Fracture of Glass Panels

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Learning Objectives

1. The different mechanisms by which exterior glass components fail and the associated causes.
2. Potential remedies to mitigate the chance of glass failure and the pros and cons associated.
3. Current New York City Code requirements and potential changes.
4. How other jurisdictions are addressing issues related to glass failure.

FISP/Local Law

- Since 1980, all buildings over 6 stories are required to submit façade inspection reports every 5 years
- 14,500 buildings in FISP Universe
- Unsafe Notifications

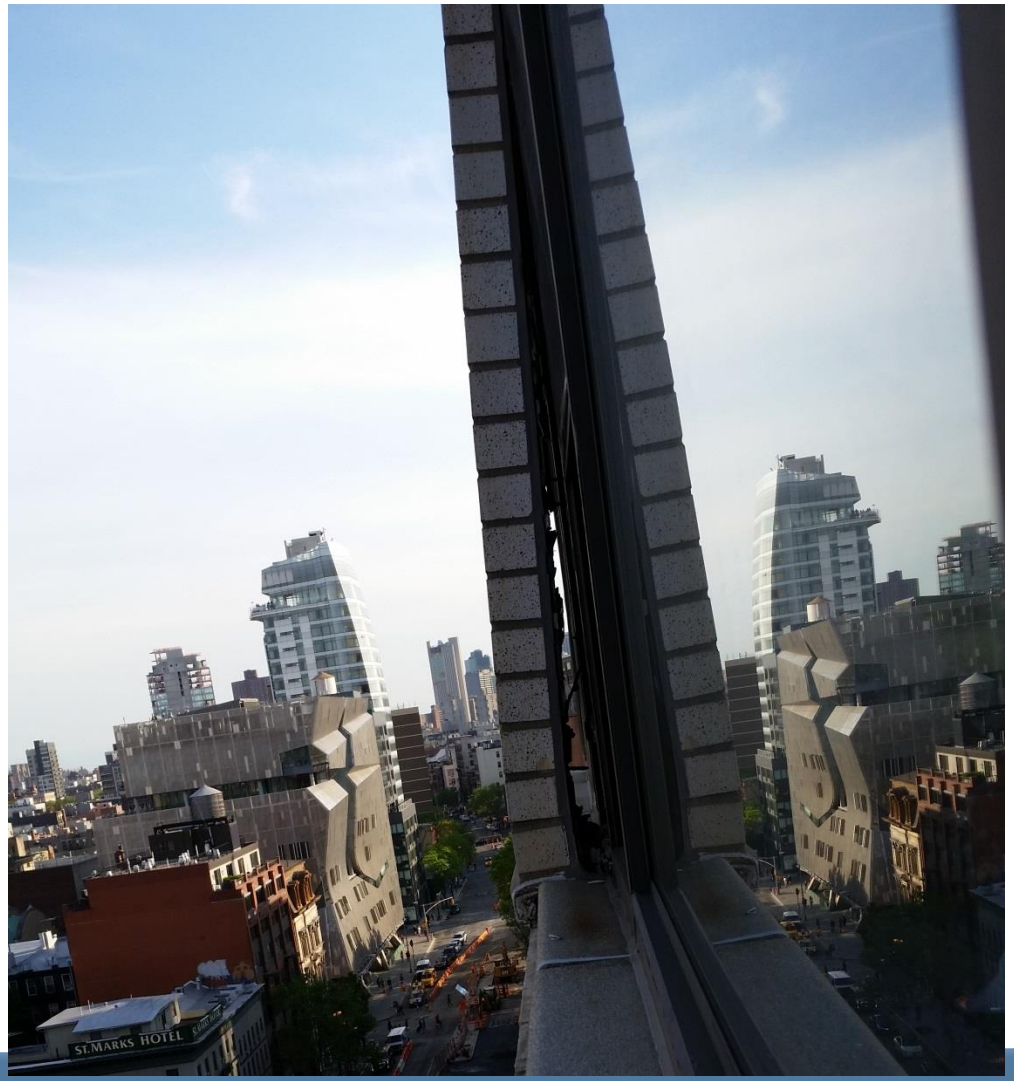
The Big Three

- Terra Cotta
  - Buildings about 100 years old
  - 10 to 30 story
  - Ornate
  - Overhangs
  - Projections

Filed SAFE: T/C sill fell - fatality

The Big Three

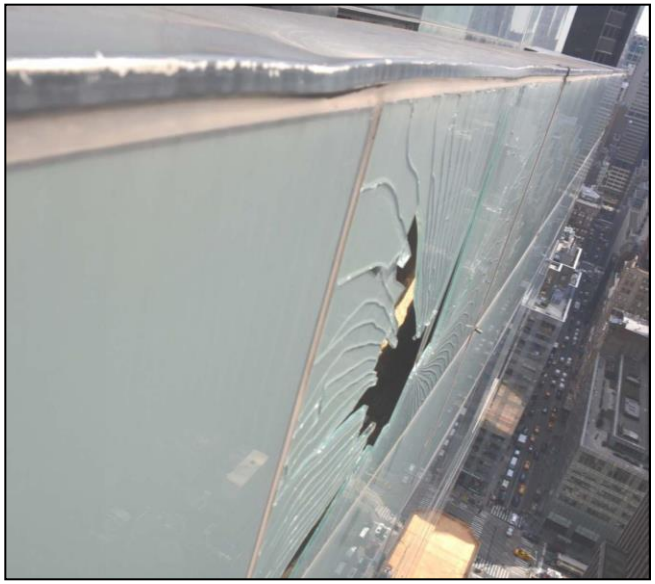
- Terra Cotta
- Cavity Walls
  - Post-war
  - Residential

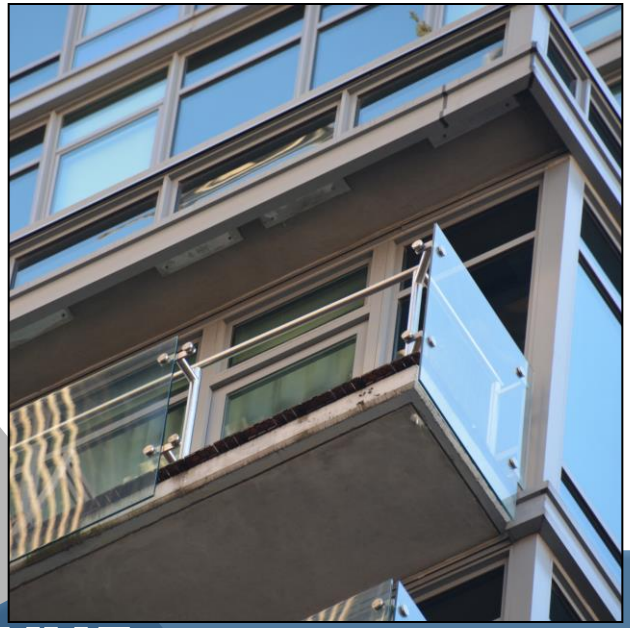


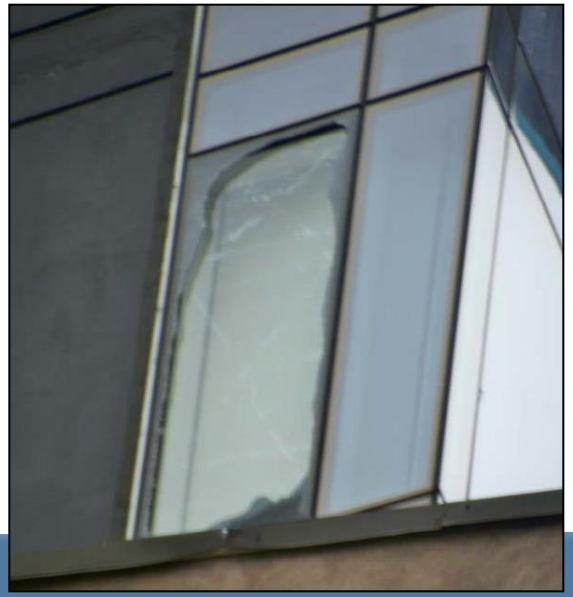
Problem jobs: cavity wall failures

The Big Three

- Terra Cotta
- Cavity Walls
- Glass curtainwall
  - 10 to 30 years old
  - High rise





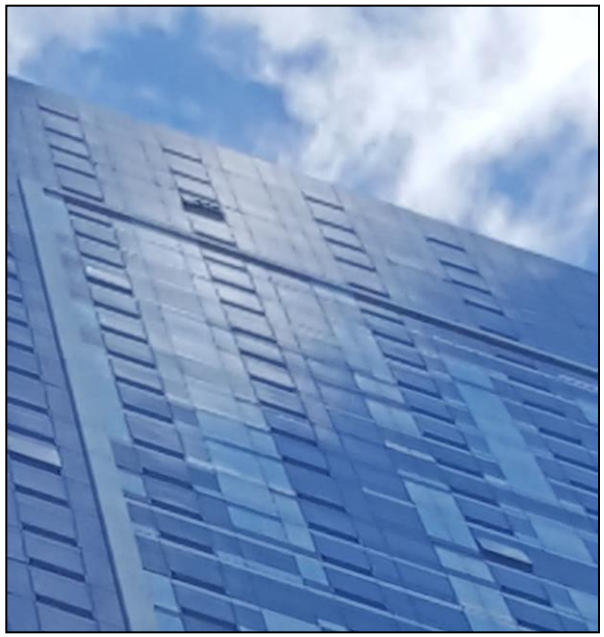


Components of Incident Response

1. FISP inspector and plan examiner go to site immediately
2. Survey condition of façade, interview building staff
3. Take immediate safety precautions: vacates, sidewalk sheds
4. Issue violation obligating owner to have a 100% hands-on inspection performed by a professional in a timely fashion

Case #1: Failure due to Impact

- FDNY responds to report of debris falling from a façade; requests DOB
- What we found:



Case #1: Investigation

- FISP unit orders 100% hands on inspection by professional and assessment of possible causes
- In the meantime…DOB receives email from occupant of the apartment with these photos

Case #1: Outcome

- It was determined the initial crack was caused by the house window washing rig
- DOB inspectors found similar cracks on other panels
- Full repair pending

Case #2: Hardware failure

- Site Safety Manager reports 6th Floor window “blew out”
- Building was undergoing repair – DOB BEST squad serves partial Stop Work Order
- Glass and frame had blown off the building

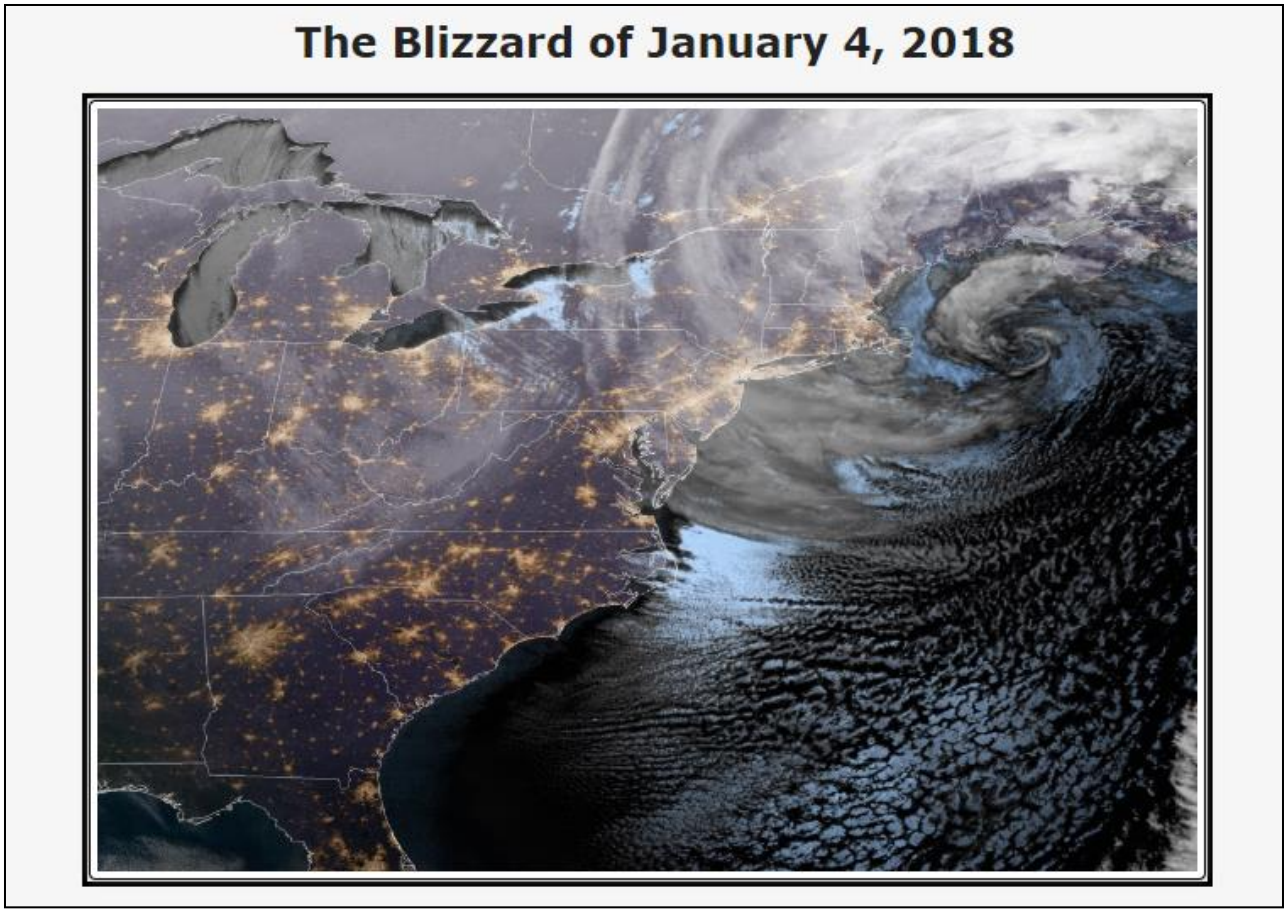
Case #2: Inspection

Case #2: Hardware

- Site Safety Manager reports 6th Floor window "blew out"
- Building was undergoing repair – DOB BEST squad serves partial Stop Work Order
- Glass and frame had blown off the building
- Referred to FISP unit where we order
  1) 100% hands on investigation and evaluation
  2) All documents relating to curtainwall installation

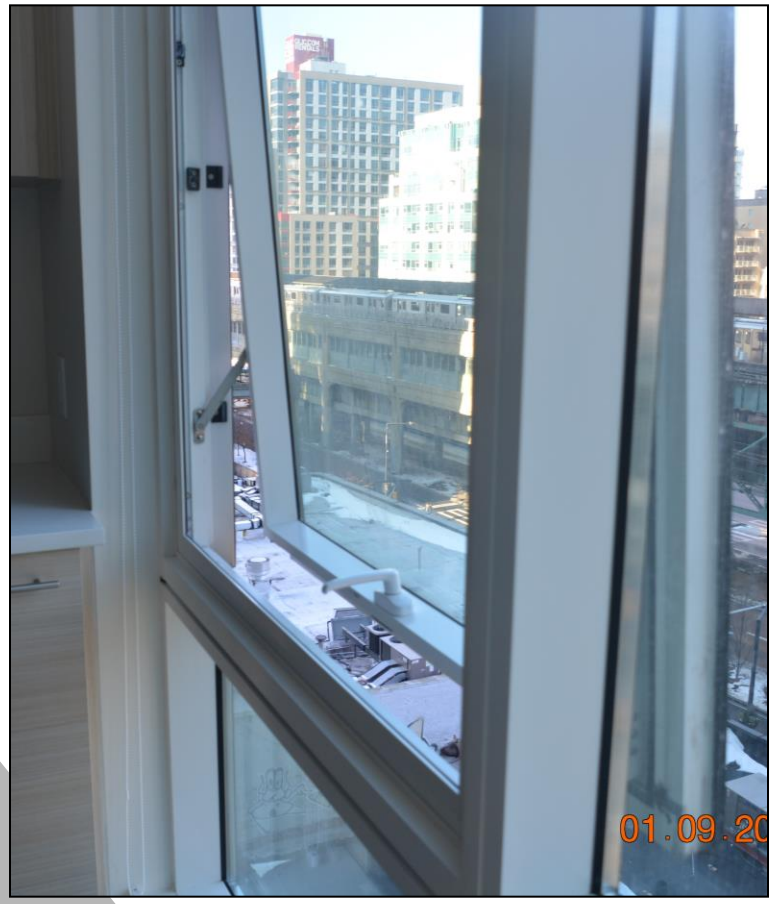
Case #2: Investigation

Weather during incident?



Case #2: Investigation

Window had been left in “open” position – 4”



Inspection protocol for Operable Windows:

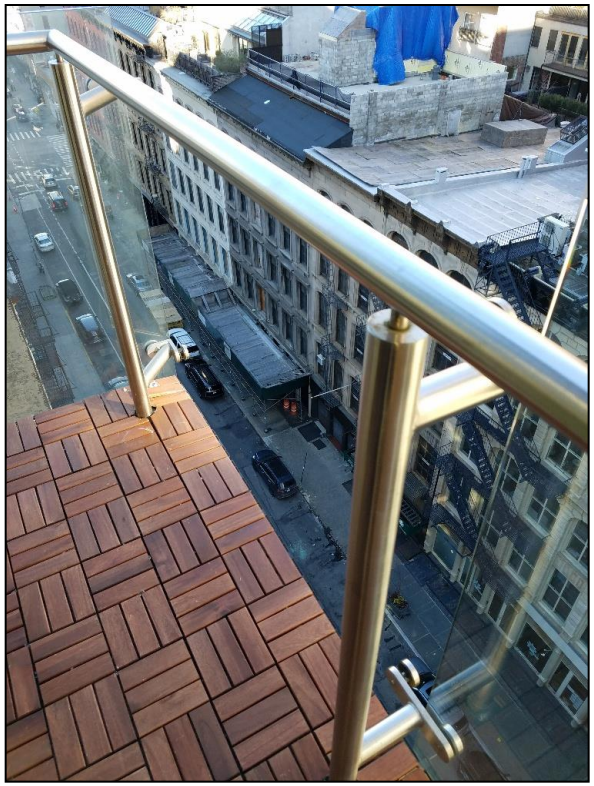
- Exterior glass surface
- Structural and weather seals on sash for voids
- Vertical gasket on outside of sash
- Horizontal gasket on bottom of sash

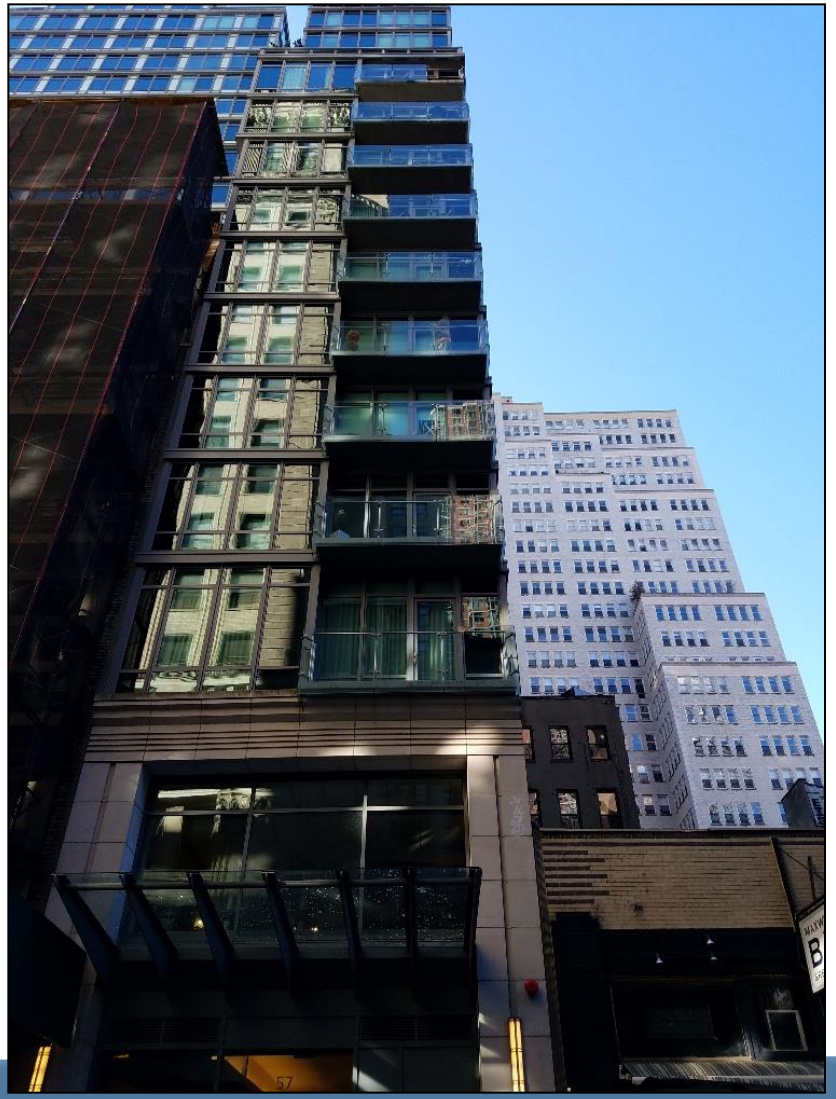
Case #2: Outcome

- Within 2 months after incident, all windows inspected and maintenance repairs completed
- Overall 60% of rain shed gaskets replaced
- No structural damage
- It was determined the incident was due to hardware failure

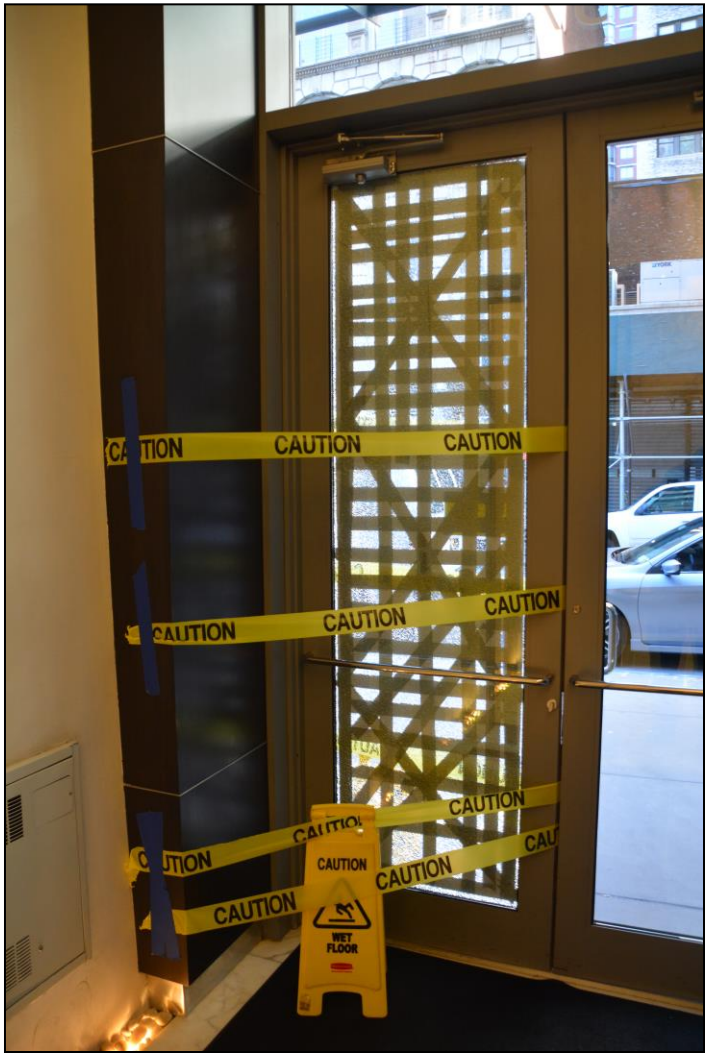
Case #3: Installation/Detailing

Thanksgiving Morning





Case #3: When we got there



Case #3: Enforcement

- Vacate all balconies and gym
- Install sidewalk shed
- 100% hands on inspection and evaluation

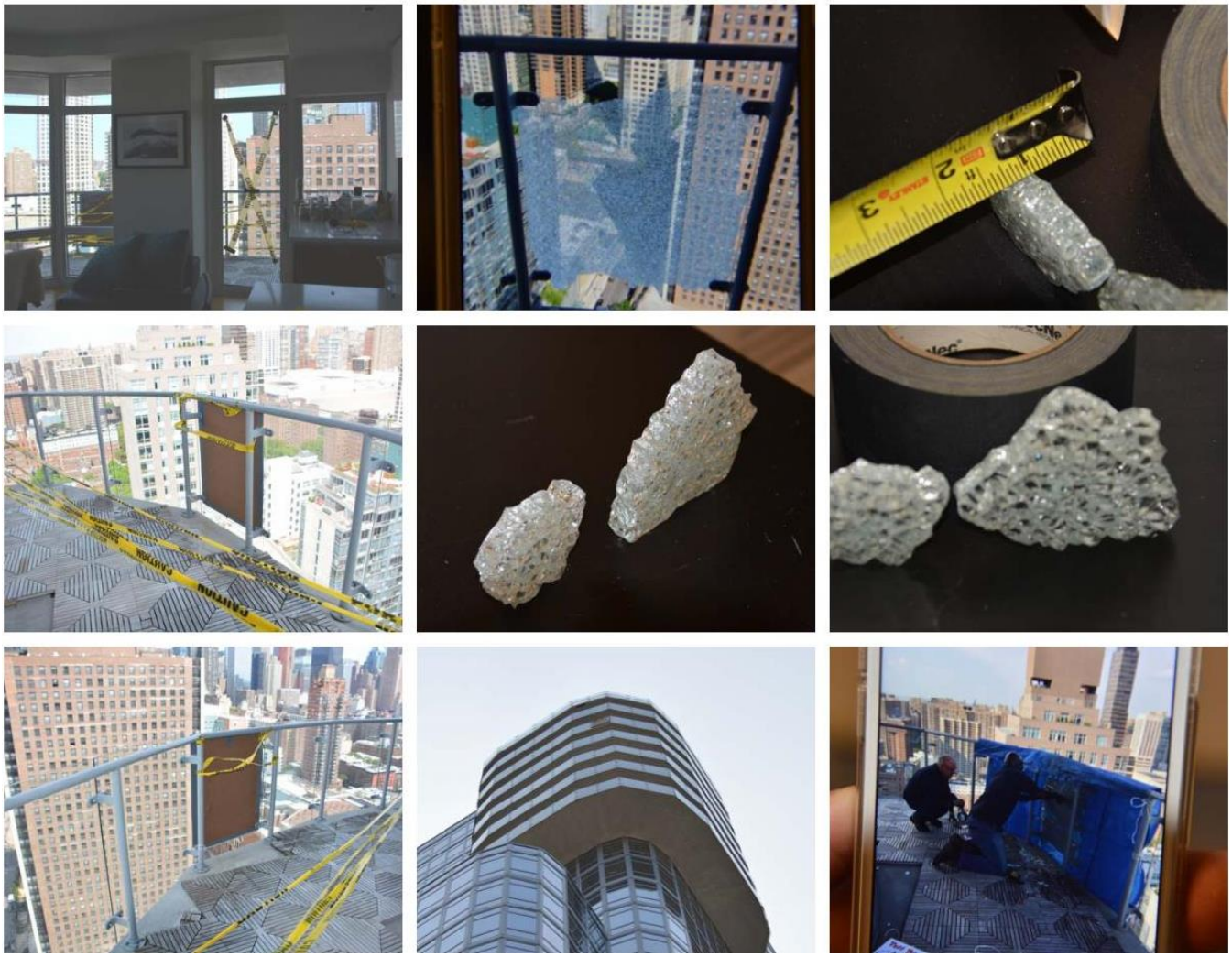
Case #3: Investigation

- Aluminum post and rail system with clamps welded to posts
- Glass panels secured with gaskets, screws, and washers

Almost all conditions varied:

- No. and size of rubber gaskets
- height and angle of glass panels
- Tightness of screws

Case #4: Failure due to Poor Construction



Case #4: Investigation

Professional pursued three possibilities:

1. Impurity inclusion
2. Contact between glass and metal
3. Physical damage to surface of glass panel

Damage due to inclusions ruled out by laboratory tests

Case #4: Cause

Construction Deficiencies:

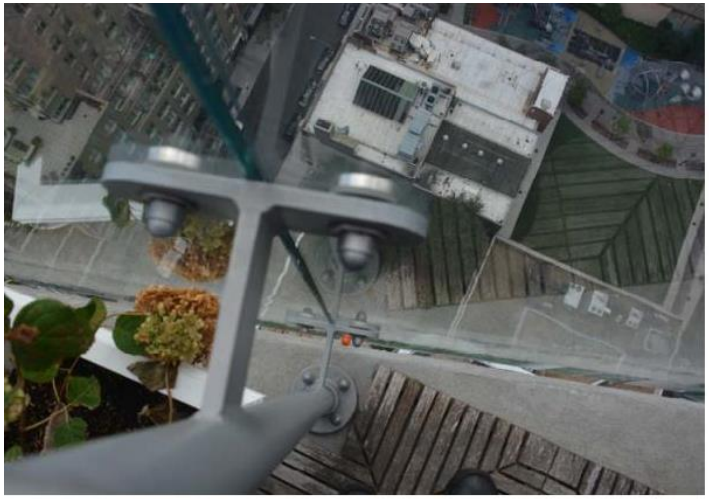
- Displaced/short gaskets
- Spalled concrete in close proximity to glass panel
- Many cases of distance between concrete slab and glass panel = ¼” (Design called for 2”)
- Deflection of balconies touching glass

Case #4: Outcome

24 scaffold drops

- 15 glass panels replaced
- Gaskets repaired at 51 locations
- Removed and reinstalled 132 glass panels to patch concrete spalls

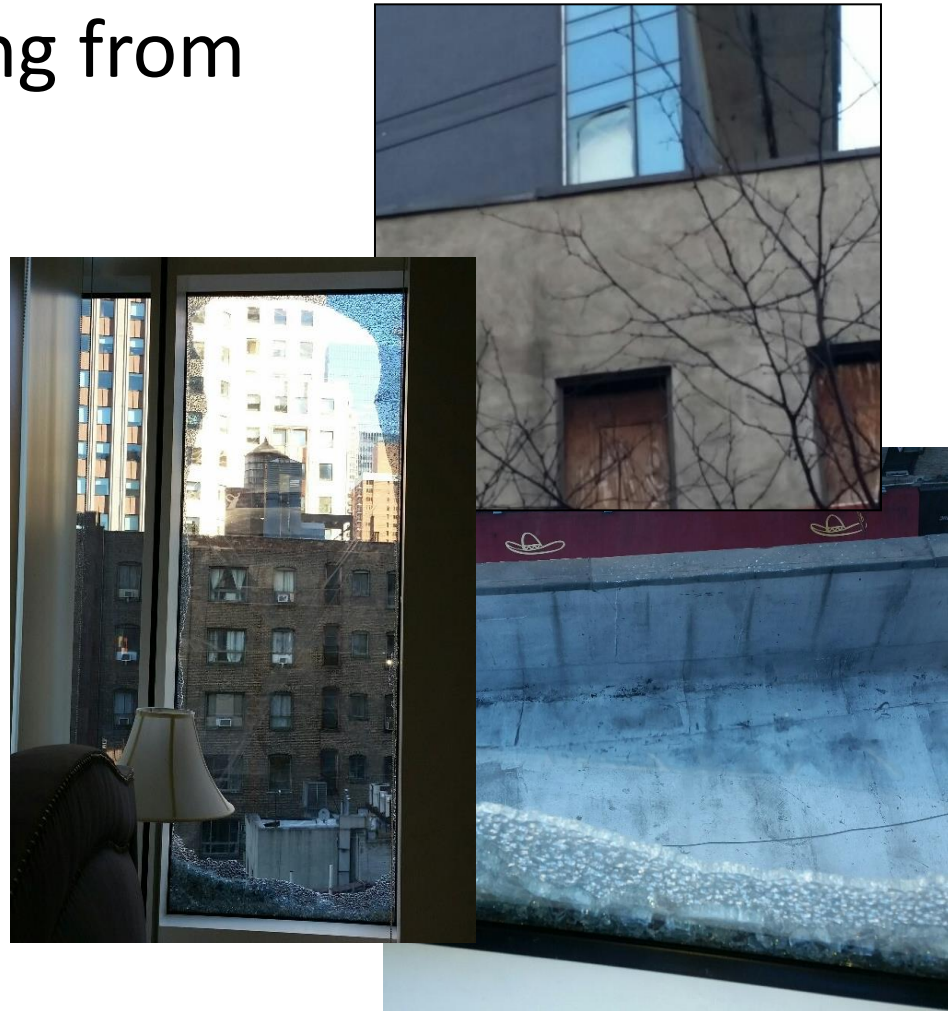
Case #4: Outcome



Case #5: Impurities inclusion

EOC report of glass falling from penthouse of a building

“Double pane insulated glass, approximately 2'X 5' had exterior pane shatter and fall onto adjacent roof”



Case #5: Investigation

- Violation for “failure to maintain” served by ERT
- QEWI followed up with unsafe notification to DOB (required by law)
- History of similar cases of spontaneous breakage going back 10+ years
- 100% hands on investigation

Case #5: Outcome

- *Likely* NiS inclusion
- Difficult to pinpoint as a cause
- In any case this building's glass breakage rates were about 0.08%
- Impact on evaluating legislation

Current NYC Code Requirements

Guards

- Single fully tempered glass
- Laminated fully tempered glass
- Laminated heat-strengthened glass
- Infill panels shall be an approved safety glazing
- No detailing requirements

Current NYC Code Requirements

Breakage

- Load Resistance Factor per ASTM E 1300
- ASTM E 1300 within Load Resistance has a breakage probability less than or equal to 8 lites per 1000 under applied load.

1968 code had a statistical probability table for breakage under applied load.

Other Jurisdictions – IBC 2015

Guards

- Laminated glass fully tempered
- Laminated glass heat strengthened
- Infill panels shall be an approved safety glazing
- No detailing requirements

Breakage Requirements – no change

Other Jurisdictions – Localities

Chicago – did not adopt Chapter 24

Seattle – adopted IBC 2015 with edits to match IBC 2018

San Francisco/California – adopted IBC 2015 with minimum glazing requirements and section for Structural sealant glazing

Other Jurisdictions – Toronto

Expert Panel on Glass Panels in Balcony Guards dated June 2012 recommendations

Detailing requirements:

Glass to hard surface contact must be avoided.

Allow sufficient movement under deflection and movement under loads and temperature changes.

Other Jurisdictions – Toronto

Expert Panel on Glass Panels in Balcony Guards dated June 2012 recommendations

Use of laminated glass that is heat strengthened.

Code Modifications Recommendations

Adopted IBC 2015 with modifications in IBC 2018

Require both baluster and infill panels be laminated.

Require detailing requirements for movement under deflection and movement under loads and temperature changes.

Code Modifications Recommendations

Breakage probability limits for both applied load and spontaneous breakage

Thank you for your time!

QUESTIONS??

This concludes The American Institute of Architects Continuing Education Systems Program