

FAÇADE FAILURES IN HIGH RISE BUILDINGS

presented by

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DESCRIPTION

This presentation will provide an overview of New York City Building Code chapters 14, 16, 21 & 24 pertaining to façade failures and discuss the responsibilities of professional consultants once failures are identified. Case studies will be used to analyze the underlying causes behind façade failures. Approaches used by other jurisdictions such as Toronto, California and Chicago to remedy similar conditions will be examined and potential changes to the New York City Building Code will be explored.

LEARNING OBJECTIVES

At the end of this presentation, you will be able to:

- Review New York City Building Code and discuss potential changes pertaining to façade failures.
- Explain the responsibilities of professional consultants once failures have been identified in order to prevent accidents.
- Discuss case studies about exterior wall failures and be able to identify specific failure mechanisms.
- Examine and discuss how other jurisdictions mitigate safety concerns for façade failures.

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
 - Call **311** or **911** (**212-NEW-YORK** if calling from a non-NYC area code)
 - DOB NOW

BIG THREE COMMON CONCERNS

- Terra Cotta
- Cavity Walls
- Glass

BIG THREE: TERRA COTTA



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TERRA COTTA

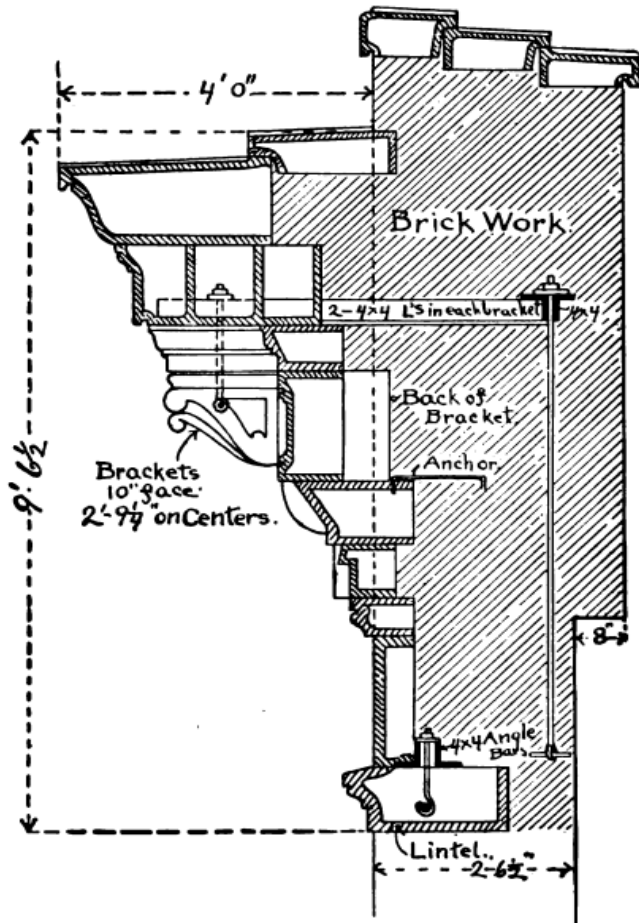


Fig. 174.

- Buildings about 100 years old
- 10 to 30 story
- Ornate
- Overhangs
- Projections
- Complex anchoring systems

WHAT IS TERRA COTTA?

- Latin for **cooked earth**
- Clay and sand molded and fired at high temperatures
- Finished with a glaze
- Comes in different forms:
 - Brownstone
 - Fireproof construction
 - Ceramic Veneer
 - **Glazed architectural** (*our focus*)

WHY IS TERRA COTTA A PROBLEM?

- Often mistaken for granite or limestone
- At the time, everyone thought it would be water resistant...quite the opposite
- Deterioration
 - Crazing
 - Spalling
 - Rusted anchors
 - Mortar (allows more water into cavity)
 - Stress

TERRA COTTA CASE #1



- Built in 1899
- Landmarked
- 14 Stories, mixed use

TERRA COTTA CASE #1



- Sept 2015 – Cycle 8A filed: **SAFE**
- May 2016 – Complaint and violation for cracked TC
- June 2016 – Subsequent filing: **UNSAFE**

TERRA COTTA CASE #1



- August 2017 – Repair work signed off
- Oct 17, 2017 – Filed Amended report with **safe** status
- Oct 20, 2017 – Violation for cracked TC

(report rejected by DOB plan exam after results of the inspection)

TERRA COTTA CASE #1



- **April 2018** – Certificate of Correction Accepted
- **August 2018** – Amended report accepted SAFE
- **January 2019** – Piece of TC fell off the building (violation served)

TERRA COTTA CASE #2



- Built ~1920
- 9 stories
- Hospital/shelter facility
- Filed **Unsafe** 3 cycles in a row

TERRA COTTA CASE #2



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TERRA COTTA CASE #2



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TERRA COTTA CASE #2



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TERRA COTTA CASE #2



How did these pieces come off?

Were they carefully removed under controlled methods?

No. They fell off in an uncontrolled manner.

TERRA COTTA: REPAIR/REPLACEMENT CAMPAIGNS

- Terra Cotta repairs are tricky
 - complex anchoring systems as discusses;
 - if a repair is not done with due care, it can cause more harm;
 - **less is more** – adding a **stronger** material like an epoxy is not necessarily, usually is not, the best thing

REPAIR/REPLACEMENT CAMPAIGNS

- **Must understand the cause of the distress before undertaking repairs**
 - If a piece is broken, do you repair or replace?
 - What is the rationale for each method?
 - Extent of repair
 - Underlying cause
 - Chance of reoccurrence

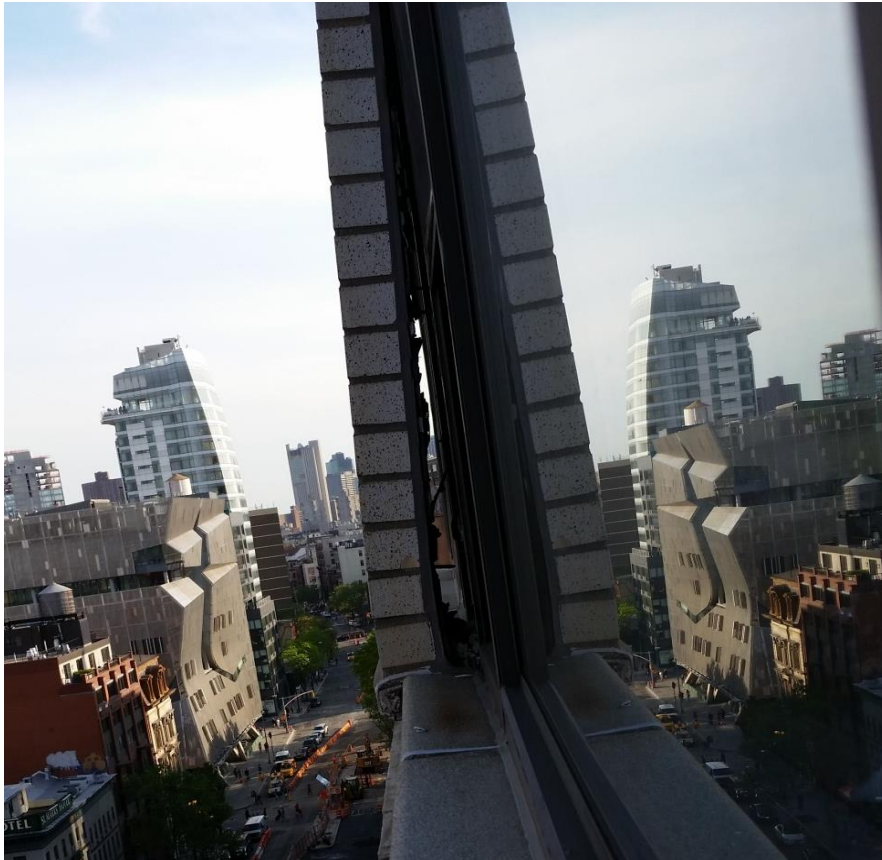
REPAIR/REPLACEMENT CAMPAIGNS

■ Replace

- In Kind
- Stone
- GFRC

Rumor DOB doesn't accept repairs, only replacements. **That is not true.** DOB accepts appropriate repairs done by qualified people under the right conditions.

THE BIG THREE: CAVITY WALLS



East Village condition caught before failure

■ Cavity Walls

- Post-war
- Residential
- * *Not understood by industry early on*
- * *Design, construction and inspection issues. Ties were either not shown on drawings, even though required in the Code, were not installed – if installed, material was mild steel – and inspections were not required.*

WHAT IS CAVITY WALL?

- **Cavity wall.** A wall built of masonry units so arranged as to provide a continuous air space within the wall between the inner and outer wythes (with or without insulating material), and in which the wythes are tied together with metal ties. (1968 Code)
- Corrosion-resistant, steel ties

CAVITY WALLS: WHY IS IT A PROBLEM?

- Many cases of masonry failure can be traced to improper details and workmanship
- Lack of ties
- Inadequate spacing of ties
- Drainage – water in cavity
- Deterioration
 - Rusted anchors
 - Mortar (allows more water into cavity)
 - Stress

CAVITY WALLS: LEVELS OF FAILURE



Upper East Side Cavity Wall Failure

- Surface erosion
- Joint failure, cracked, spalling, or missing bricks
- Deteriorated anchors indicating possible instability of masonry
- Failure of supporting structure – stability of the façade is compromised

CAVITY WALL #1



- Residential building in Queens built in 1963

CAVITY WALL #1



- Two story section of face bricks failed and landed on the ground

CAVITY WALL #1



- Many failures of masonry wall caused by the lack of bond between the outer wythes and backup masonry.
- Omitted or failed ties

CAVITY WALL #1



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CAVITY WALL #1



- Anchors were not installed as frequently as required

OR

- Anchors possibly deteriorated and caused the outer wythe to pull away from the backup masonry

CAVITY WALL #2



CAVITY WALL #2



- The cumulative weight of inadequately anchored wall may cause areas of masonry to buckle outwards.

CAVITY WALL #2



- Stabilization of the area
- Public protective measures installed

CAVITY WALL #2

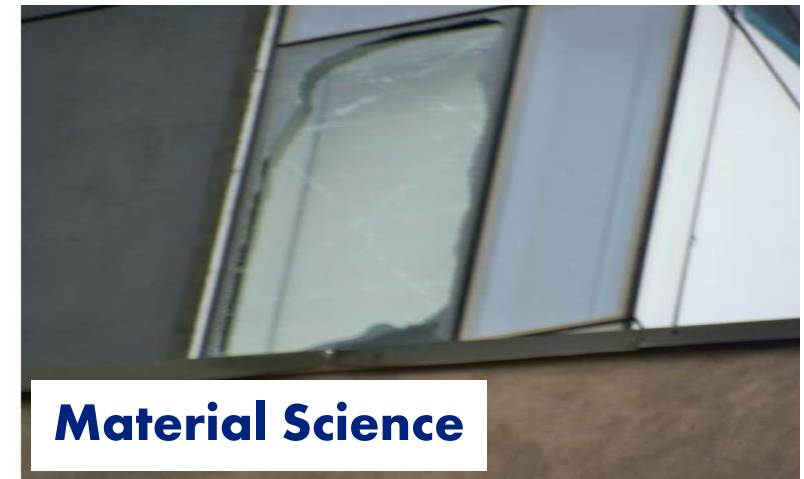


- Removal of unsafe section of façade
- Providing proper anchorage and waterproofing
- Reinstalling face brick to match existing

THE BIG THREE: GLASS CURTAIN WALL

- Glass curtainwall
 - 10 to 30 years old
 - High rise

GLASS CURTAIN WALL: TYPICAL FAILURES



CASE #1: FAILURE DUE TO IMPACT

- FDNY responds to report of debris falling from a façade; requests DOB



- What we found



CASE #1: INVESTIGATION

- In the meantime...DOB receives email from occupant of the apartment with these photos

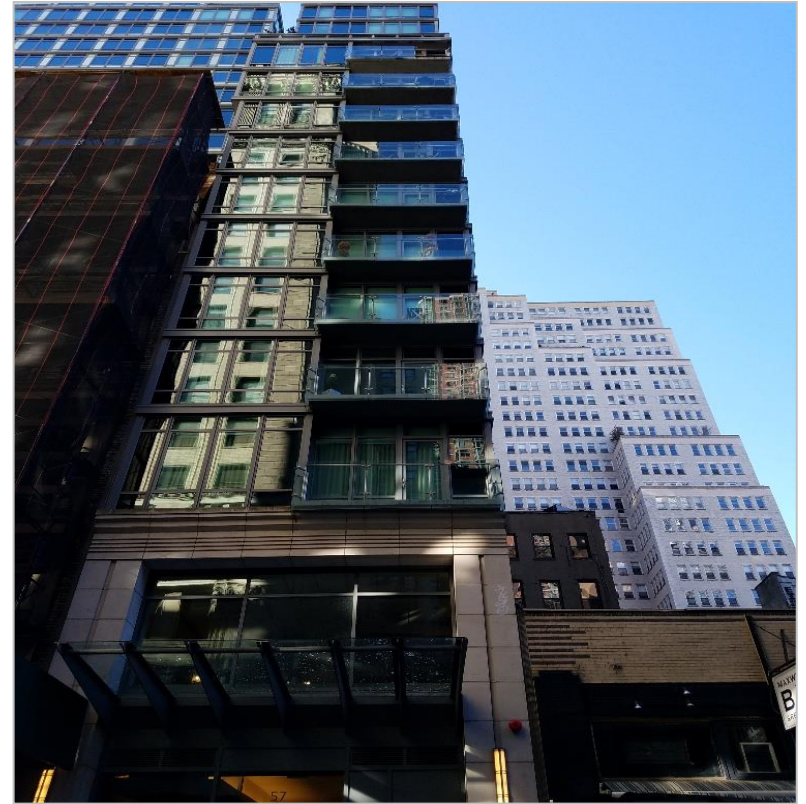
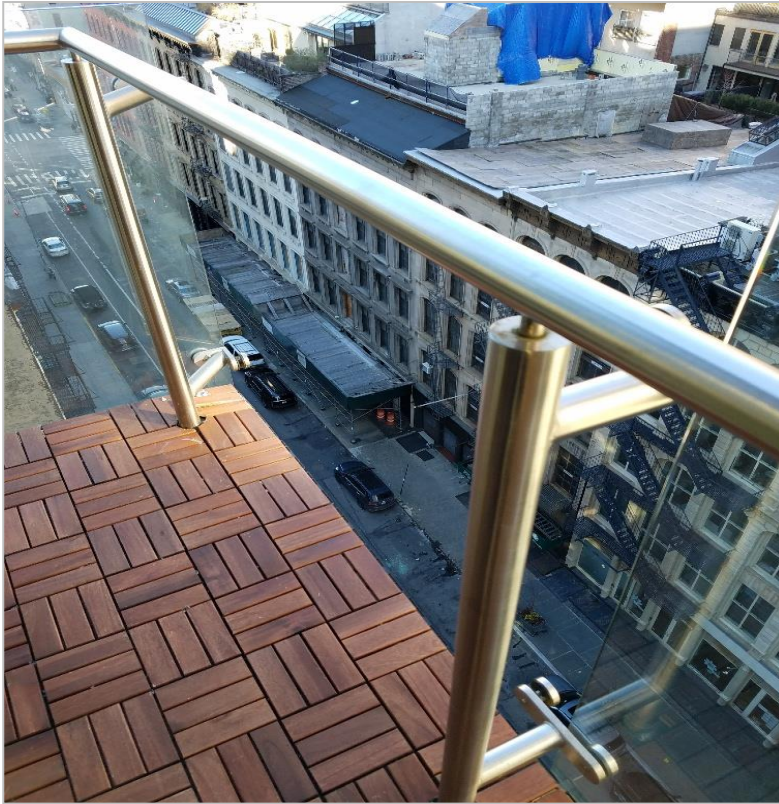


CASE #1: OUTCOME

- 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 along with retrofit of house rig

CASE #2: INSTALLATION/DETAILING

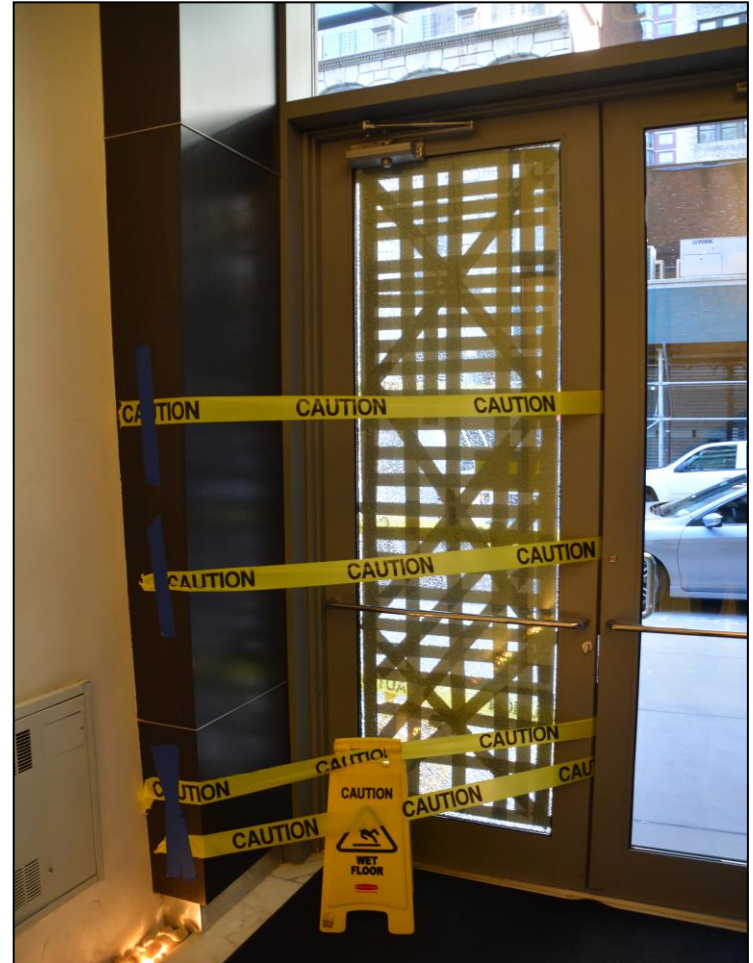
Thanksgiving Morning



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CASE #2: WHEN WE GOT THERE



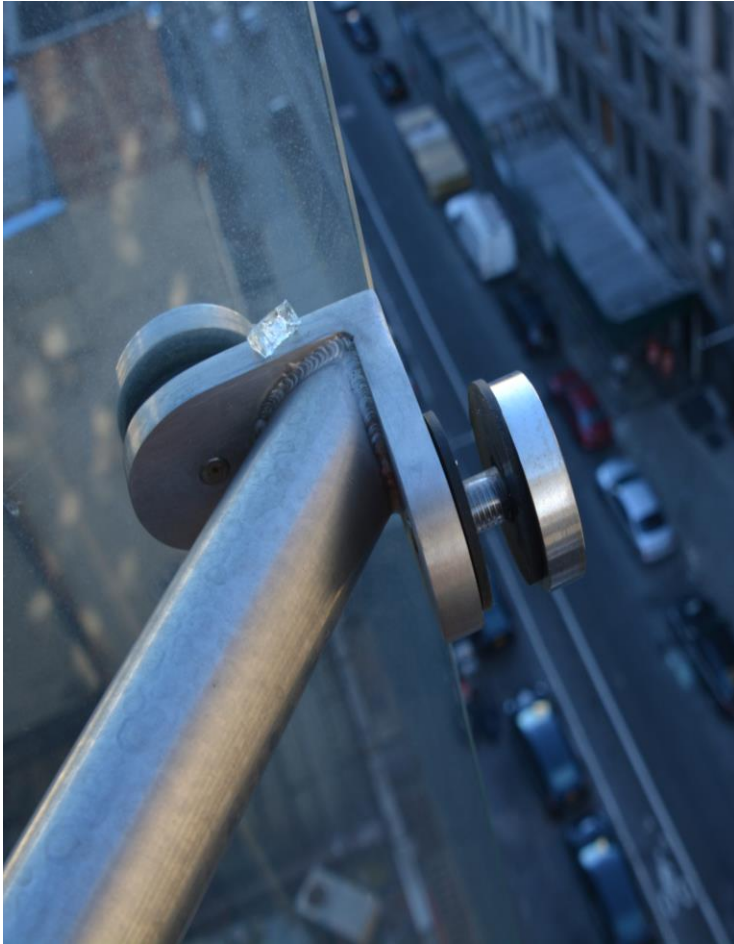
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CASE #2: ENFORCEMENT

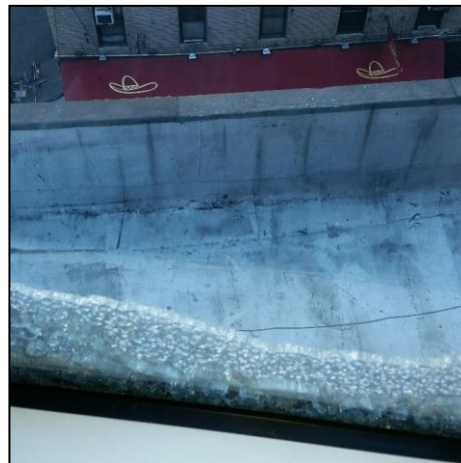
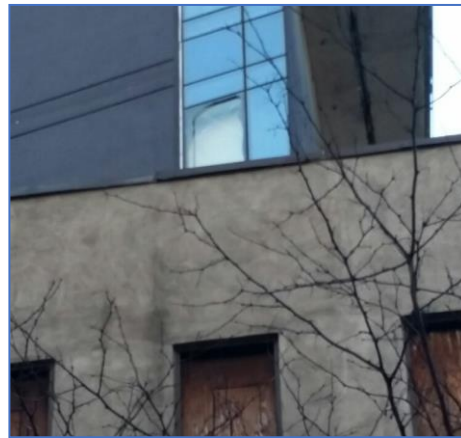
- Vacate all balconies and gym
- Install sidewalk shed
- 100% hands on inspection and evaluation

CASE #2: INVESTIGATION & OUTCOME



- Aluminum post and rail system with clamps welded to posts
- Glass panels secured with gaskets, screws, and washers
- Almost all conditions varied
 - Rubber gaskets
 - Glass panels
 - Attachment

CASE #3: 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 #3: 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 #3: OUTCOME

- *Likely* NiS inclusion
- Difficult to pinpoint as a cause
- Inspection revealed additional lites of glass to be removed and replaced
- Glass breakage rates were 0.08%
- Impact on evaluating legislation

CURRENT NYC/IBC/OTHER JURISDICTIONS CODE REQUIREMENTS TERRA COTTA

- Minimum thickness of element and anchor
- Spacing requirements for webs and anchors
- Anchorage requirements
 - Corrosion Resistant
 - Anchors shall have sufficient strength to support weight of TC in tension.

*NYC Historic Codes: Minimum crushing strength, **sounds, hard and well burnt**, center of gravity requirements.*

CURRENT NYC/IBC/OTHER JURISDICTIONS CODE REQUIREMENTS CAVITY WALLS

- Reference ACI 530
 - Anchor spacing limits by sq. ft.
 - Corrosion resistant ties
 - Height limits
- Specific requirements for stone vs masonry

NYC Historic Codes: Maximum tie spacing, joint spacing limits, corrosion resistant.

CURRENT NYC CODE REQUIREMENTS GLASS

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 GLASS

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 GLASS

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 GLASS

- **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
- **Toronto** – formed panel on glass due to numerous failures in 2011 and 2012. Led to detailing requirements. Laminated glass at balconies.

CODE MODIFICATION RECOMMENDATIONS GLASS

Adopt 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.
- Breakage probability limits for both applied load and spontaneous breakage.

CODE MODIFICATION RECOMMENDATIONS

TERRA COTTA

Adopt IBC 2015

- Façade Unit requests repair details for all Terra Cotta repair/replacement jobs.
- Possible procedure change with DOB NOW: *Build*
 - Façade Unit will plan exam all façade repairs for all buildings within FISP.

CODE MODIFICATION RECOMMENDATIONS

CAVITY WALLS

Adopt IBC 2015

Change to Façade Rule 103-04 to include probes on cavity wall buildings as part of the standard FISP hands on inspection.



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