

Deterioration of the Historic Construction & Prior Codes - How They Mesh

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Course Description

This course will discuss the complexities of the *structural* evaluation and assessment of existing buildings in New York City.

The intent is to bring to light the dense and robust codified requirements governing existing buildings, which set forth minimum standards for identification of safe, unsafe and in-between conditions (the engineer may choose to be more stringent). The course will give an overview of the evolution of building codes including, but not limited to, certificate of occupancies, prescriptive provisions, factors of safety, material thresholds, and engineering formulas. Special consideration will be paid to the relationship and interaction between age, environment and material.

Alteration and repair of buildings is an important consideration and subject matter; however, it is outside the scope of this course.

Learning Objectives

1. Participants will learn the evolution of building codes (integrated vs. disparate) and understand administrative provisions governing their use, maintenance and operation.
2. Participants will be assisted with the terms **Safe**, **Unsafe**, and the middle ground between these terms.
3. Participants will review how to identify critical building elements based on specifications.
4. Participants will review case studies of different building failures.

2014 Administrative / Building Code

- **§ 28-101.2 Intent.** The purpose of the New York city construction codes is to provide reasonable **minimum** requirements and standards, based upon current scientific and engineering knowledge, experience and techniques, and the utilization of modern machinery, equipment, materials, and forms and methods of construction, for the regulation of building construction in the city of New York in the interest of public **safety**, health, welfare and the environment, and with due regard for building construction and maintenance costs.
- **§ 28-102.4 Existing buildings.** The lawful use or occupancy of any existing building or structure, including the use of any service equipment therein, may be continued unless a retroactive change is specifically required by the provisions of this code or other applicable laws or rules.
- **§ 28-301.1 Owner's responsibilities** - All buildings and all parts thereof and all other structures shall be maintained in a **safe** condition...

Structural Evaluation: Administrative Provisions

- § 28–301.1 Owner’s responsibilities - All buildings and all parts thereof and all other structures shall be maintained in a **safe** condition.
 - This specific provision can be traced to the 1968 Code (There is a slightly different version in earlier NYC Building Codes.)
 - Based on minimum standards
- Now we need to consider the other end of the spectrum... **UNSAFE and some state in-between safe and unsafe (28-302.6 SWARMP)**
- **Unsafe:** 1860 NYCBC - Chap. 470 - an act to provide against **unsafe** buildings in the city of New York.
- There are many colors to the term **UNSAFE:** Buildings, Facades, Retaining Walls, Party Walls

Structural Evaluation : Minimum Standards

- **1860** - Chap. 470 - An act to provide against unsafe buildings in the city of New York.
- **1906** - The following provisions shall constitute and be known as the Building Code and may be cited as such, and presumptively provides for all matters concerning, affecting or relating to the construction, alteration, or removal of buildings or structures erected or to be erected in the city of New York...
- **1922** - In interpreting and applying the provisions of this resolution, they shall be held to be the minimum requirements adopted for the promotion of the public health, safety, comfort, convenience and general welfare.
- **1938** - The purpose of this title is to provide standards, provisions and requirements for safe and stable design, methods of construction and sufficiency of materials in structures constructed, or demolished, after January 1st, 1938, and to regulate the equipment, maintenance, use and occupancy of all structures and premises.
- **1968** - This code shall apply to the minimum requirements and standards for the construction, alteration, repair, occupancy and use of new and existing buildings in the city of New York ... All buildings to be maintained safe.

Existing Buildings: Distinguishing Between Evaluations and Repairs

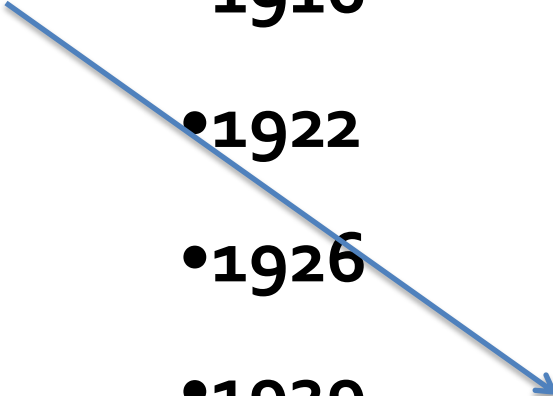
- Occupancy of Existing Structures is defined by the construction codes with specific reference dating back to 1916 (Base building/minimum standards)
- Base building evaluations is different from programming evaluations, and collateral issues from new site development

§28-102.4 Existing buildings. The lawful use or occupancy of any existing building or structure, including the use of any service equipment therein, may be continued unless a retroactive change is specifically required by the provisions of this code or other applicable laws or rules.

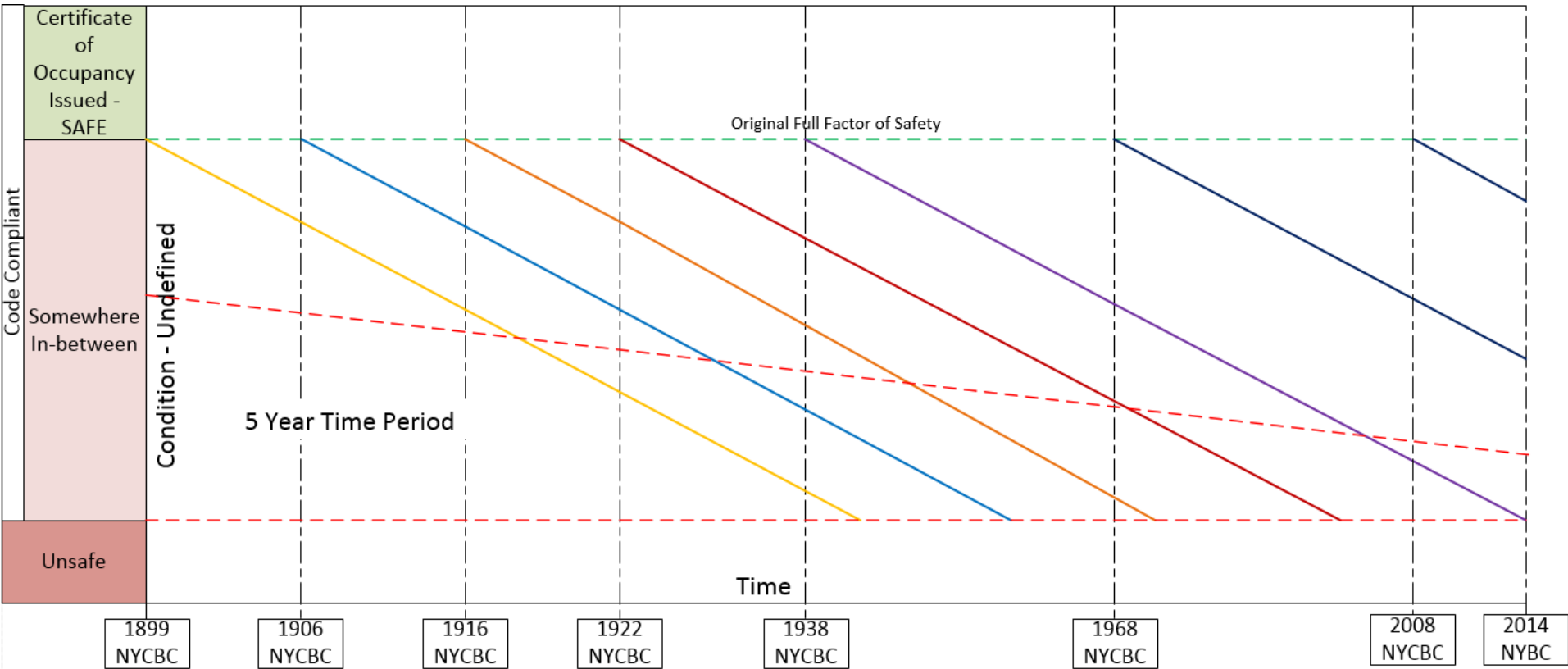
Structural Evaluations

What Building Code Governs The Existing Construction In Your Building?

New York City Building Codes:

- 1860
 - 1887
 - 1896
 - 1899
 - 1916
 - 1922
 - 1926
 - 1929
 - 1938
 - 1968
 - 2008
 - 2014
- 

Condition vs. Time: Safe vs. Somewhere in-between vs. Unsafe



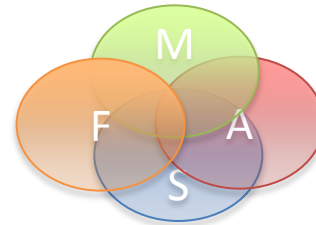
System Evaluation

- Building is to be **substantially compliant** to the construction code upon which it was built to obtain a **Certificate of Occupancy**

- **Codes define a system :**

Architectural, Structural, Mechanical, Fire Code

(All a very intertwined in earlier codes.)



- **Defines Minimum Standards**

§28-116.2.4.1 Final inspection prior to certificate of occupancy. In all cases where the permitted work requires the issuance of a new or amended certificate of occupancy, the final inspection shall be performed by the department in the presence of the permit holder, the registered design professional of record or the superintendent of construction. Such inspection shall be performed after all work authorized by the building permit is completed and before the issuance of the certificate of occupancy. All failures to comply with the provisions of this code or approved construction documents shall be noted and the owner promptly notified thereof in writing. All defects noted in such inspection shall be corrected. Reports of such final inspections shall be maintained by the department. The final inspection report shall confirm that defects noted have been corrected, that the work is in substantial compliance with the approved construction documents and with this code and with other applicable laws and rules and that all required inspections were performed.

Terms

Terms

- Safe
- Unsafe
- Minimum Standards: Prescriptive Engineering vs. Analysis
- Factors of Safety
- Certificate of Occupancy

Comments

- The 1860's-1916 Building Codes: Prescriptive and Minimum Standards = Integrated Building Systems
- After 1916: 1938, 1968, 2008, 2014... Integrated Design Separated By Component Regulation = Disparate Systems

Structural Evaluation: Specifications

1) Performance and Engineering

- Prescriptive Requirements
- Load Requirements
- Deflection
- Factor of Safety
- Formulas and Methods of Analysis

2) Materials

- Brick (1860)
- Stone (1860)
- Terra Cotta (1960)
- Cast Iron (1860)
- Wrought Iron (1860)
- Cast Steel (1899)
- Steel (1899)
- Wood (1860)
- Concrete (1860)
- Mortar (1860)

3) Variables

- Landmarks
- Houses of Worship
- Funding
- Time of Identification

Upper Bound : Factors of safety

Lower Bound: Minimum requirements

***Provides redundancy and durability with allowance for Aging of materials.**

Structural Evaluation: Thresholds

NB FOS

**Safe Operating
Life of Building**

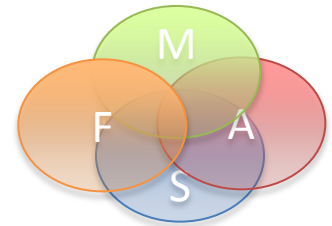
**Code Defined
Minimums**

**Unpredictable Behavior
and Potential Failure**

- What happens if you exceed your minimums?
 - How *critical* is this?
 - It can range:
 - Some elements are critical: brittle materials, exterior elements hazardous to the public (weathering)
 - Others are not as critical: serviceability failures, ductile materials
 - The ability to identify this is a key component
 - Brittle vs. Ductile

Structural Evaluation: System Identification

- For an evaluation you must know the system.
- Previous Codes: Construction building systems *were integrated*. Architecture + Mechanical + Structure + Fire Code
 - If one thing changes – the rest are impacted
- 1938 – 2014 Codes: The evolution of construction moved toward *disparate* systems.



Structural Evaluation: Administrative Provisions

2014 NYCBC

- § 28–102.1 - Applicability –General – Most restrictive provision shall govern
- § 28–102.4 – The lawful use of an existing building or structure may continue unless there is a retroactive change required
- § 28–103.2 – Interpretation - This code shall be **liberally** interpreted to secure the beneficial purposes thereof.
- § 28–103.8 - Matters Not Provided For – To be determined by the DOB.
- § 28–301.1 - Failure to Maintain – Owner’s Responsibilities – Safe
- § 28–301.2 – Intent – Minimum Standards

Recap

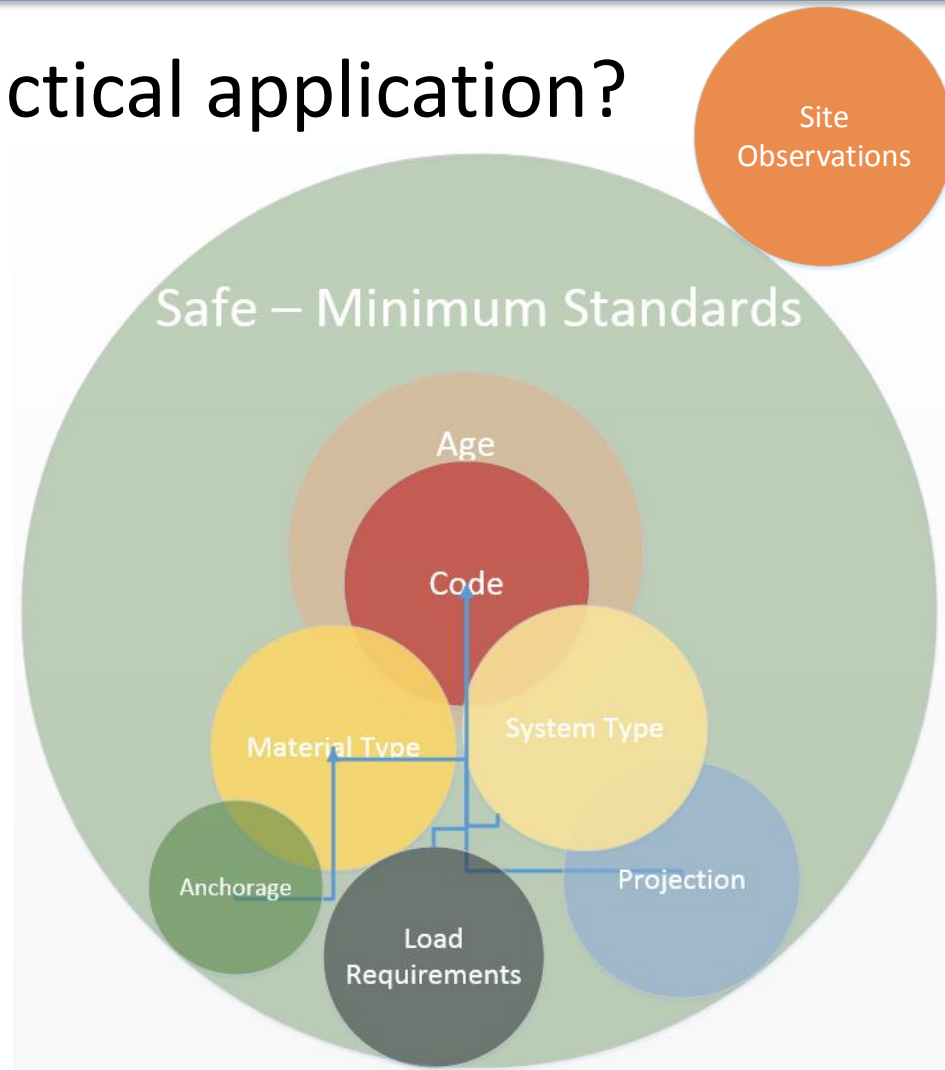
- Building Codes – Intent – Provide minimum standards
- **Safe** vs. **Unsafe** and the condition in-between
- All buildings governed by Administrative Code
 - Buildings shall be maintained **Safe**.
- Evaluation vs. Repair
- Buildings are governed by the code at the time they were built:
 - How does this help? *Assessment and Evaluation*
- Code Evolution: Integrated System vs. Disparate Systems
- Structural Specification: Prescriptive vs. Engineering, Materials

Application of Evaluation Principles

What's an example of a practical application?

– Façade Evaluation

- Age → Code
- Projections
- Anchorage
- System Type
- Material Type and Integrity (brittle vs. ductile)
- Material Strength
- Load Requirements
- **Site Observations**

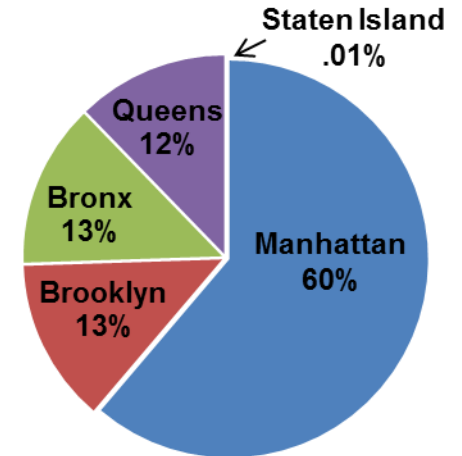


NYC Building Information

From a total of 1,050,000 buildings citywide, 13,126 must comply with FISP.

Total Buildings and FISP Buildings by Borough

Borough	Total Buildings	Local Law Facade Buildings	%
Manhattan	47,718	7,913	16.6%
Bronx	106,798	1,735	1.6%
Brooklyn	320,400	1,694	0.5%
Queens	440,311	1,654	0.4%
Staten Island	137,890	130	0.09%



- New Buildings must file FISP report 5 Years after receiving a TCO or C of O

Exterior Assessment – RCNY 103-04

- RCNY 103-04 (Formerly 32-03) identifies:
 - Known history of the building and materials will dictate extent of investigations:
Must know historical building construction – *system* and *material*

The known history of the building, the nature of the materials used and the conditions observed will dictate the extent of the critical examination.

- *Must follow all provisions of the Administrative Code*
- Critical items for inspection
- Performance tests may be required
- Requirements for: inspection, report, filing, SAFE, UNSAFE, SWAMP, etc.

The QEWI shall utilize a professional standard of care to assess the building's condition, including splitting or fracturing of terra cotta on buildings, cracking of masonry and brick work in brick faced buildings, loosening of metal anchors and supports, water entry, movement of lintel angles, and shall ascertain the cause of these and such other conditions detected. The QEWI shall order any special or additional inspections and/or tests that may be required to support investigations and to determine the causes of any defects.

Structural Evaluation: Key Factors

What can be controlled?

Interior vs. Exterior

Age (System Identification, Minimum Standards/Code)

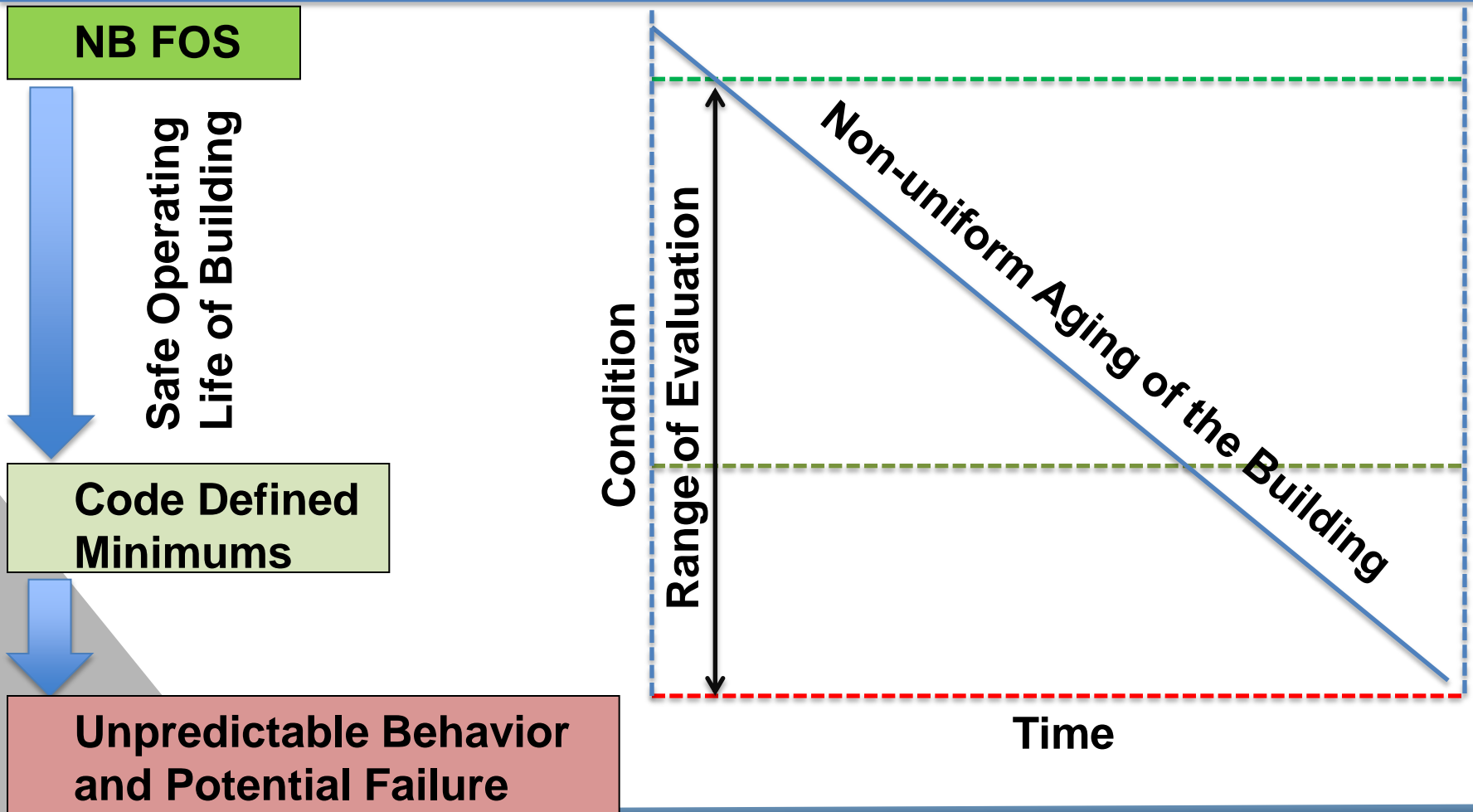
vs. Environment (Alterations, Adjacent Construction, Generally Variable in Nature)

vs. Material Science (Deterioration, Maintenance, Range)

Brittle vs. Ductile

Structural Evaluation:

Key Factors - Condition vs. Time



Structural Evaluation: Use of Prior Codes

How much room is there for evaluation error on a brittle material failure?

Critical: Know the Material History

- Were there material science issues?
 - Design allowable stresses may have changed over the building operational use.
 - What do you use for evaluation? The most restrictive provision.
- What does this mean? Big Picture -
 - The same material in different buildings may be aging at different rates.
 - The building may have been built to code defined minimums; however, there is less factor of safety than what was originally intended.
 - The building can reach a critical age at an earlier date than its counterparts.

Critical: Know the Building History

- Age of materials → Code
- Applicable provisions
- Intended load path?
 - *Has the load path changed?*

Structural Evaluation: Use of Prior Codes

How much room is there for evaluation error on a brittle material failure?

Cast Iron Limited Case Study

- Column Minimum Provisions: 1899-1938
 - $\frac{3}{4}$ " minimum thickness in all parts or:
 - 1899, 1906 – $\frac{1}{12}$ *diameter or ***greater*** side dimension
 - 1916, 1922, 1938 - $\frac{1}{12}$ *diameter or ***least*** side dimension
 - Potentially less restrictive in later codes
- Column Allowable Working Stress Evolution: 1899-1938
 - **Significant reduction** in allowable strength in 1916.
 - **No eccentricity** permitted starting in 1916
- Lintel Provisions: 1899-1938
 - 1899, 1906 – 16' Maximum Span
 - 1916,1922,1938 – **6'** Maximum Span
 - ***Much more restrictive in later codes.*** Advancement in analysis & material science? Typo in code provisions?

1899 & 1906

L/r = 70 - 9,200 psi
L/r = 60 - 9,500 psi
L/r = 50 - 9,800 psi
L/r = 40 - 10,100 psi
L/r = 30 - 10,400 psi
L/r = 20 - 10,700 psi
L/r = 10 - 11,000 psi

1916, 1922, 1938

L/r = 70 - 6,200 psi
L/r = 60 - 6,600 psi
L/r = 50 - 7,000 psi
L/r = 40 - 7,400 psi
L/r = 30 - 7,800 psi
L/r = 20 - 8,200 psi
L/r = 10 - 8,600 psi

Structural Evaluation: Use of Prior Codes

How much room is there for evaluation error on a brittle material failure?

Cornice Limited Case Study

- This is primarily an architectural detail, but can have a big impact on public safety
- Provisions have remained largely consistent from 1899 – 2014
- Permissible projection distance became more restrictive in 1968.
- What you can't see can become a critical failure path; know what to look for.

Example of Provisions

- Walls shall be carried up plumb and straight (1860, 1899, 1906, 1916, 1922, 1938, 1968)
 - Walls to follow ACI tolerances (2008, 2014)
- Center of gravity within the middle 1/3 of the wall (1860, 1938, 1968, 2008, 2014)
- Anchored to the structure in an approved manner (1899, 1906, 1916, 1922, 1938, 1968, 2008, 2014)
- Material Strength and Requirements:
 - Prescriptive material provisions
 - Applicable ASTM Standards (time of construction)
 - Factors of Safety (1899, 1906, 1916, 1922)

Structural Evaluation: Prior Code Factors of Safety

How much room is there for evaluation error on a brittle material failure?



- For any **timber** not described - allowable unit stress to ultimate strength = **1 to 6**
- For any **metal** not described - allowable unit stress to ultimate strength = **1 to 4**
- For any **stone** (natural or artificial), brick or stone masonry not described - allowable unit stress to ultimate strength = **1 to 10**



Structural Evaluation: Existing Buildings



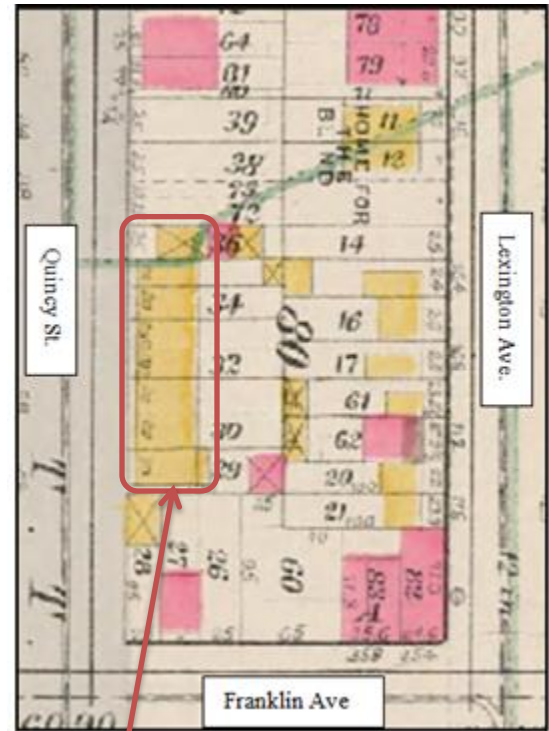
Structural Evaluation: Existing Buildings



Recap

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- **Safe** vs. **Unsafe** and the condition in-between
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- Buildings are governed by the code at the time they were built:
 - How does this help? Assessment and Evaluation
- Code Evolution: Integrated System vs. Desperate Systems
- Structural Specification: Prescriptive vs. Engineering, Materials
- Thresholds
- Key Factors

Structural Evaluation: Case Study



Formerly a group of 8 row houses; currently 4 row houses

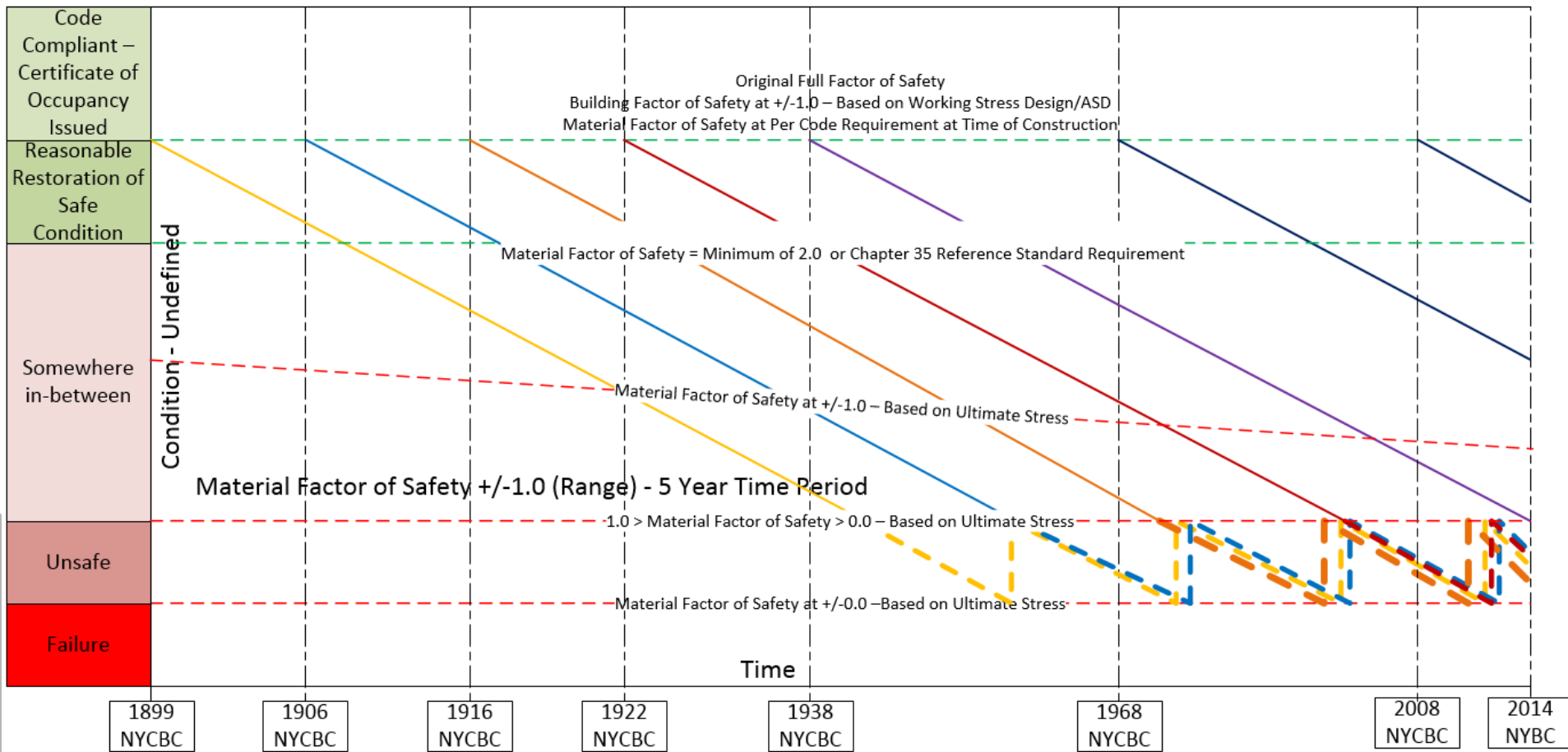
Structural Evaluation: Case Study



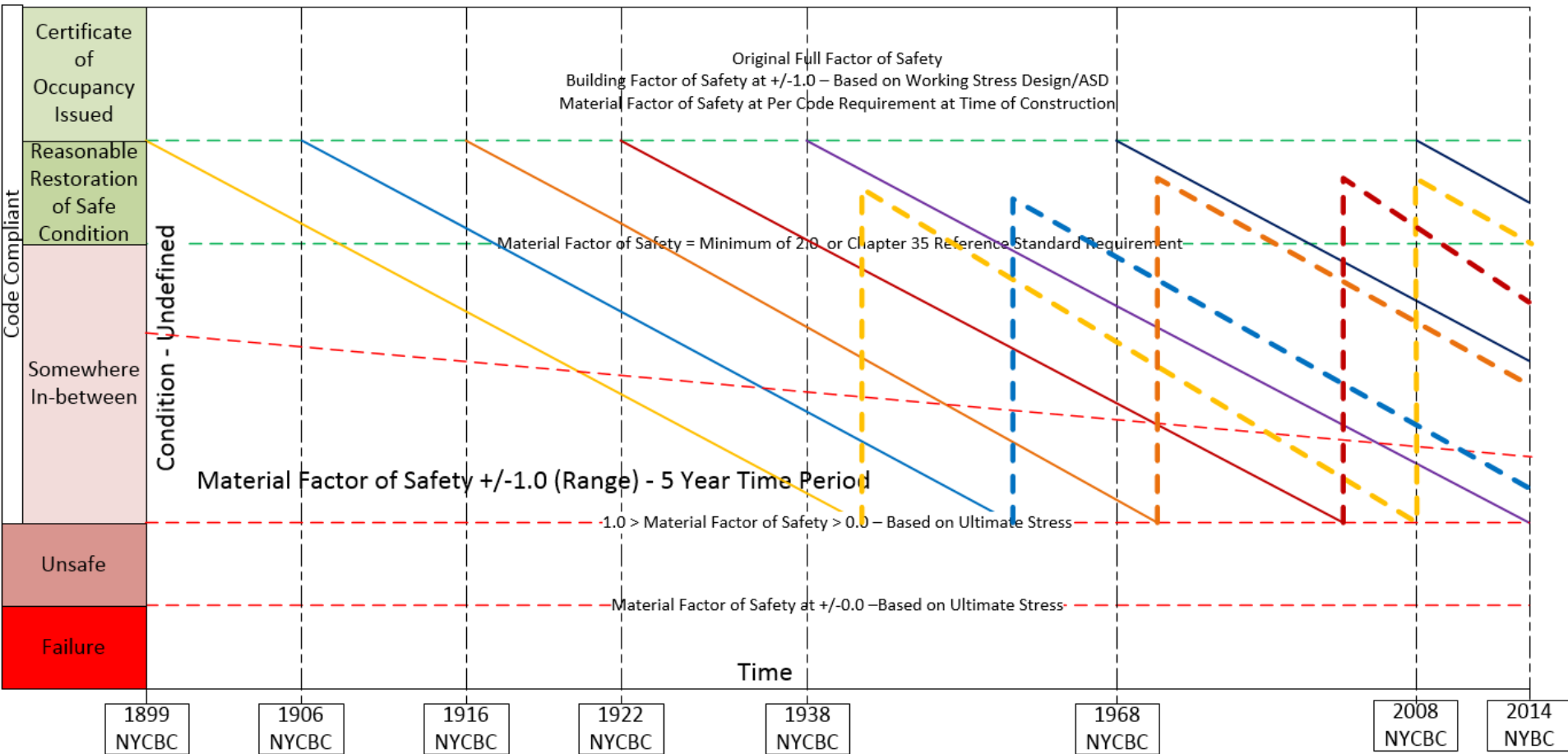
Relieving Walls:

1. Provisions found as early as 1860 NYCBC.
2. Progressive collapse provisions, as well as, structural requirements

Condition vs. Time: For Consideration



Condition vs. Time: For Consideration

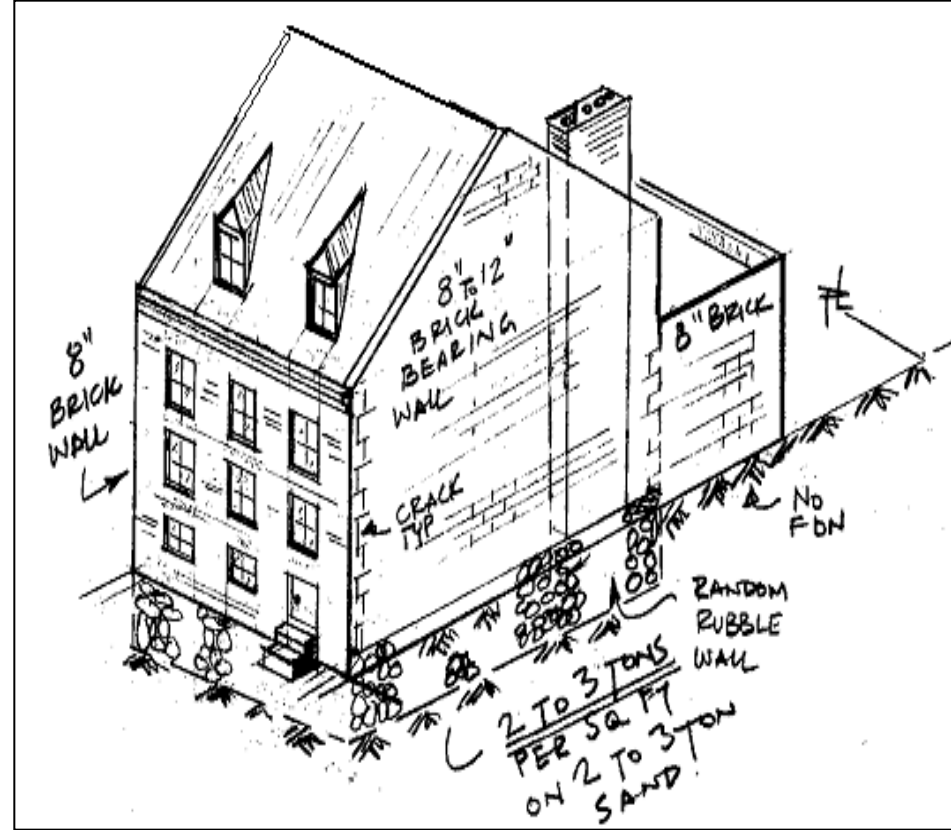


Evaluation: Key Resources

Oasis www.oasisnyc.net	Open Accessible Space Information System (OASIS)
NYC DOB www.nyc.gov/buildings	Alterations, Certificates of Occupancy, Actions, Insurance & Violations
NYC HPD www.nyc.gov/hpd	Floor Plans & Alteration History
NY Public Library www.nypl.org	Digital Historical Maps & Photos
NYC DOF www.nyc.gov/finance	NYC Automate City Register Information Systems (ACRIS) – Ownership Information
Google & Bing www.google.com / www.bing.com	Maps

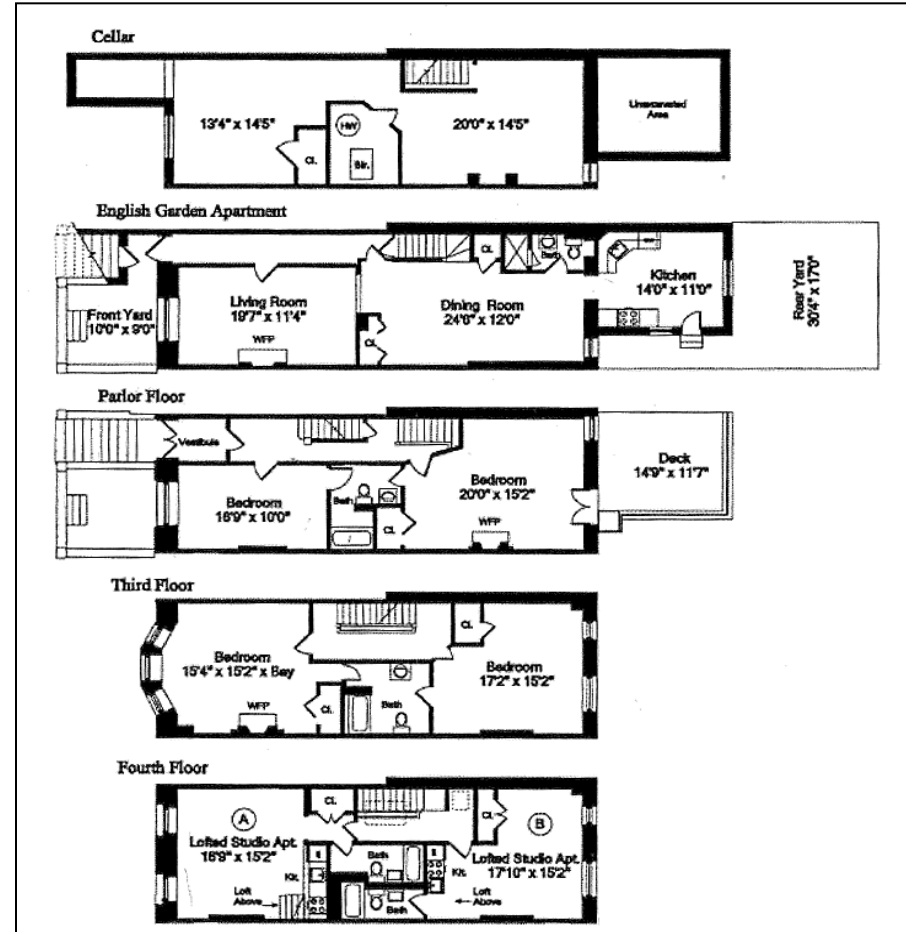
Identifying the Buildings

Federal Era Buildings (1789 – 1865)



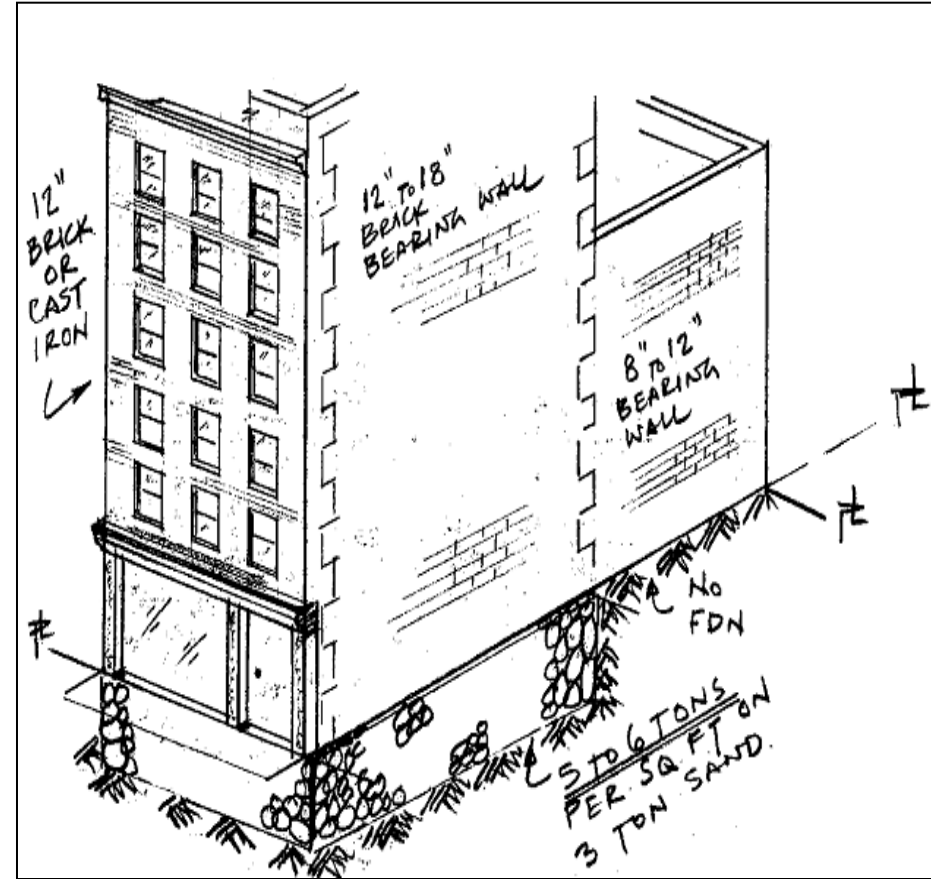
Identifying the Buildings

Row Houses (1840's – 1898)



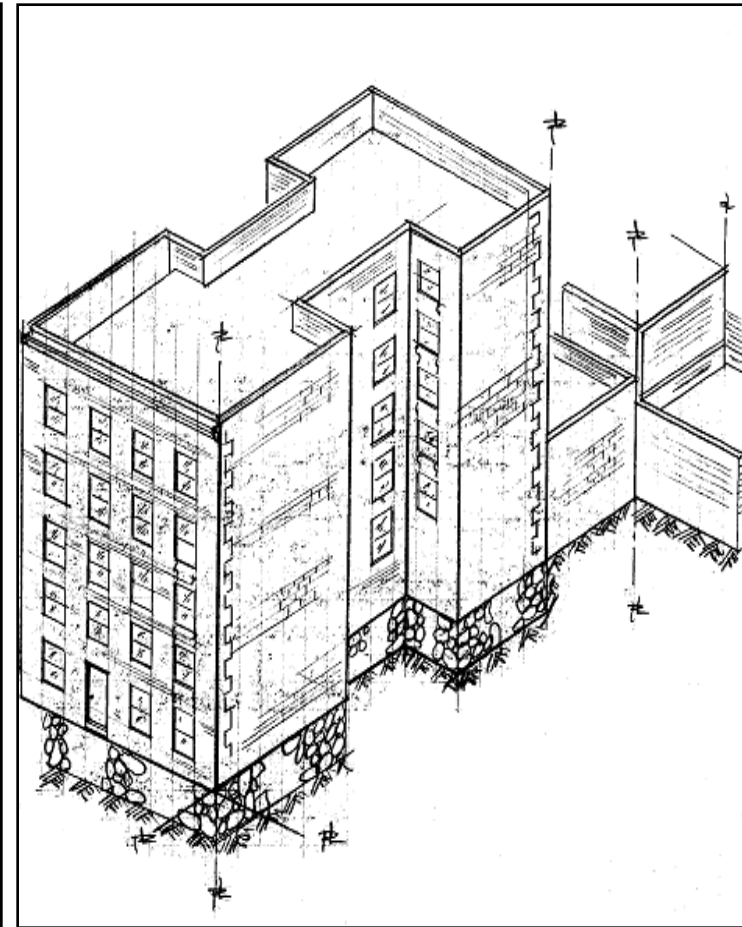
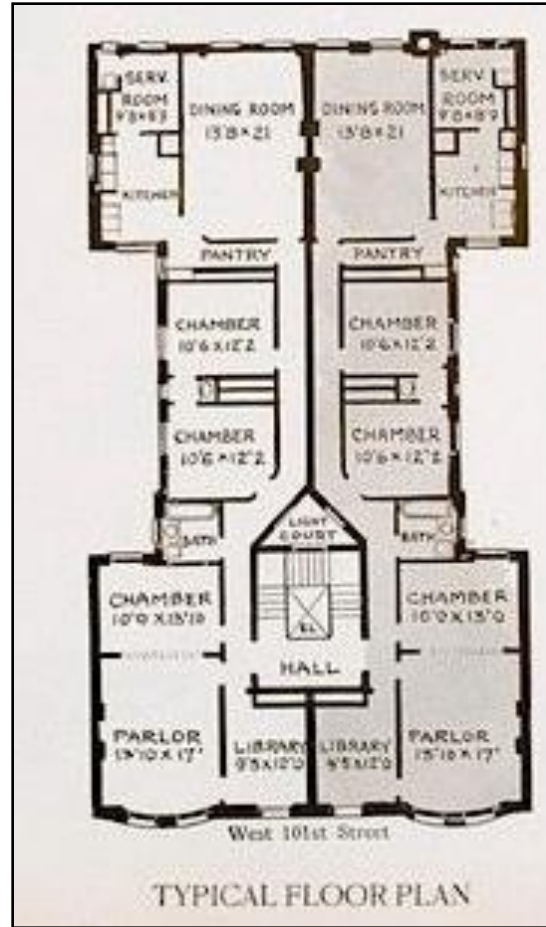
Identifying the Buildings

Mercantile Loft Buildings (1845 – 1895)



Identifying the Buildings

Old/New Law Tenement (1880 – 1930)



Questions?

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