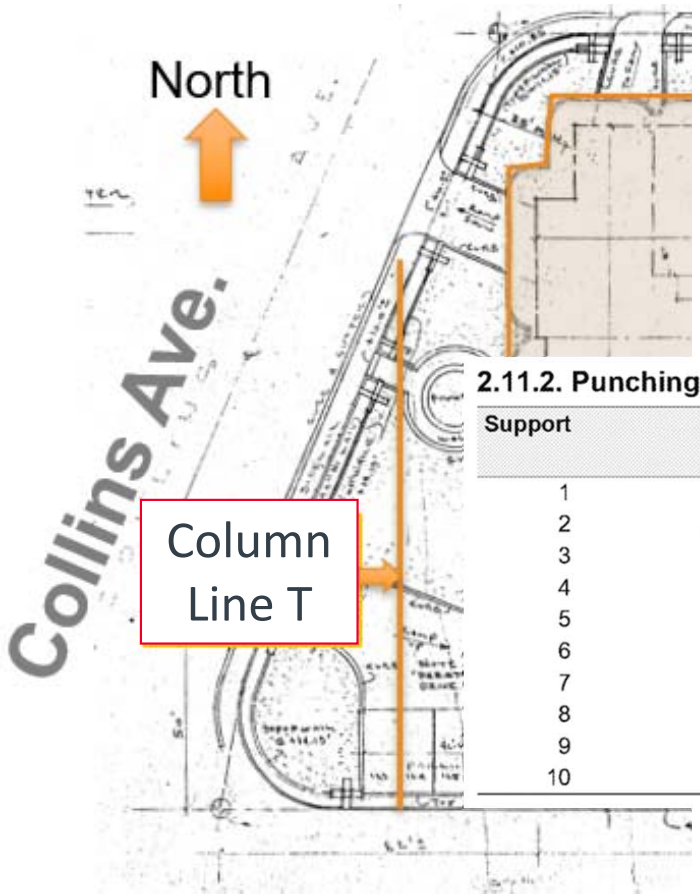


Excessive Cover

Recertification Investigation - Planters



Recertification Engineer Calculations

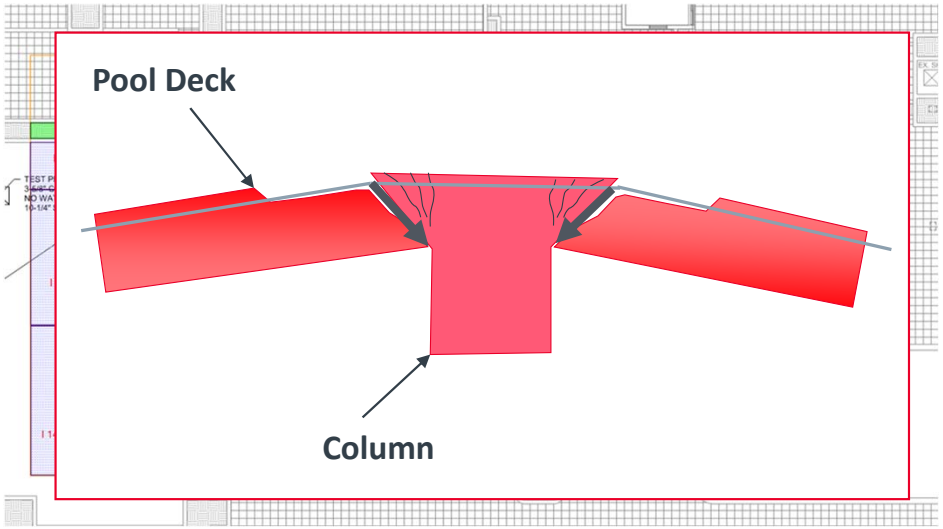


- Recertification engineer analyzed the slab along Column Line T
- Punching shear results were exceeded in every calculation iteration.

2.11.2. Punching Shear Results

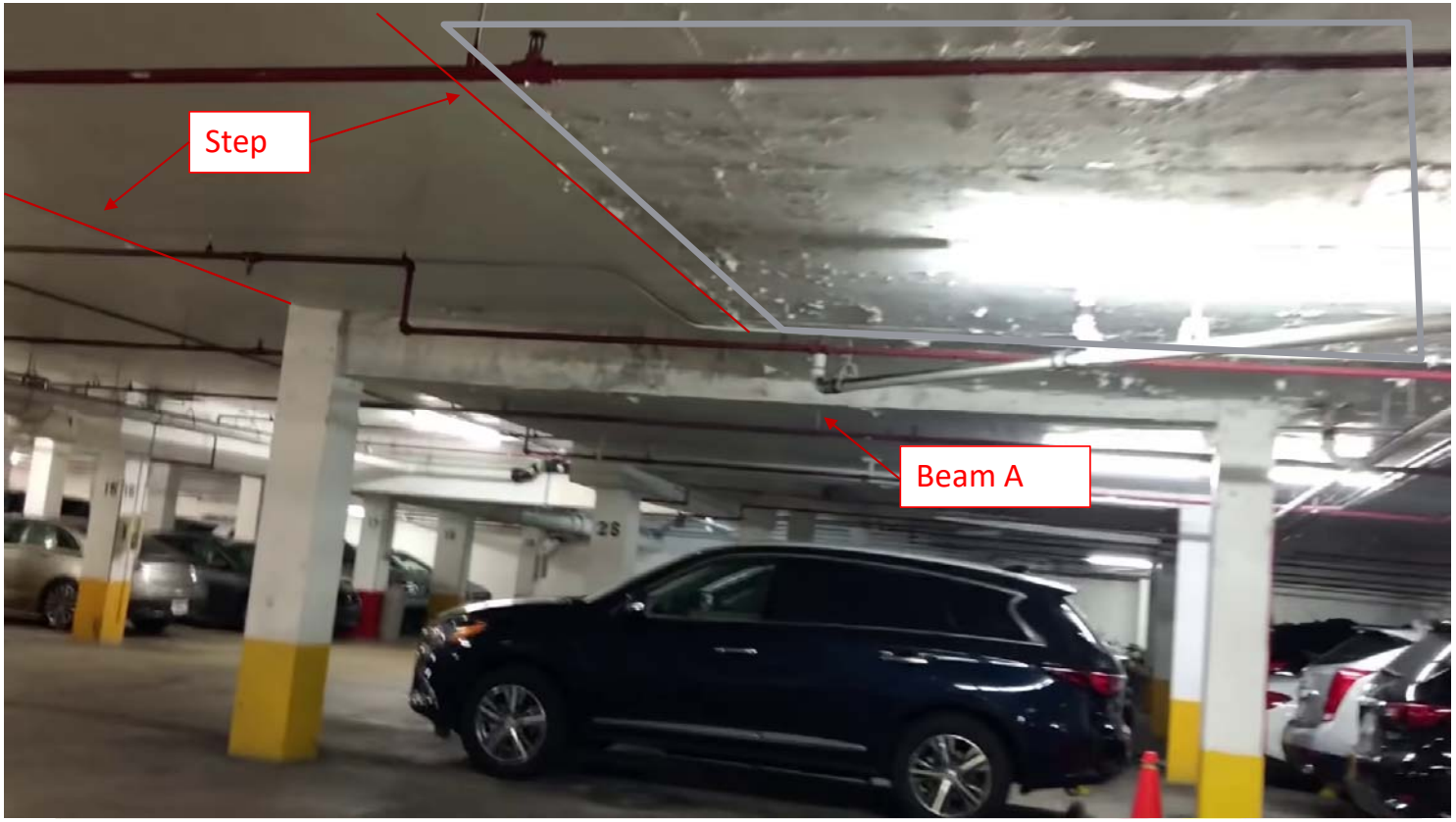
Support	V_u kip	v_u psi	M_{unb} k-ft	Comb	Patt	γ_v	v_u psi	ΦV_c psi
1	80.05	31.9	195.51	U1	All	0.117	343.7	101.5 *EXCEEDED
2	202.56	236.6	10.47	U1	All	0.415	244.8	189.7 *EXCEEDED
3	133.15	183.2	-39.19	U1	All	0.422	217.6	189.7 *EXCEEDED
4	164.83	192.5	12.83	U1	All	0.375	200.5	189.7 *EXCEEDED
5	176.45	206.1	-18.39	U1	All	0.415	217.8	189.7 *EXCEEDED
6	133.61	183.9	6.98	U1	All	0.422	190.0	189.7 *EXCEEDED
7	156.94	216.0	6.70	U1	All	0.422	221.8	189.7 *EXCEEDED
8	146.79	171.5	-25.71	U1	All	0.375	191.2	189.7 *EXCEEDED
9	178.11	180.7	16.77	U1	All	0.380	190.3	189.7 *EXCEEDED
10	77.04	30.7	-172.04	U1	All	0.117	299.8	101.5 *EXCEEDED

L13.1 Slab/Column Distress – Nov. 13, 2020



K13.1 Slab/Planter Distress - June 2, 2021

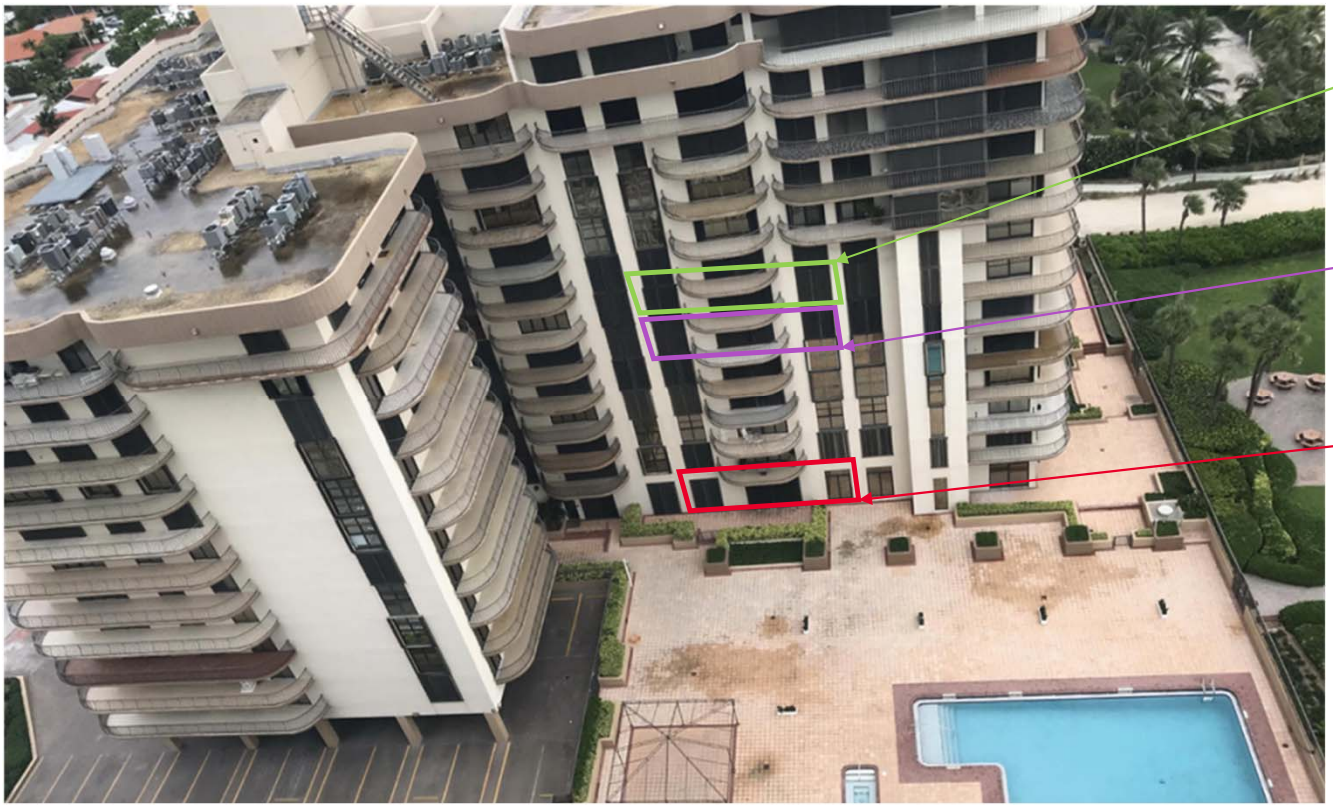
Garage Walkthrough Video



1:18 AM - TikTok Video

~1:15-1:22 AM - Unit 711 Ring Video

Resident Observations



Unit 711

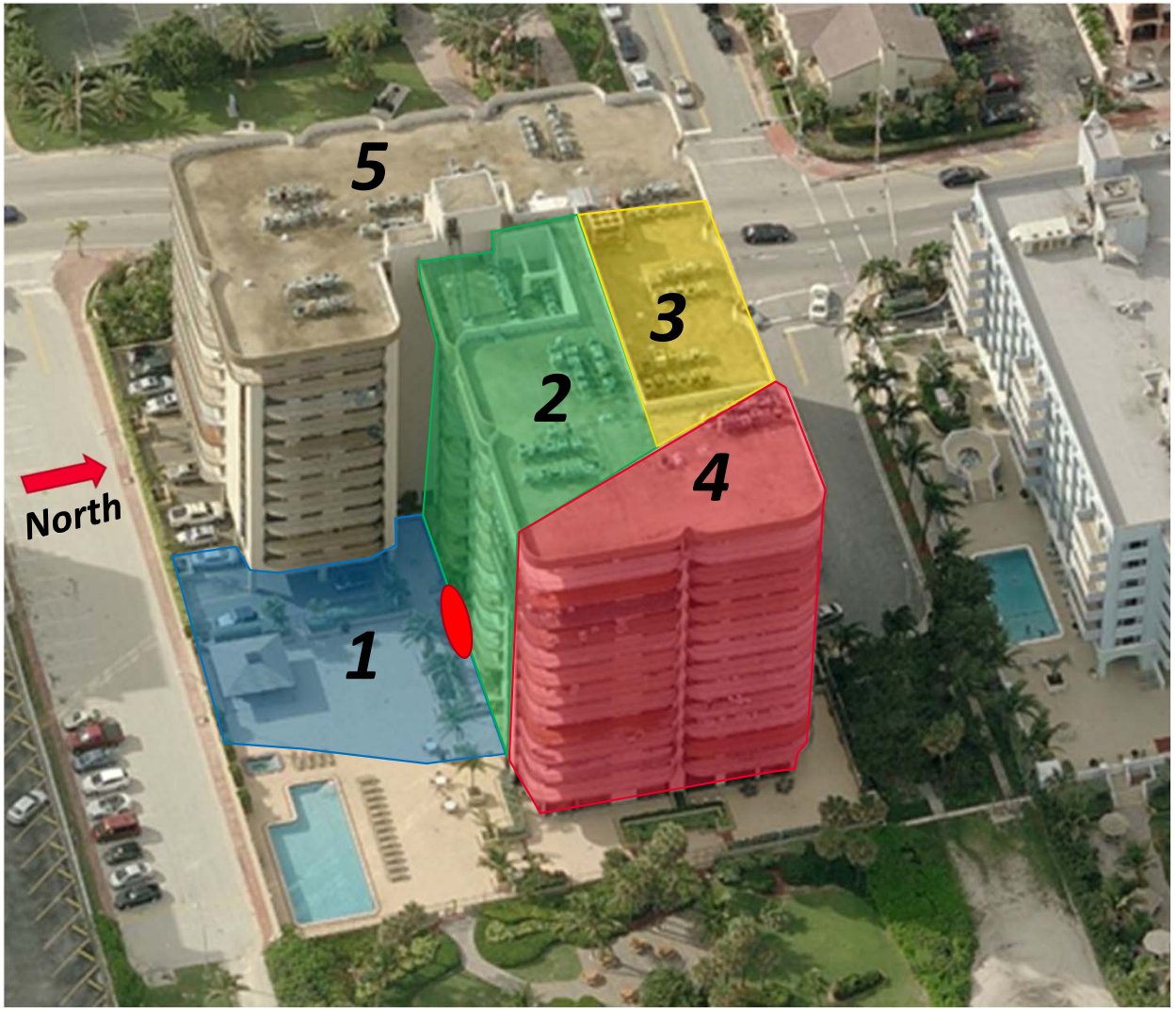
Ring Video

Unit 611

Cracks in Walls

Unit 111

12:30 am:
Construction Noises
1:10-1:15 am:
Pool Deck Collapse



Collapse Timeline
June 24, 2021

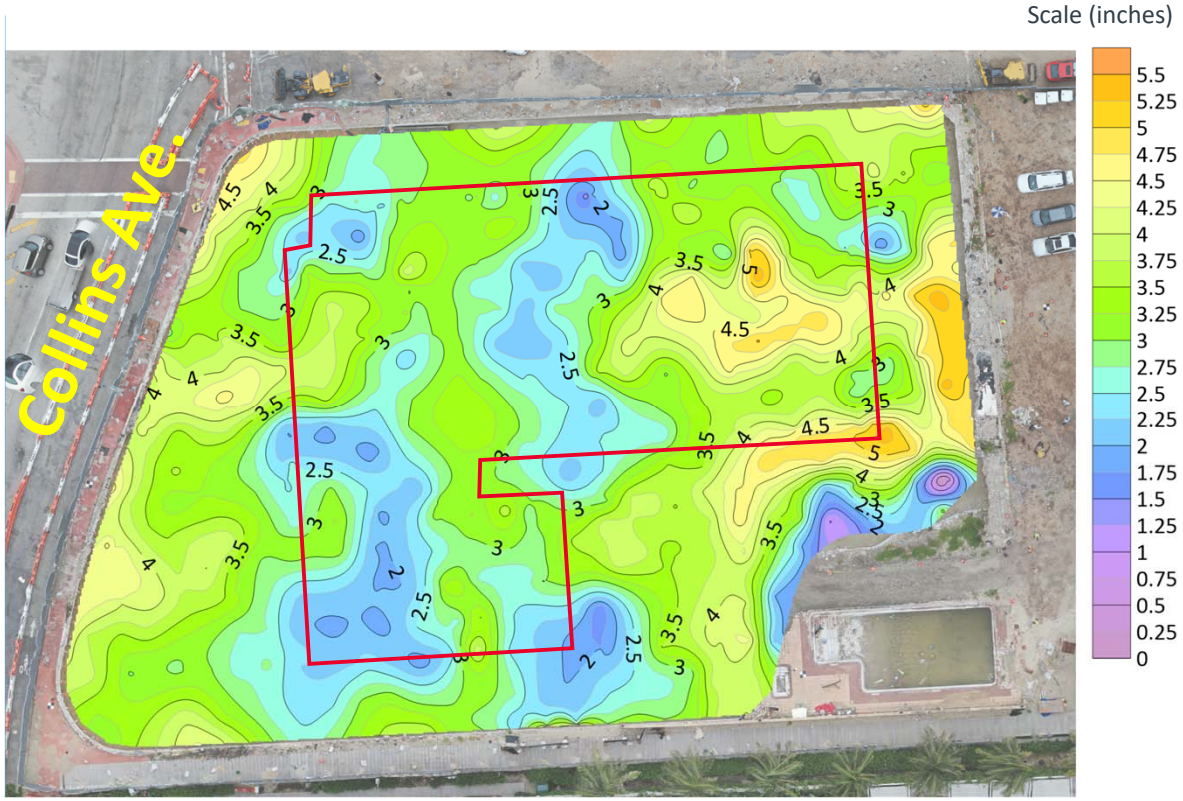
1	1:10– 1:15 AM	Pool Deck
7 – 12 minutes		
2	1:22 AM	East Tower South
3	+ 3 seconds	East Tower North
4	+ 8 seconds	East Tower East
5	West portion does not collapse	

Findings & Observations

Site Investigation

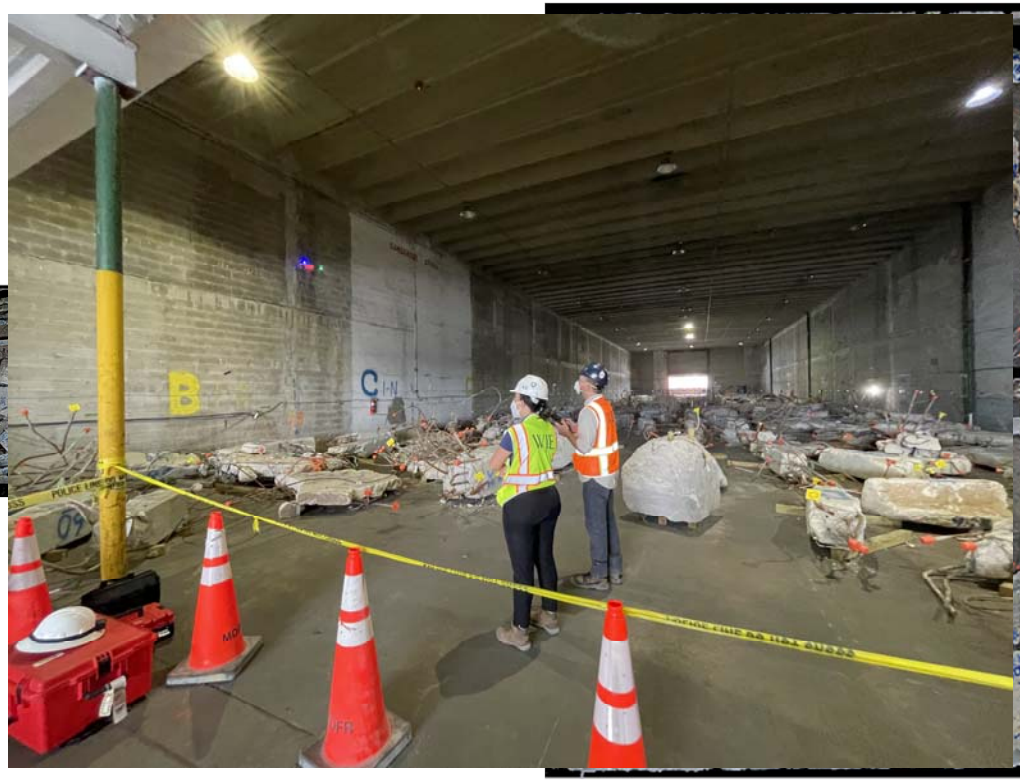
Collapse Site – October 2021

Basement Slab Survey - Topography

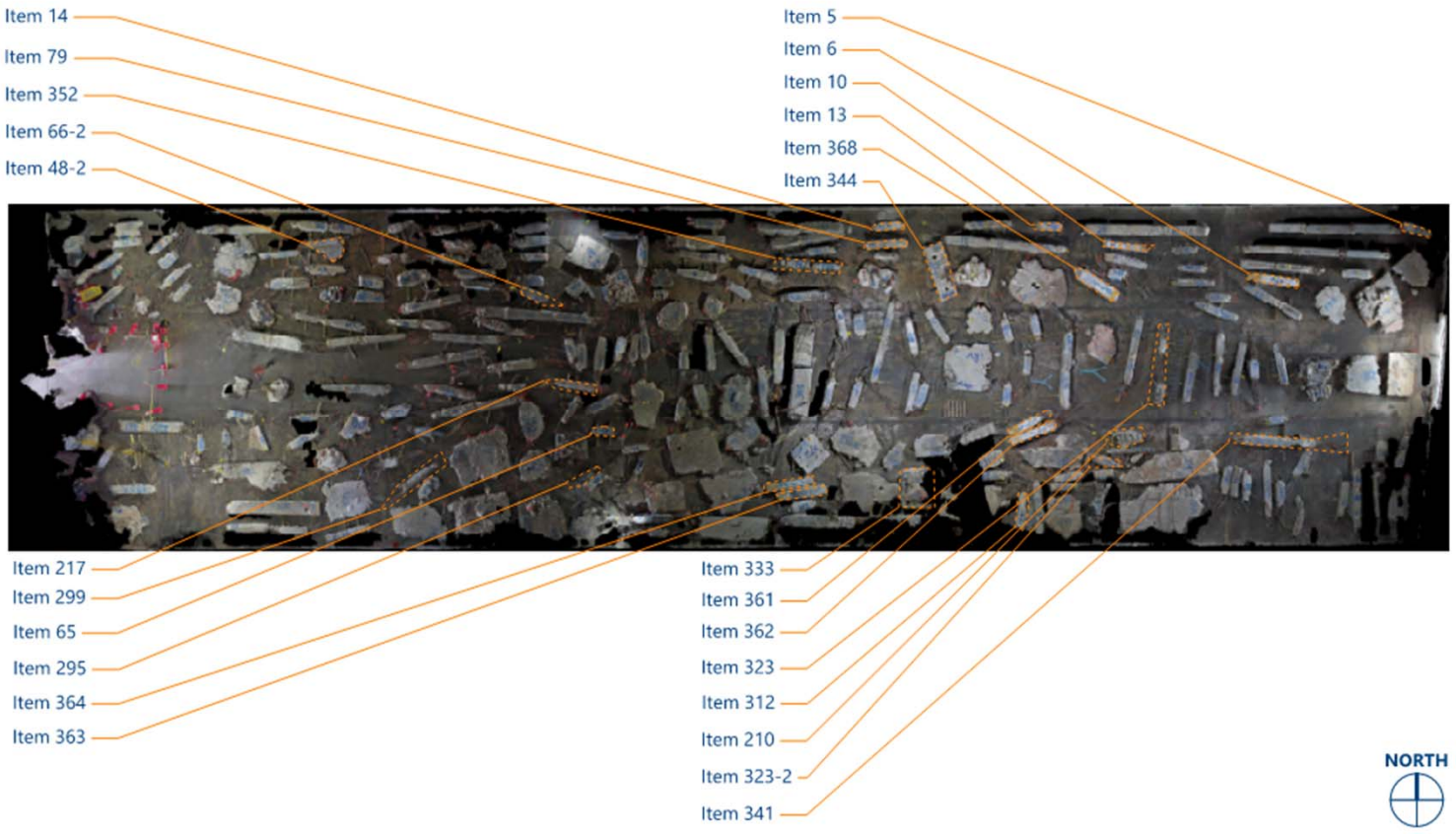


Collapse Site Sampling

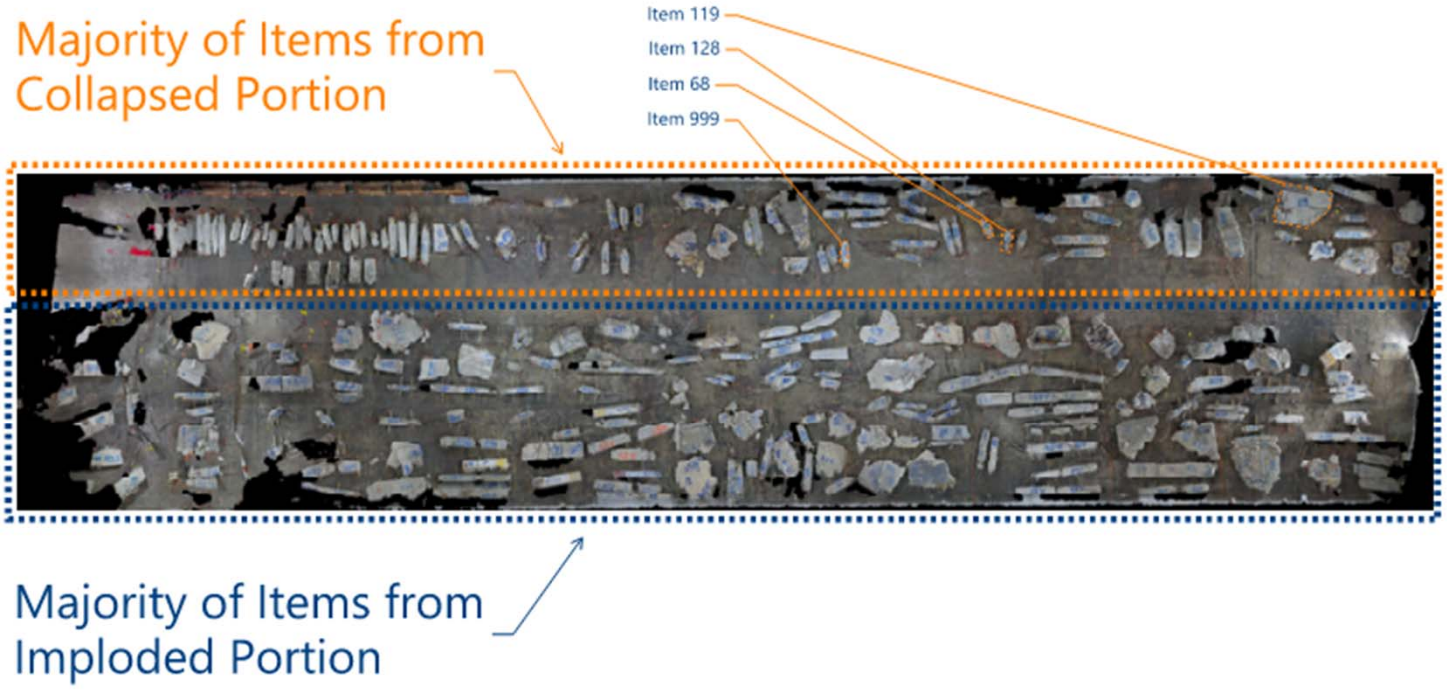
NIST/NCST - Primary Evidence Facility



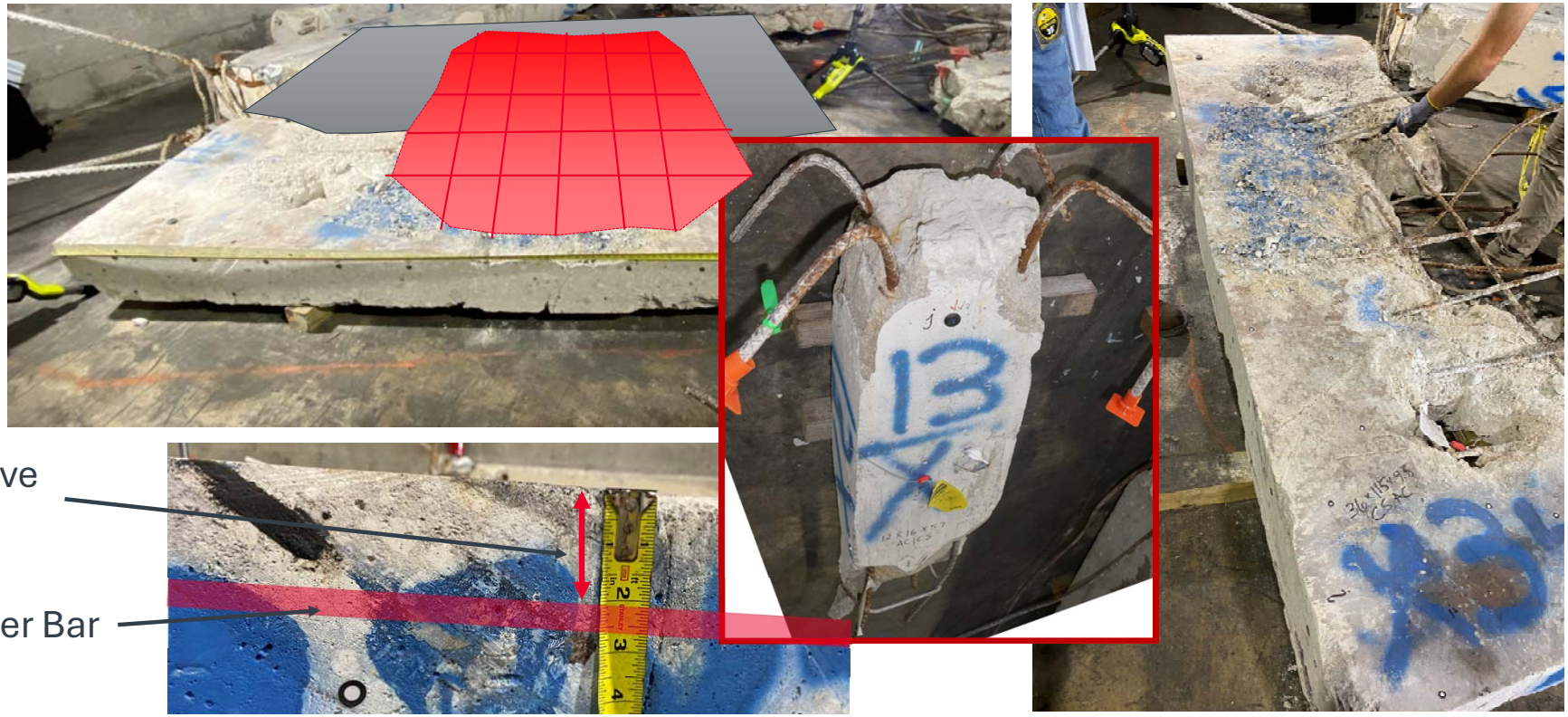
Primary Evidence Facility – North Bay*



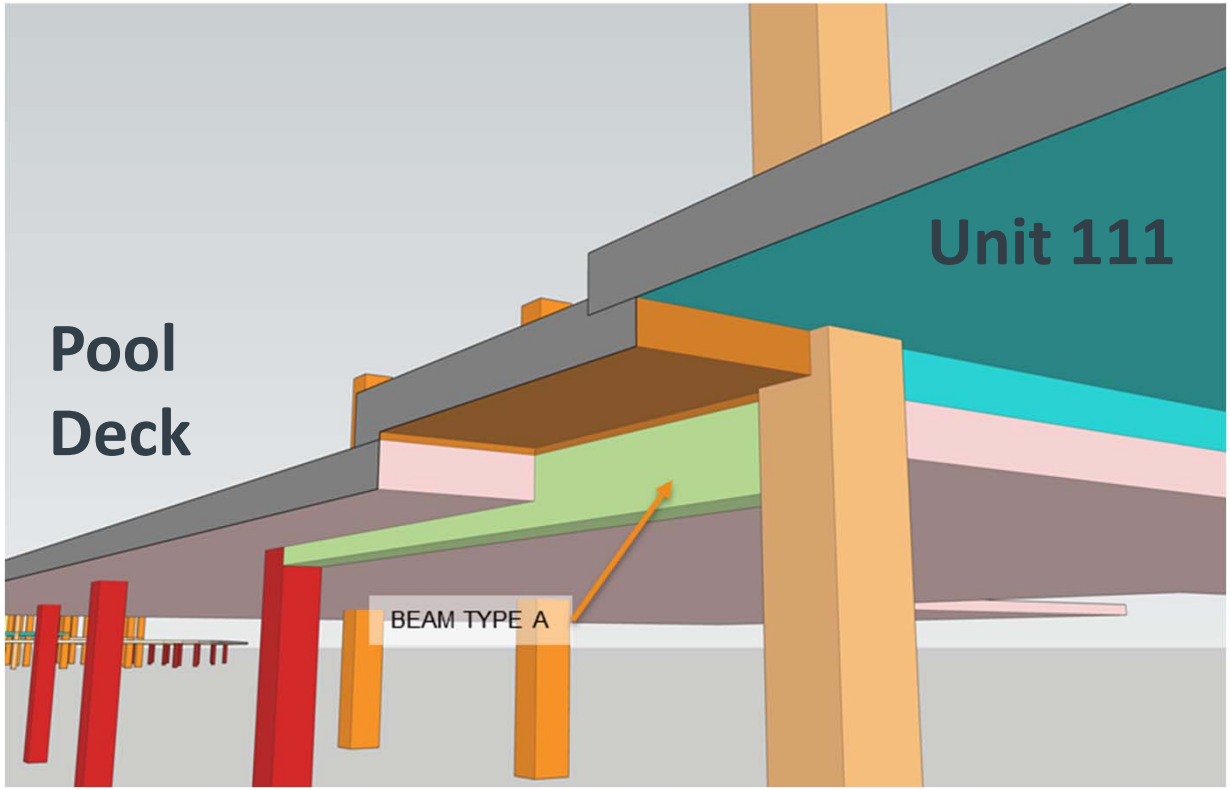
Primary Evidence Facility – South Bay

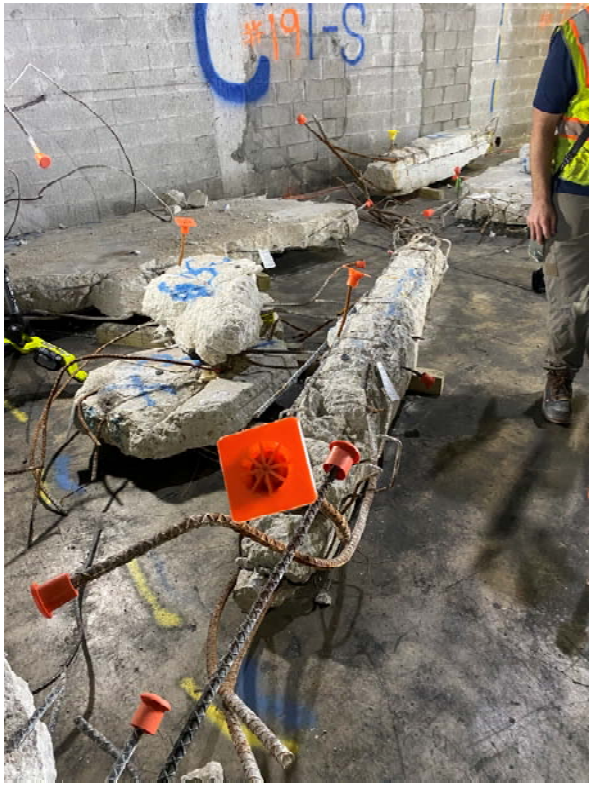


Primary Evidence Facility – Item 344 "Punched Slab"

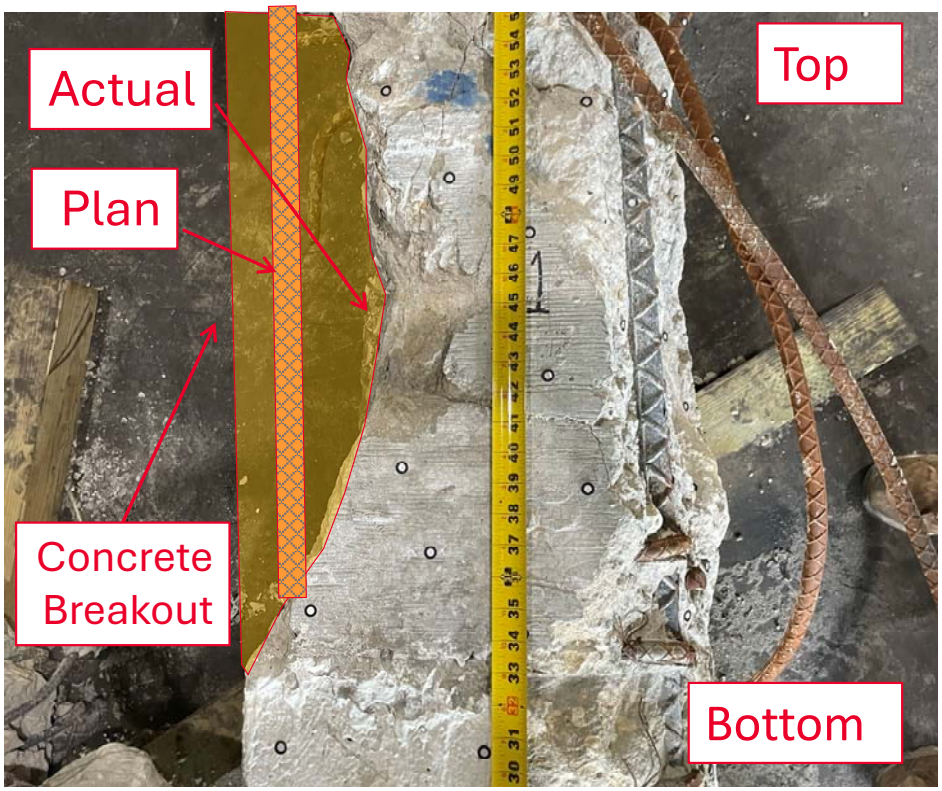


PEF – Item 299 "Beam A"





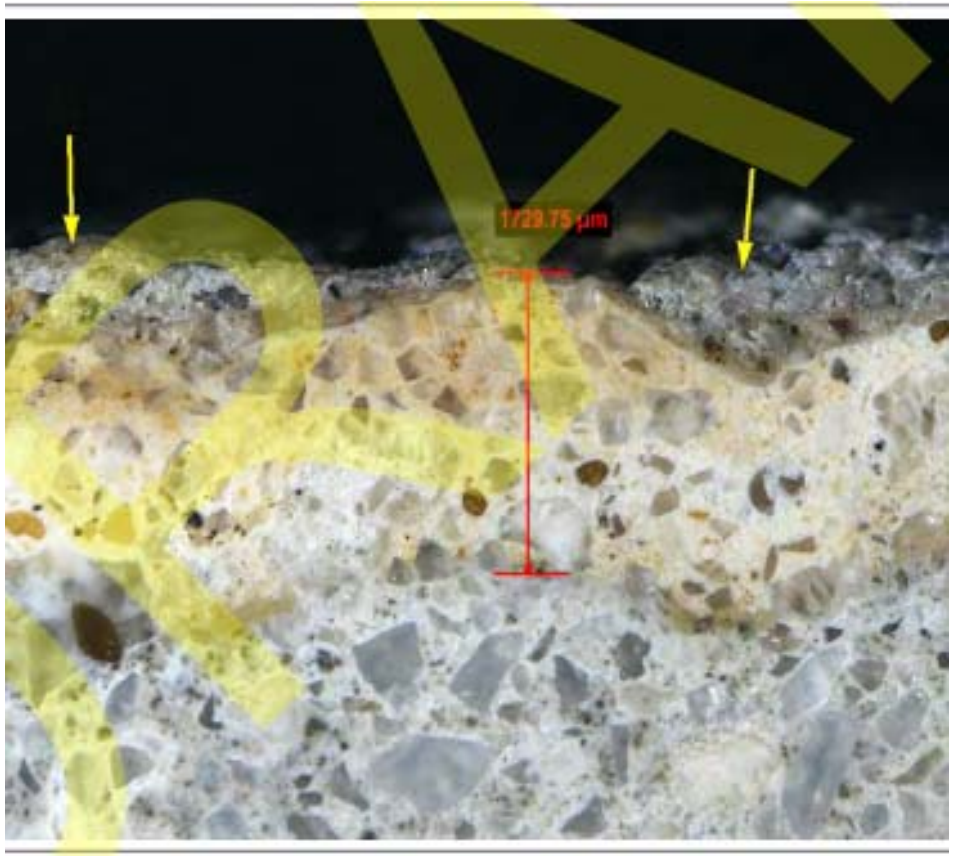
Primary Evidence Facility – Item 341 - 16x16 Column



Findings & Observations

Laboratory Studies

Concrete Petrography and Testing

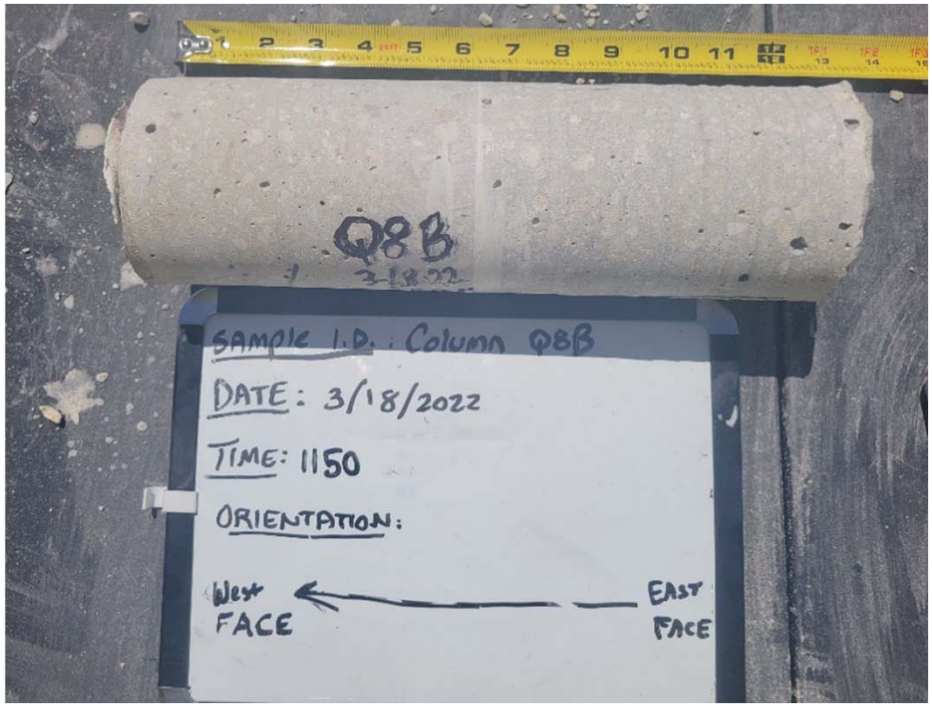


Basement Slab Samples

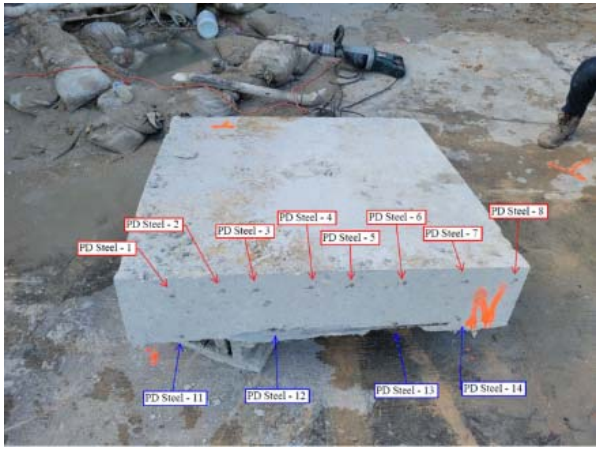
- Concrete typical to Florida
  - Moderate w/c ratio (0.35-0.45)
  - Well mixed
  - Non-air entrained
- Corrosion consistent with that at concrete placement
- Low chlorides and carbonation

Concrete Material Properties

Location	Average Compressive Strength psi (MPa)	Min. Specified Compressive Strength psi (MPa)
Transfer Girder	3560 (25)	4000 (28)
Column M15.1	3785 (26)	6000 (41)
Column Q8	5820 (40)	6000 (41)
Pool Deck	4475 (31)	4000 (28)
Perimeter Wall	4280 (30)	4000 (28)
Shear Wall East	6600 (46)	6000 (41)
Shear Wall West	8155 (56)	6000 (41)



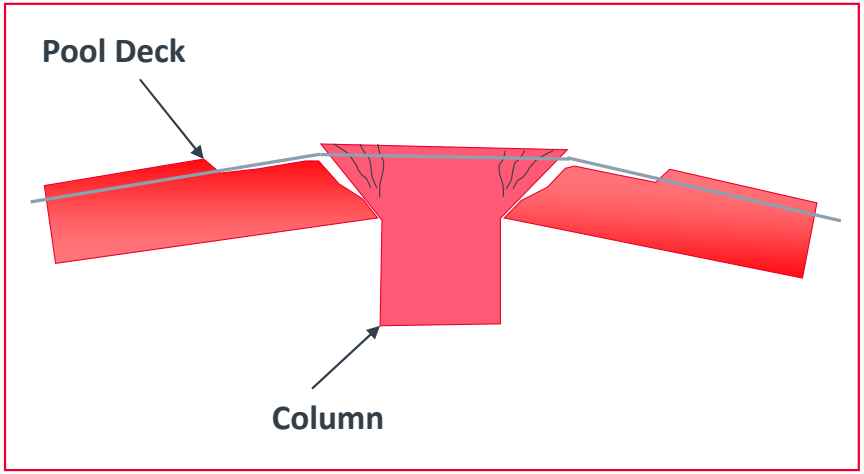
Steel Reinforcement



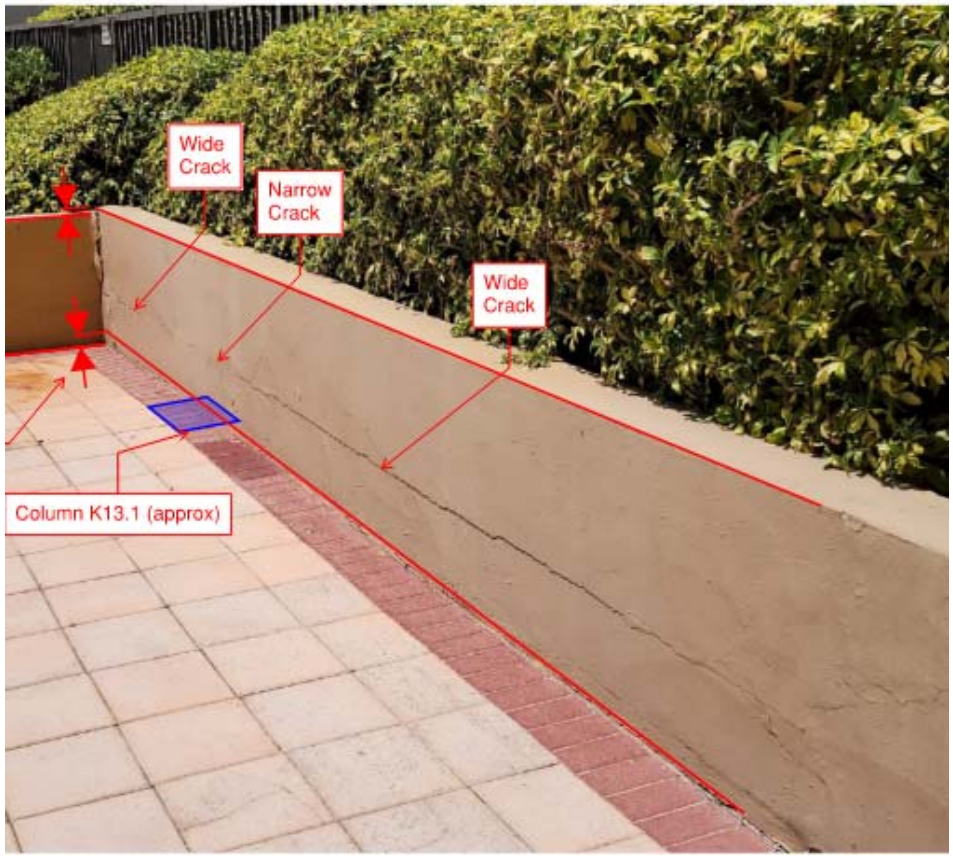
	Min. Specified (ASTM 615 Gr. 60)	Perimeter Wall (avg.)	Pool Deck (avg.)
Yield – F_y: psi (MPa)	60,000 (414)	69,948 (482)	77,012 (531)
Ultimate – F_u: psi (MPa)	90,000 (621)	106,814 (736)	110,300 (760)
Elongation (%)	7-9 depending on bar size	12.4	12.9

Findings & Observations
Structural Analysis

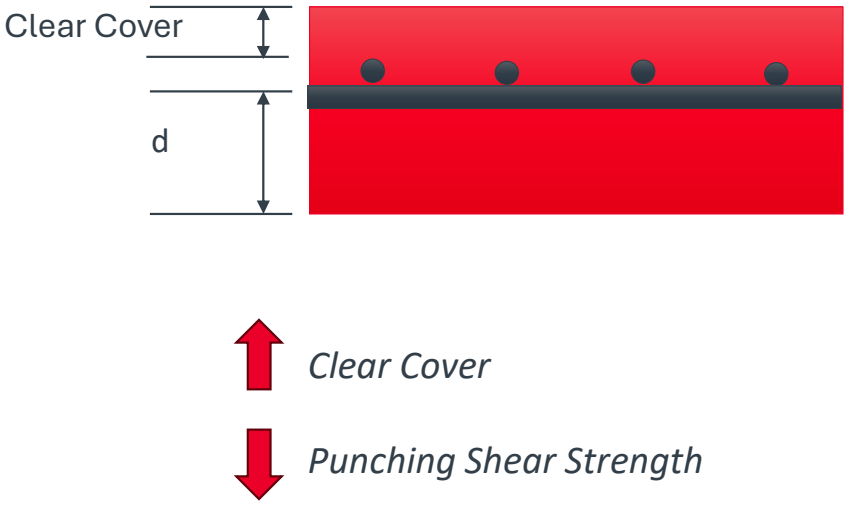
Punching Shear Failures



Pool Deck Slab Distress

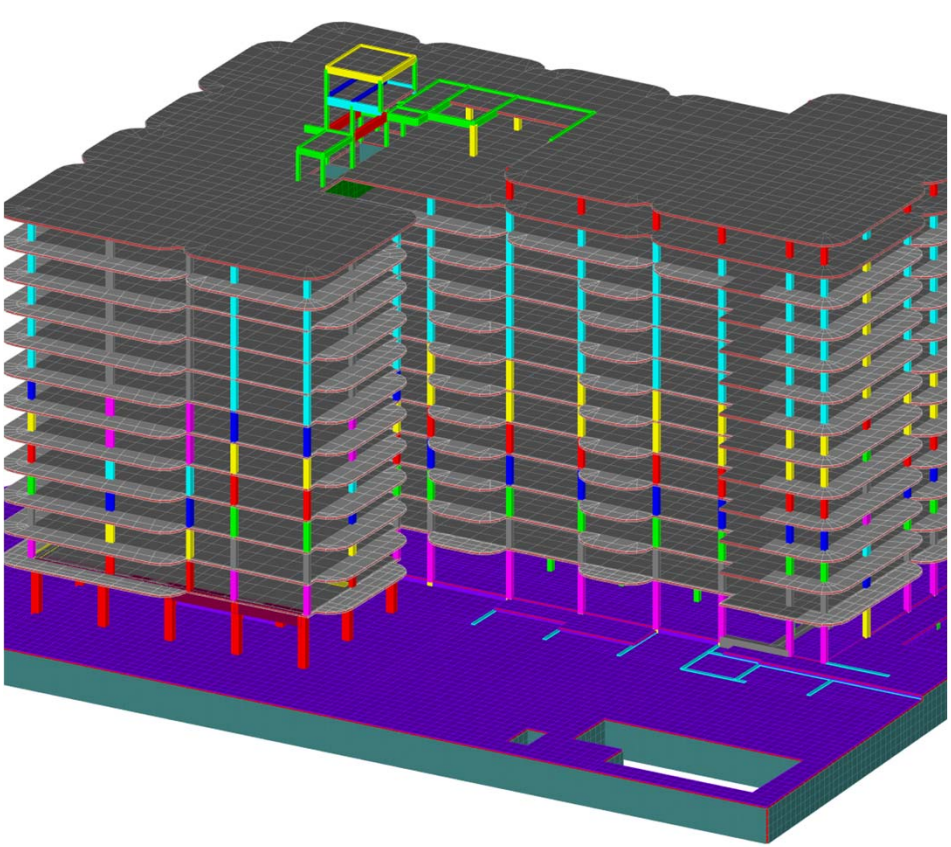


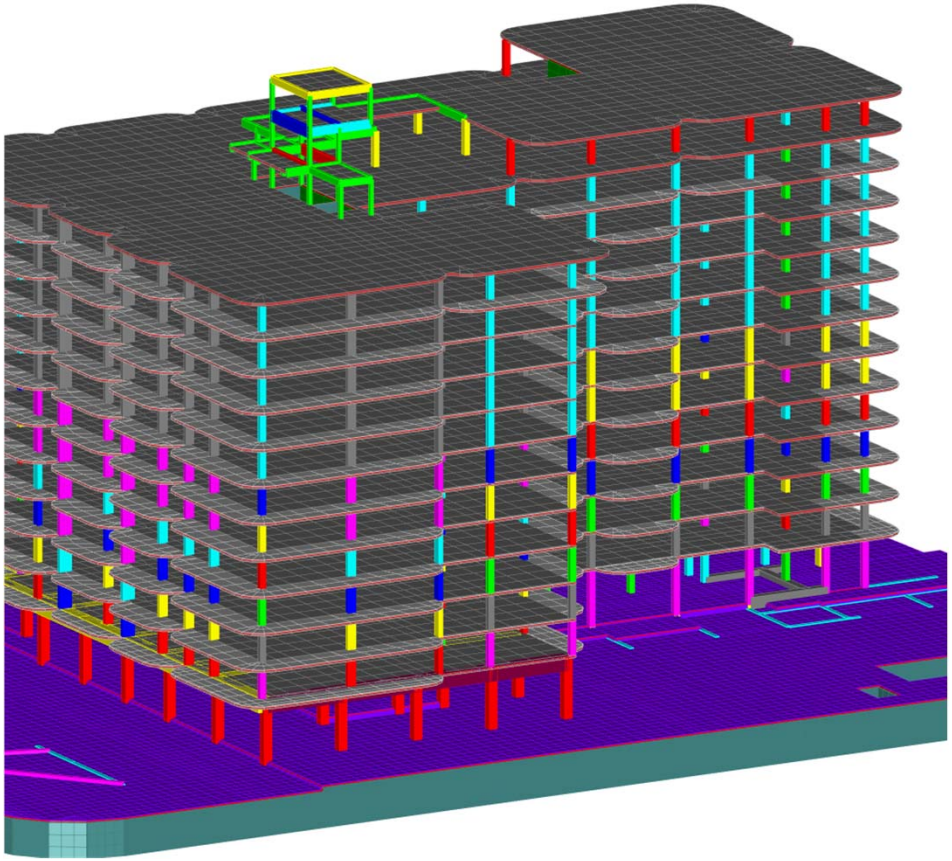
Punching Shear



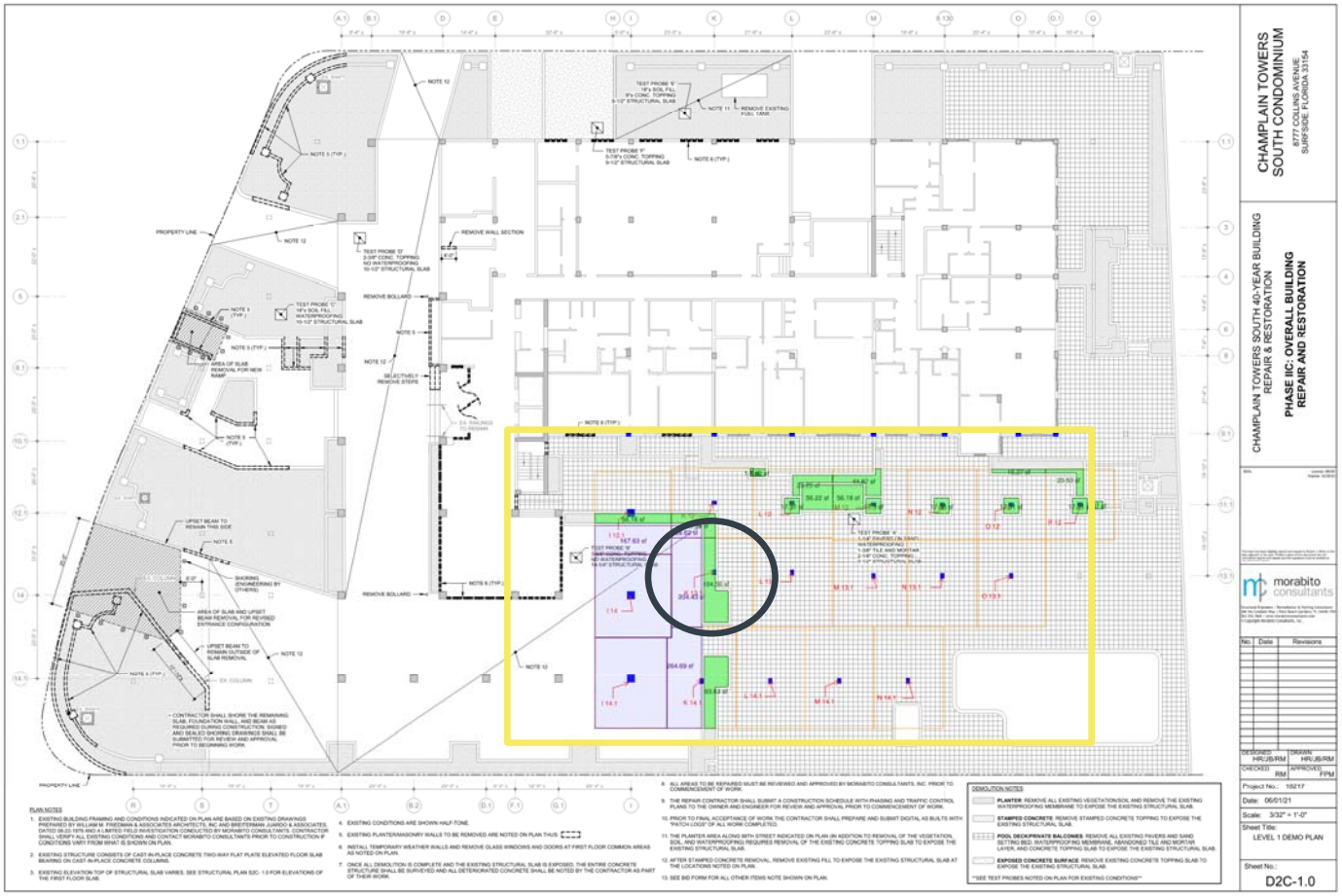
- Punching Shear
  - Dependent on slab depth and concrete strength
  - $V_c = \mathbf{4}\sqrt{f_c'}b_o d$
- Current research shows that:
  - Dependent on flexural reinforcement and slab thickness
  - A coefficient of 4 may be unconservative for low reinforcement ratios

Full Building – Finite Element Model

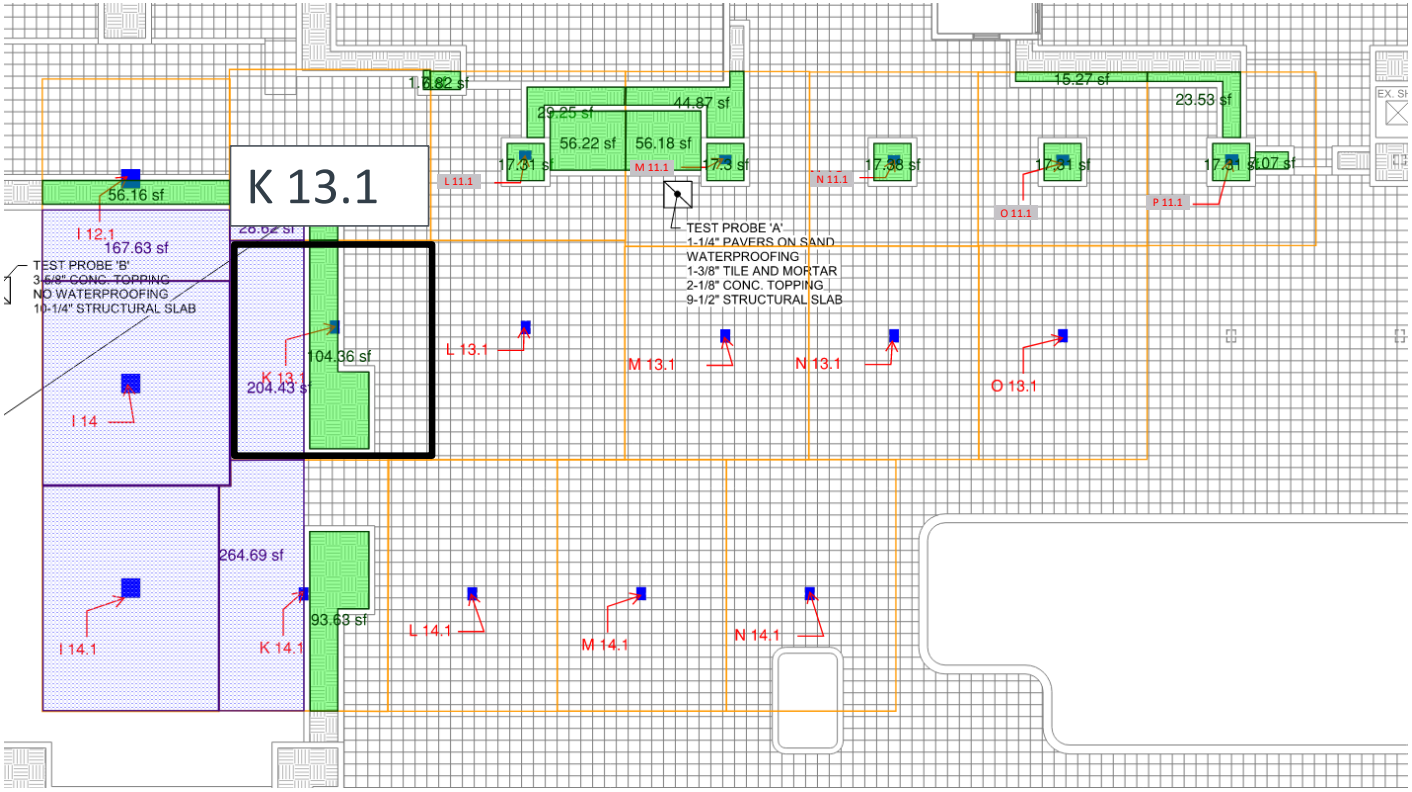




Pool Deck – At Collapse



Pool Deck – At Collapse



Pool Deck Punching Shear (Column K 13.1)

$3\sqrt{f_c'}$

As Designed (safety factor)	K 13.1
Size (in x in)	16x12
Nominal f'_c (psi)	4000
Clear Cover (in)	0.75
Factored Load (kip)	266
Reduced Nominal Capacity (kip)	155
Demand to Capacity Ratio	**1.72**

At Collapse (no safety factor)	K 13.1
Size (in x in)	16x12
Estimated f'_c (psi)	5000
Clear Cover (in)	2.13
Estimated Load (D) (kip)	128
Nominal Capacity (kip)	150
Demand to Capacity Ratio	**0.85**

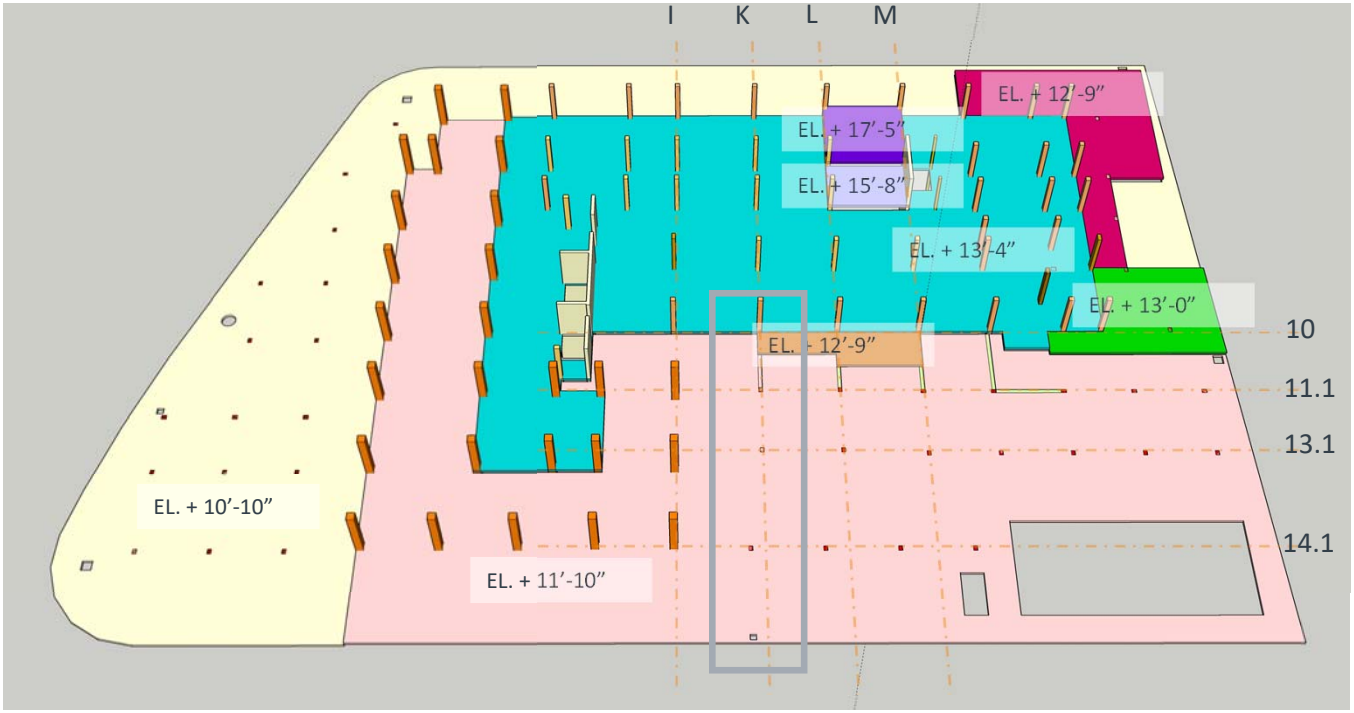
Demand to Capacity Ratio > 1 = BAD
Demand to Capacity Ratio < 1 = GOOD

Lobby Level Slab – Finite Element Model

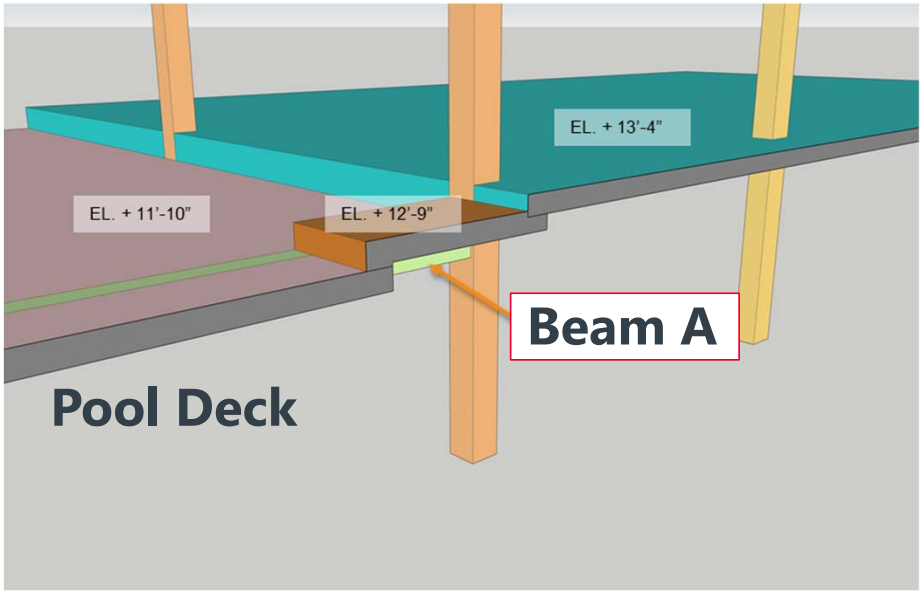
As-Designed Positive Bending, 1.4D+1.7L, Φ = 0.85

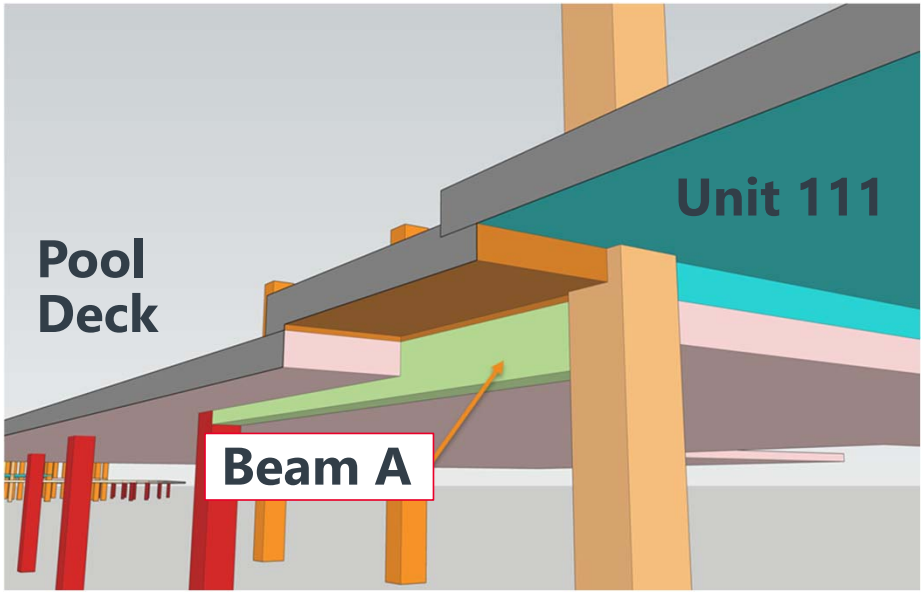
Collapse Theory

Pool Deck/Lobby Level



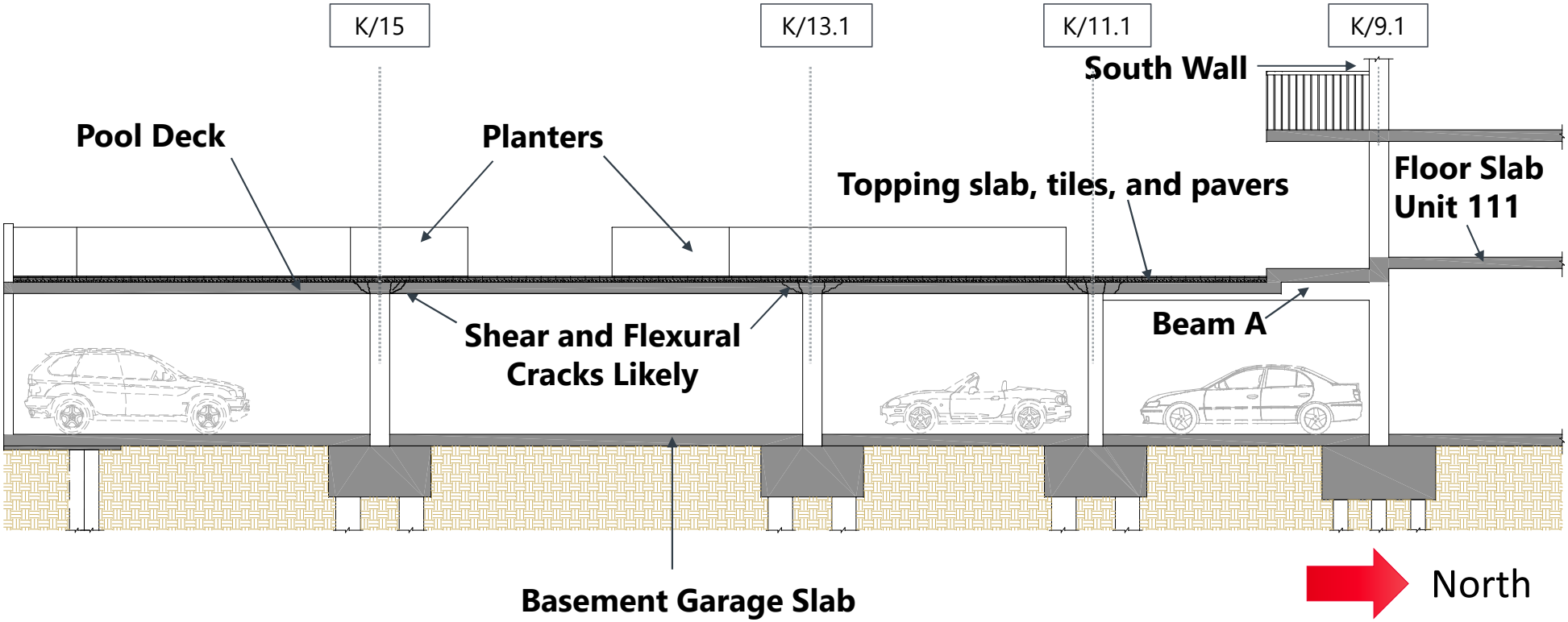
Slab Elevations





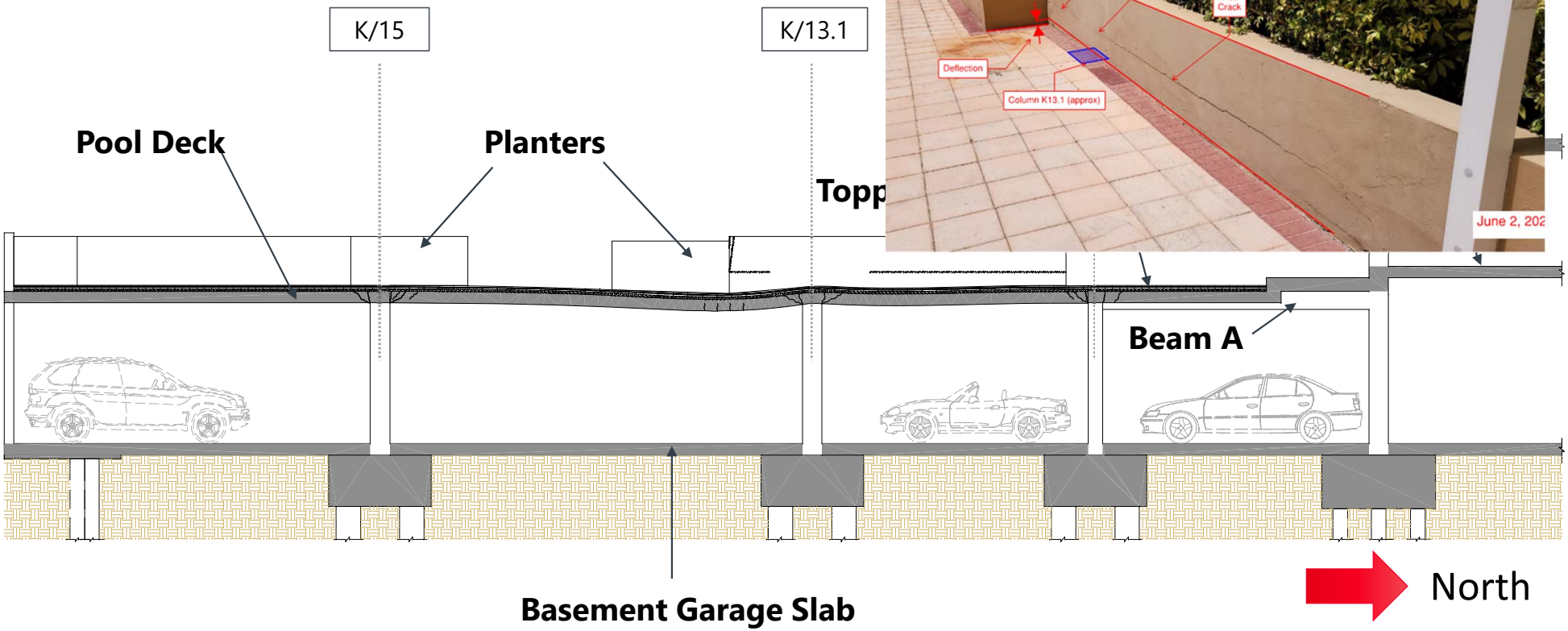
Collapse Hypothesis

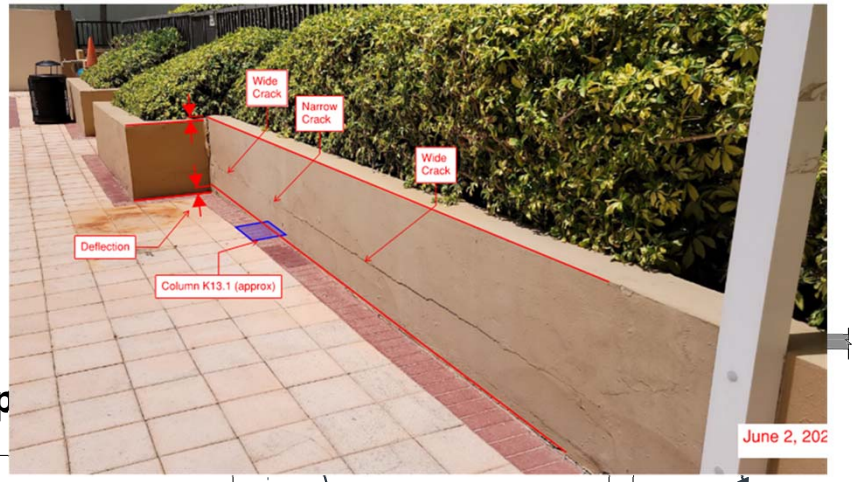
Before April 13, 2020



Collapse Hypothesis

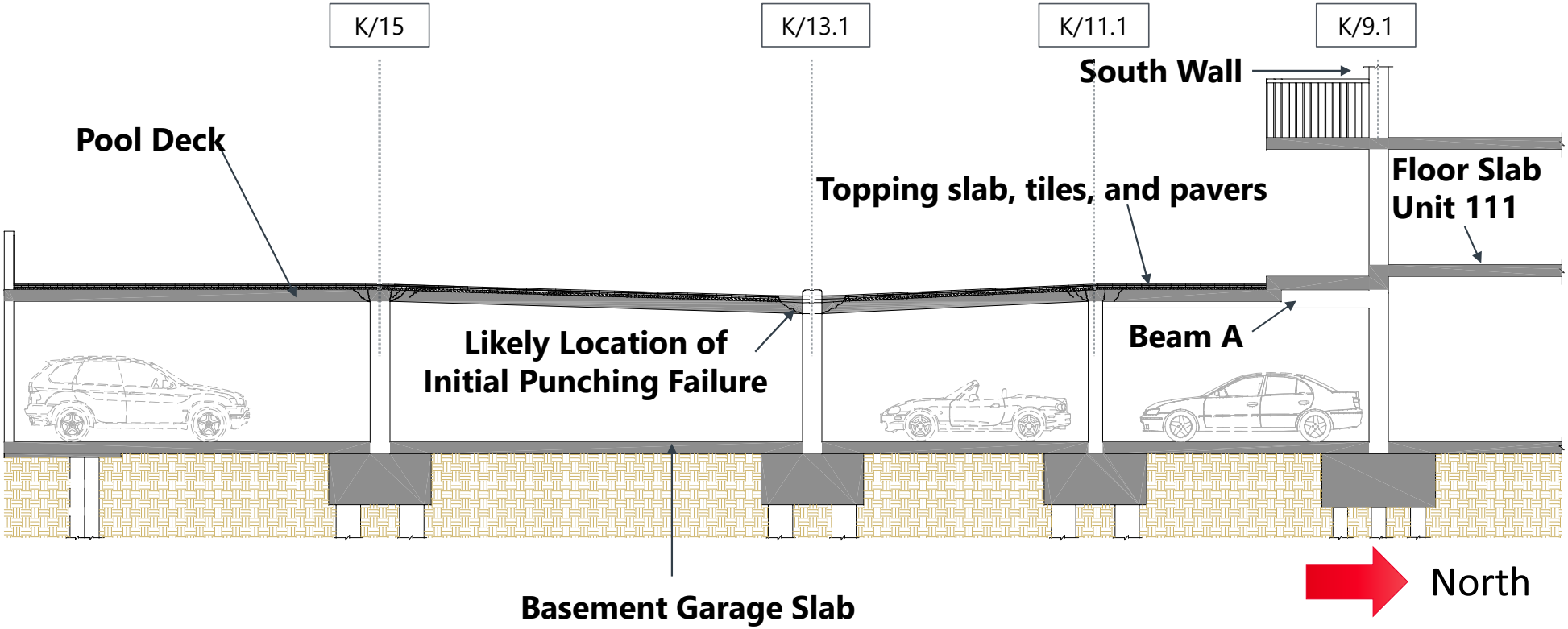
After April 13, 2020 and Before June 2, 2021





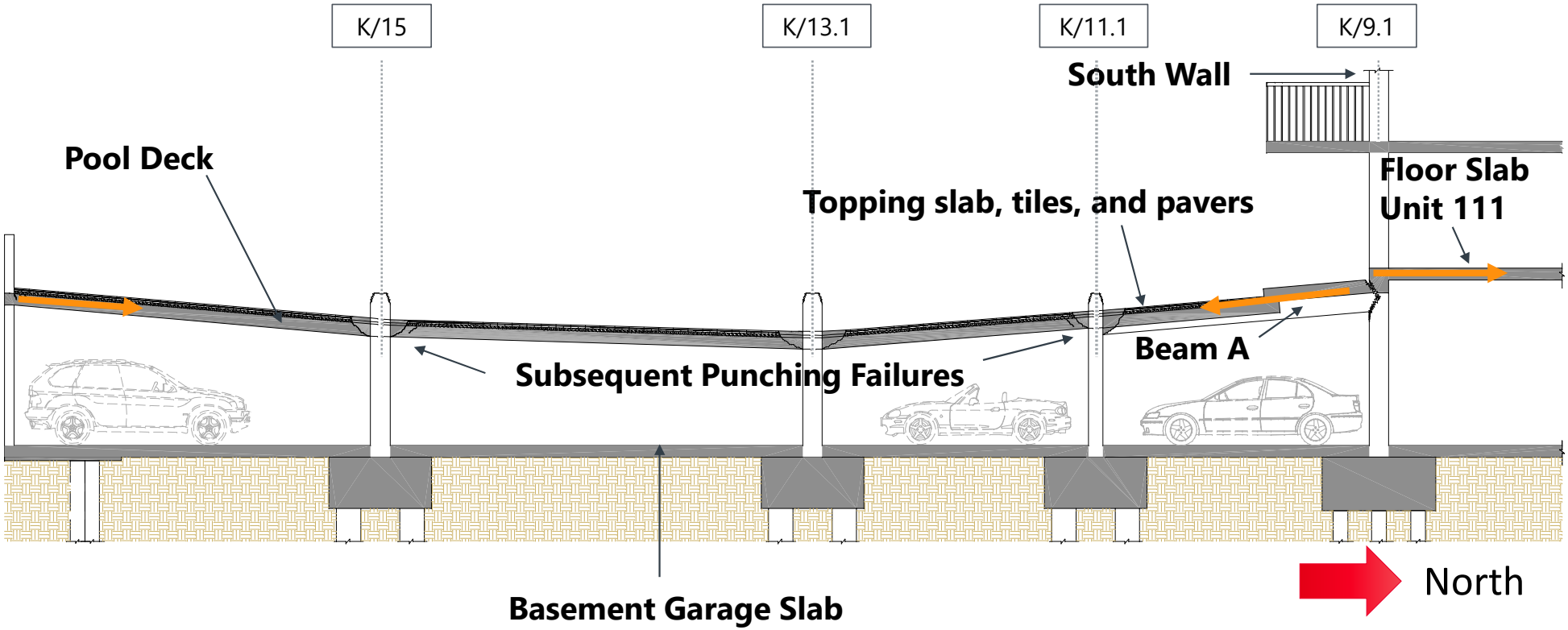
Collapse Hypothesis

June 24, 2021: 1:10 – 1:15 AM



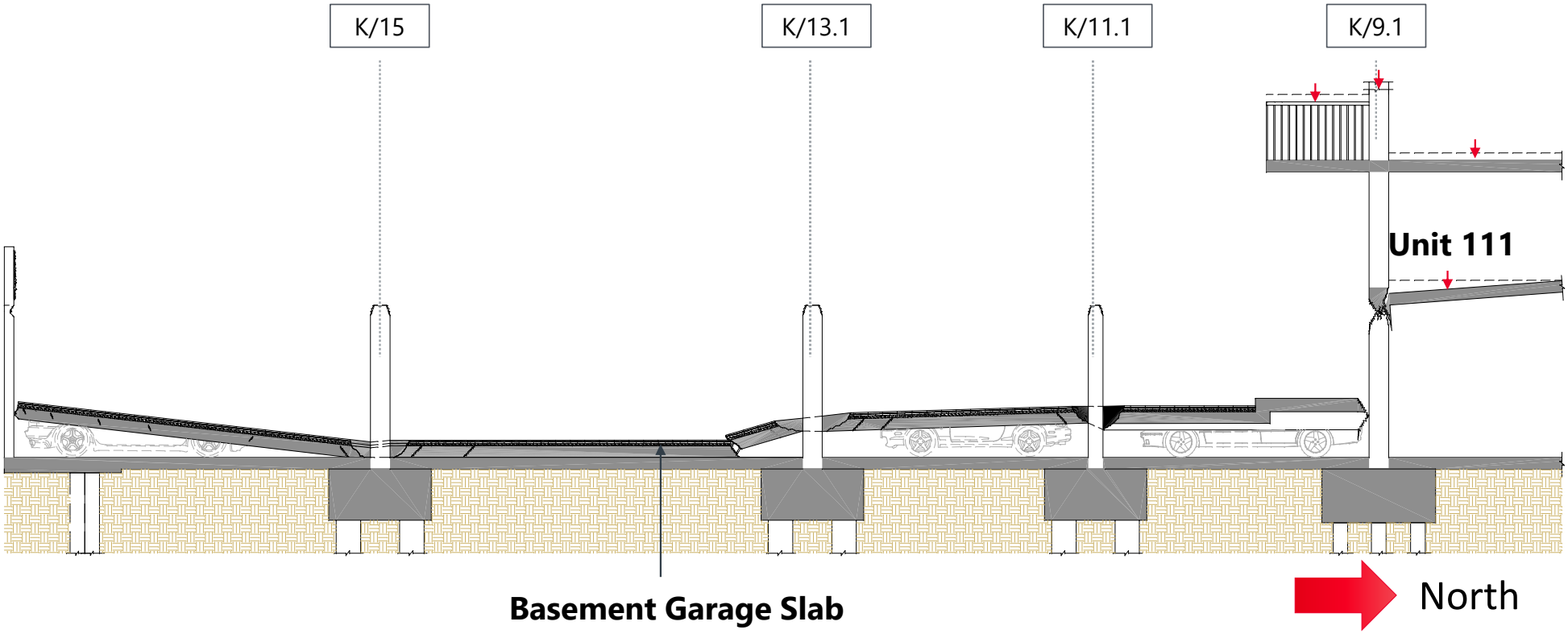
Collapse Hypothesis

June 24, 2021: 1:10 – 1:15 AM

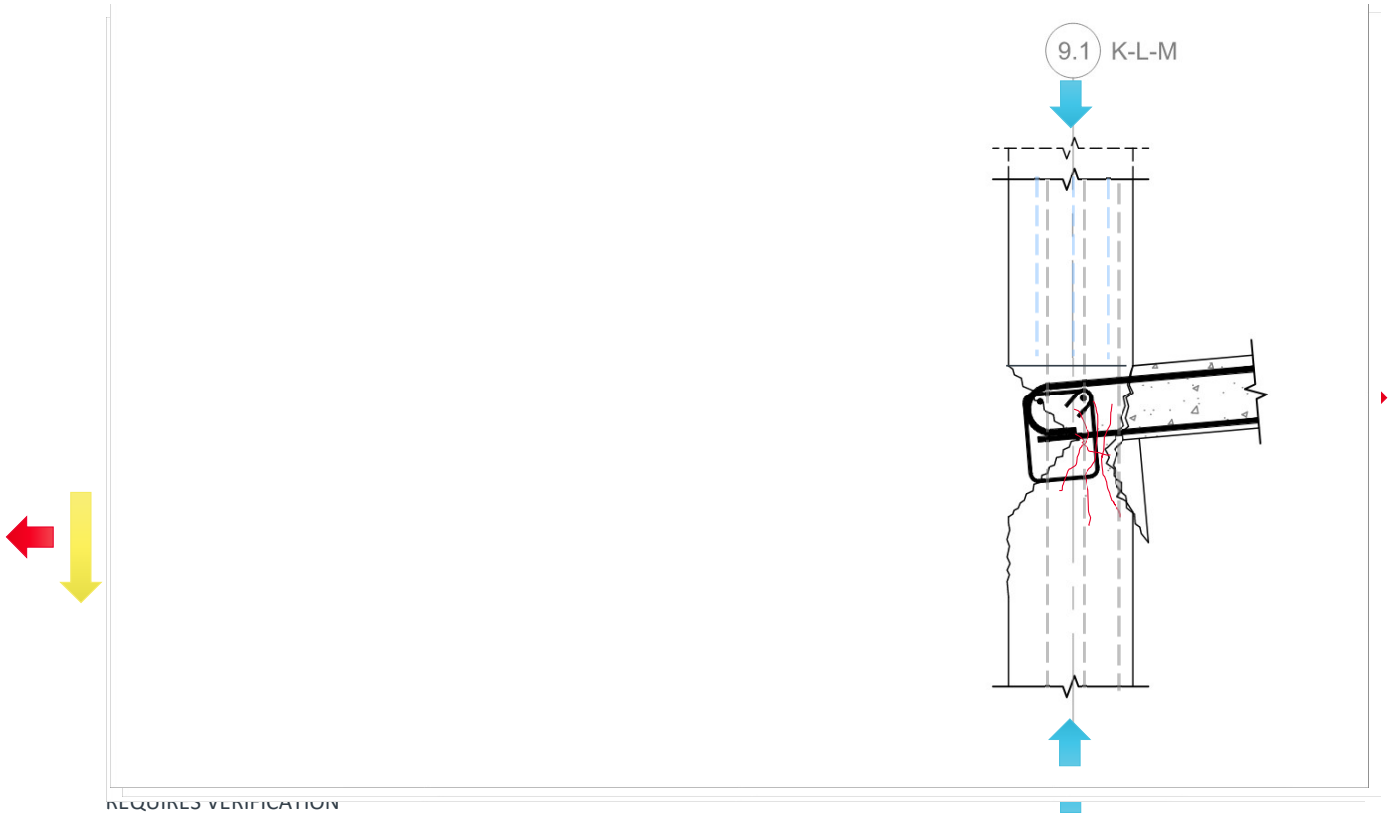


Collapse Hypothesis

June 24, 2021: 1:10 – 1:15 AM

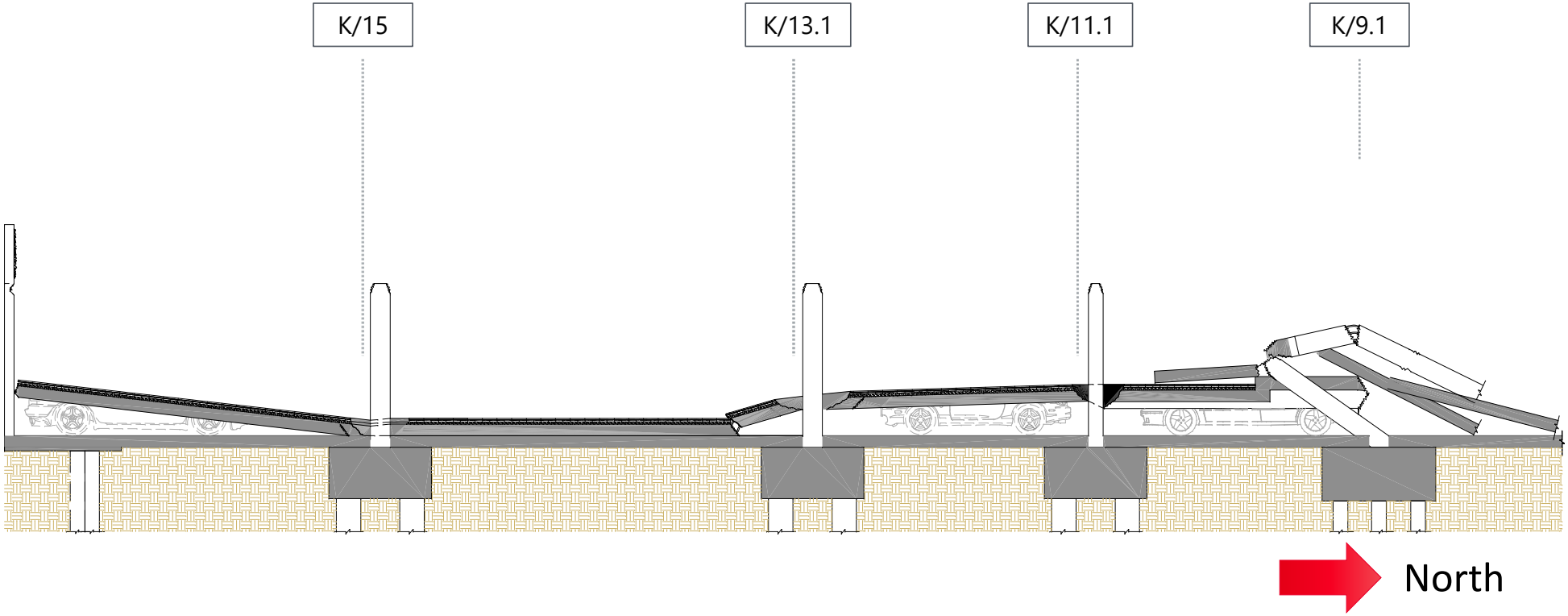


Progressive Collapse Mechanism



Collapse Hypothesis

June 24, 2021: 1:22 AM



Collapse Summary

Mistakes that Appear to have Contributed

Inadequate design of pool deck slab

- Especially punching shear

Excess weight on pool deck

- Original concrete overlay not shown on drawings
- Addition of pavers
- Larger planters than shown on design drawings

Shallow top reinforcement

- Decreasing punching shear strength

Engineers responsible for repairs failed to identify the deficiency

Other Potential Contributing Causes

- Long-term sustained load effects
- Low top flexural reinforcement ratio
  - Code now requires more reinforcement
- Significance unclear
  - Water buildup in planters
  - Corrosion

Judge gives final approval to ‘remarkable’ $1 billion Surfside condo collapse settlement

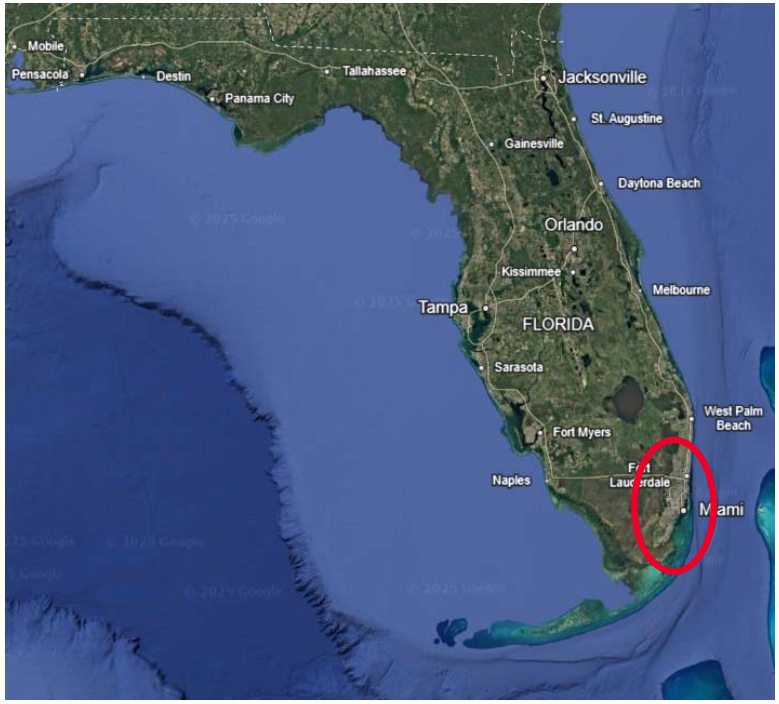
BY LINDA ROBERTSON

UPDATED JUNE 24, 2022 8:48 AM

State of Structural Investigations in Florida

Current Status in Florida

- Miami-Dade/Broward have had structural “Recertification”
- Statewide adoption of “Recertification” (SB-4D and SB 154) after Champlain Towers Collapse.
- Affects all condominiums 3 stories and higher
- Thousands of buildings, ~900,000 units over 30 years old
- This is spreading to other states…



What is Safe?

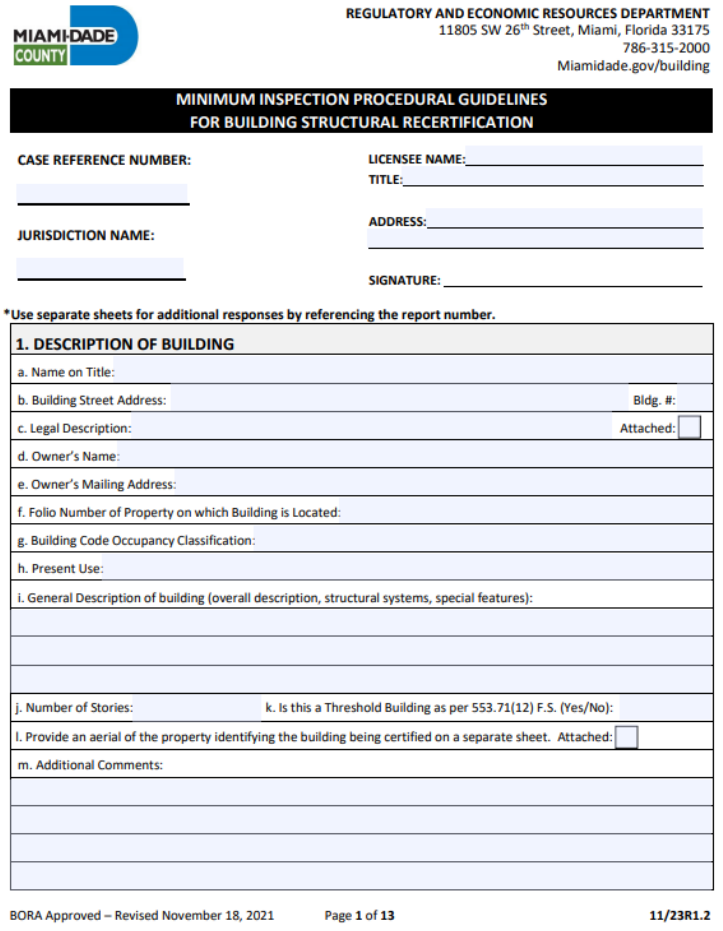
Substantial Structural Deterioration. Means a condition that negatively affects a building's structural condition and integrity or a major structural component whose condition meets the definition of Dangerous. The term does not include surface imperfections such as cracks, distortion, sagging, deflections, misalignment, signs of leakage, or peeling of finishes unless the licensed engineer or architect performing the phase one or phase two inspection determines that such surface imperfections are a sign of substantial structural deterioration.

developed by WJE to meet the requirements of the City of Miami for the recertification inspection for the subject building. The subject building is structurally safe for its use and present occupancy. If you have any questions or require additional information, please reach out to us.

"As a routine matter, in order to avoid possible misunderstanding, nothing in this report should guarantee for any portion of the structure. To the best of my knowledge and ability, this report represents an accurate appraisal of the present condition of the building based upon careful evaluation of observed conditions to the extent reasonably possible."

Recertification Requirement

- Inspections are:
  - Prescriptive
  - Visual-only
  - Limited to observable distress
- Design deficiencies are undetectable without distress manifestation
- Examples
  - Example 1. Actual structural distress is often missed
  - Example 2. Perceived distress can lead to premature recommendations
  - Example 3. Maintenance/non-structural upgrades are often imposed on owners



MIAMI-DADE COUNTY

REGULATORY AND ECONOMIC RESOURCES DEPARTMENT
11805 SW 26th Street, Miami, Florida 33175
786-315-2000
Miamidade.gov/building

MINIMUM INSPECTION PROCEDURAL GUIDELINES FOR BUILDING STRUCTURAL RECERTIFICATION

CASE REFERENCE NUMBER:

JURISDICTION NAME:

LICENSEE NAME:
TITLE:
ADDRESS:
SIGNATURE:

*Use separate sheets for additional responses by referencing the report number.

1. DESCRIPTION OF BUILDING	
a. Name on Title:	
b. Building Street Address:	Bldg. #:
c. Legal Description:	Attached: ☐
d. Owner's Name:	
e. Owner's Mailing Address:	
f. Folio Number of Property on which Building is Located:	
g. Building Code Occupancy Classification:	
h. Present Use:	
i. General Description of building (overall description, structural systems, special features):	
j. Number of Stories:	k. Is this a Threshold Building as per 553.71(12) F.S. (Yes/No):
l. Provide an aerial of the property identifying the building being certified on a separate sheet. Attached: ☐	
m. Additional Comments:	

BORA Approved – Revised November 18, 2021 Page 1 of 13 11/23R1.2

Example 1 - Early 1970's Beam With Shear Cracking

- Noted by eng
  related to the
  - Already ca
    concrete re
  - Original ret
- Engineer's ur
  department l
  of beams
  - No analysi
  - Displacem
- Association
  issue due to

Slide 64

CB1 displacement of over 100 family
Calderone, Brian, 2024-05-29T15:35:55.881

CB2 an unnecessary
Calderone, Brian, 2024-05-29T15:37:07.993

Examples 2 - Late 1970s Building With Excessive Column Tie Spacing

- During extensive structural maintenan CB2 work related to an ongoing recertification
- Tie spacing in colu CB1 ns was found to be greater than the current code-prescribed minimums
  - Invasive and unsubstantiated investigation
- Engineer drafted a letter recommending conditional occupancy without a proper analysis or understanding of the significance CB3
- Column tie spacing has a minor effect on columns dominated by axial loads (<5% of capacity)

CB1 current
Calderone, Brian, 2024-05-29T15:38:30.820

CB2 invasive and at time unsubstantiated
Calderone, Brian, 2024-05-29T15:38:57.462

CB3 without understanding or substantiating the significance (or lack thereof) of the condition identified.
Calderone, Brian, 2024-05-29T15:42:08.203

CB4 As most columns do, these column had substantial ritual capacity (as built D/C well below 1.0), meaning this slight reduction in capacity had no significant impact on the column's ability to carry minimum code loads, and no action was required.
Calderone, Brian, 2024-05-29T15:57:53.864

Example 3 – Excessive Maintenance Level Upgrades

- 40-year assessment noted maintenance level distress; the engineer required $ 30 M+ maintenance upgrades
  - No structural deficiencies, laboratory evaluation, or analysis conducted
- Engineers cannot mandate work
  - Waterproofing can alter the architectural characteristics
  - Significant upfront costs burden owners
  - Some owners may prefer architectural considerations over maintenance-level performance

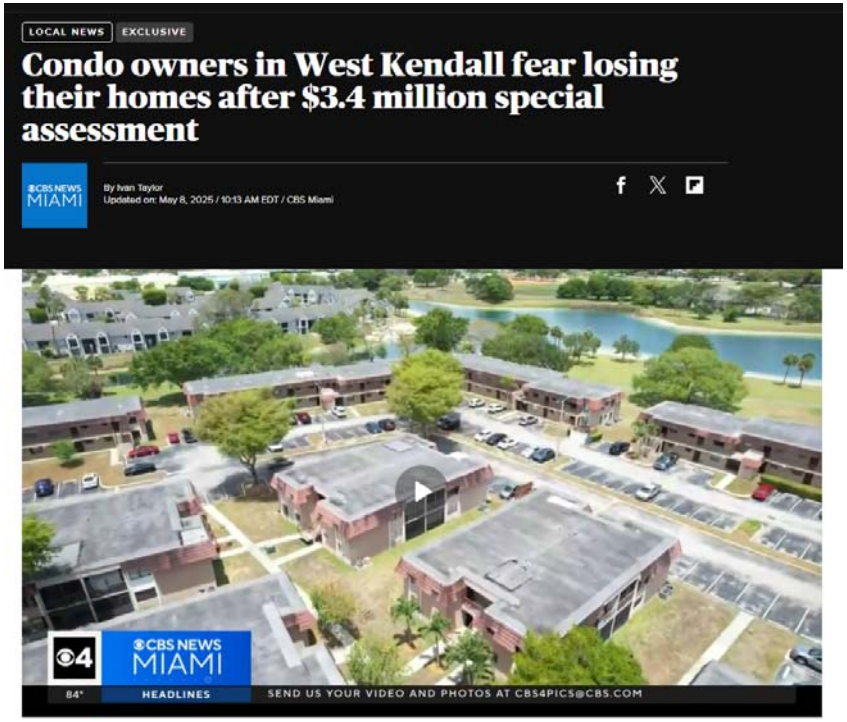
CB1 without identifying any conditions that currently fail to meet the applicable building code requirements.
Calderone, Brian, 2024-05-29T16:00:14.009

CB2 While buildings generally need to be maintained,
Calderone, Brian, 2024-05-29T16:01:01.073

CB3 Recommending repair options and requiring repairs are not the same thing.
Calderone, Brian, 2024-05-29T16:01:46.809

We must recognize that engineers:

- Can fail to recognize the significance of observed distress
  - Future standards and guides should promote critical thinking
- Do “drive-by” assessments to get
  - Maintenance-level repair
  - Construction inspections and administration work
- Owners do not always understand the statutory requirements of the codes/standards
  - Engineers should protect owners from unnecessary and costly repairs
  - Best practice ≠ Required
  - Substantiate the need for structural repairs/retrofit appropriately



Most Importantly

- Educate the general public to understand:

Structural Repairs ≠ Maintenance

Maintenance = Best Practice

- No practical assessment can certify that a building is free of structural deficiencies or “safe”

What is Safe Enough?

Acknowledgements

- **Akerman LLP:** Michael Goldberg and Brenda Radmacher
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  - Document review
  - Structural modeling and review
  - Geotechnical consulting

walter p moore

Thank You