Excavations + Existing Buildings (2014 Codes)

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NYC Buildings

Existing/ New Buildings and Building Codes

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

This course provides an overview of excavation, support of excavation, underpinning and its effects on adjoining structures. This subject will be approached from a design & field point of view. Special emphasis will be given to providing safety protection to adjoining structures and properties.

Another area of importance is how to properly approach the evaluation of structures and how to gather data about adjoining structures prior to the design of underpinning. Various design approaches will be discussed as they relate to code sections governing the type of work being performed.

Learning Objectives

At the end of this course, participants will be able to:

1. Identify sections that govern excavation work in the 2014 NYC Building Code for Chapters 33, 17 and 16.

2. Distinguish between the various tools available to gather information about existing buildings adjoining an excavation.

3. Review techniques used to evaluate structures & adjoining properties to improve the design of excavations.

4. Review factors for consideration when developing an underpinning design and will be able to identify methods to approaching situational designs.

Existing Buildings: 2014 Administrative Code

§ 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. The continuation of the unlawful use or occupancy of a building or structure after the effective date of this code contrary to the provisions of this code or other applicable law or rule shall be a violation of this code.

Owner's Responsibility: 2014 Administrative Code

§ 28-301.1 Owner's responsibilities. All buildings and all parts thereof and all other structures shall be maintained in a **safe** condition……

Whenever persons engaged in building operations have reason to believe in the course of such operations that any building or other structure is dangerous or unsafe, such person shall forthwith report such belief in writing to the department.

The owner shall be responsible at all times to maintain the building and its facilities and all other structures regulated by this code in **a safe and code-compliant manner** and shall comply with the inspection and maintenance requirements of this chapter.

Lots: 2014 Administrative Code

§ 28-102.5 Grading of lots. The regulation of lots, in conformity with the street on which they are situated, **shall be calculated at curb level**. Where a lot has more than one street frontage, and is so situated that the street frontages intersect, the curb of the longest street frontage shall be used. When the street frontages do not intersect, the curb along each frontage shall be used to one-half the depth of the lot between street frontages. A lot as referred to in this section 28-102.5 shall mean a parcel of land twenty-five feet by one hundred feet, or less, in one ownership whether adjacent land be in the same or other ownership; but, for this purpose, no land in the same ownership may be divided into lots smaller than twenty-five feet by one hundred feet.

In 1627: lots were defined as 25'x35', 25'x50', and 25'x75'

Adherence to Lot Diagram: 2008 Administrative Code

§ 28-105.12.3 Adherence to lot diagram.

All work shall be **strictly located in accordance with the lot diagram approved in accordance with this code and no lot or plot shall be changed, increased or diminished in area from that shown on the approved lot diagram,** unless and until a revised diagram showing such changes, accompanied by the necessary statement of the owner or applicant, shall have been submitted to and approved by the commissioner.

Lot Diagram: 2008 Building Code

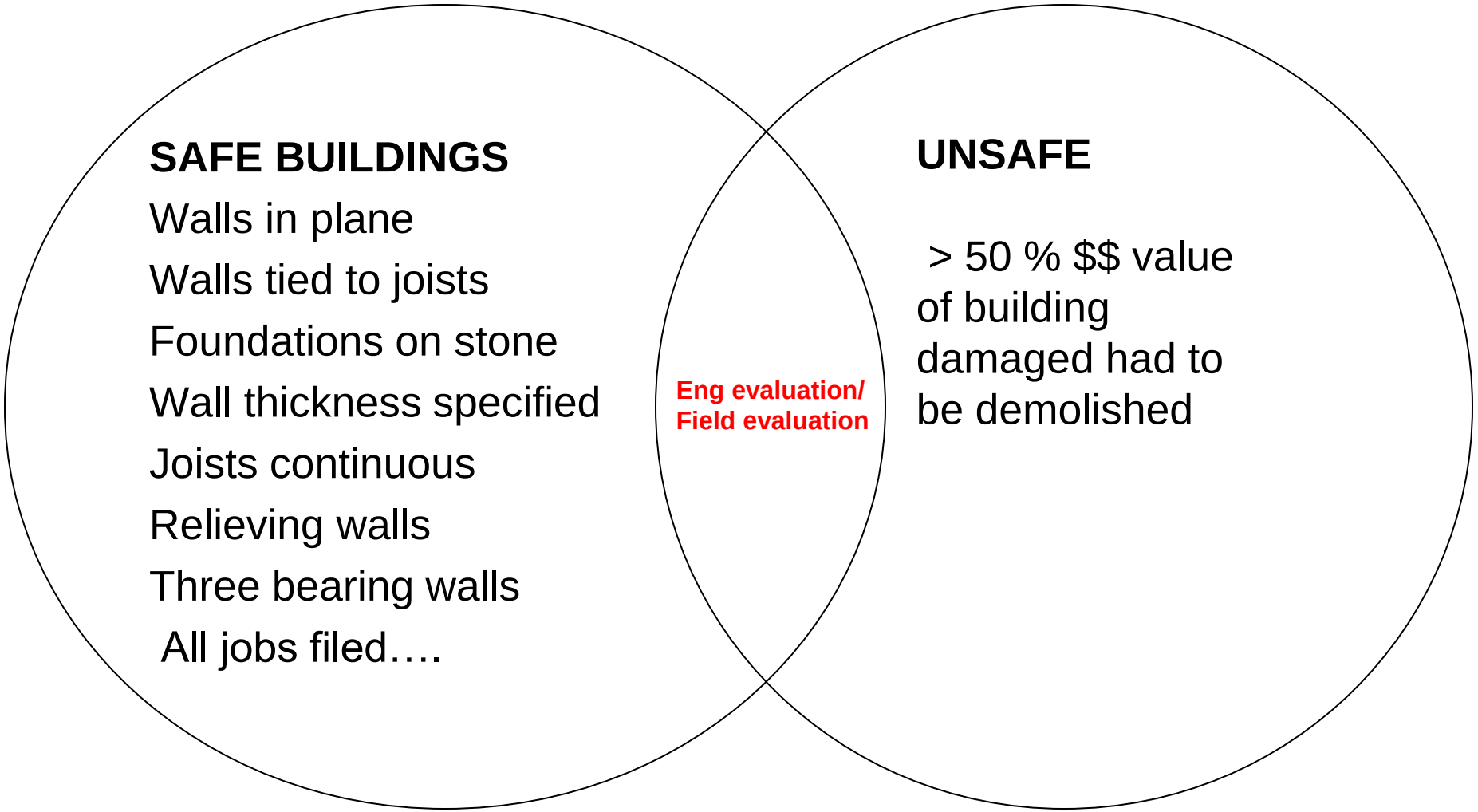
106.3 Lot diagram. The lot diagram shall show compliance with the New York City Zoning Resolution, indicating the **size, height, and location** of the proposed construction including parking and curb cuts; **all existing structures on the zoning lot and their distances from lot and street lines**; the established grade and existing curb elevations; and the proposed final grade elevations of the site shown by contours or spot grades at reasonable intervals….

Prior Codes: Safe and Unsafe Buildings (50 yrs.)

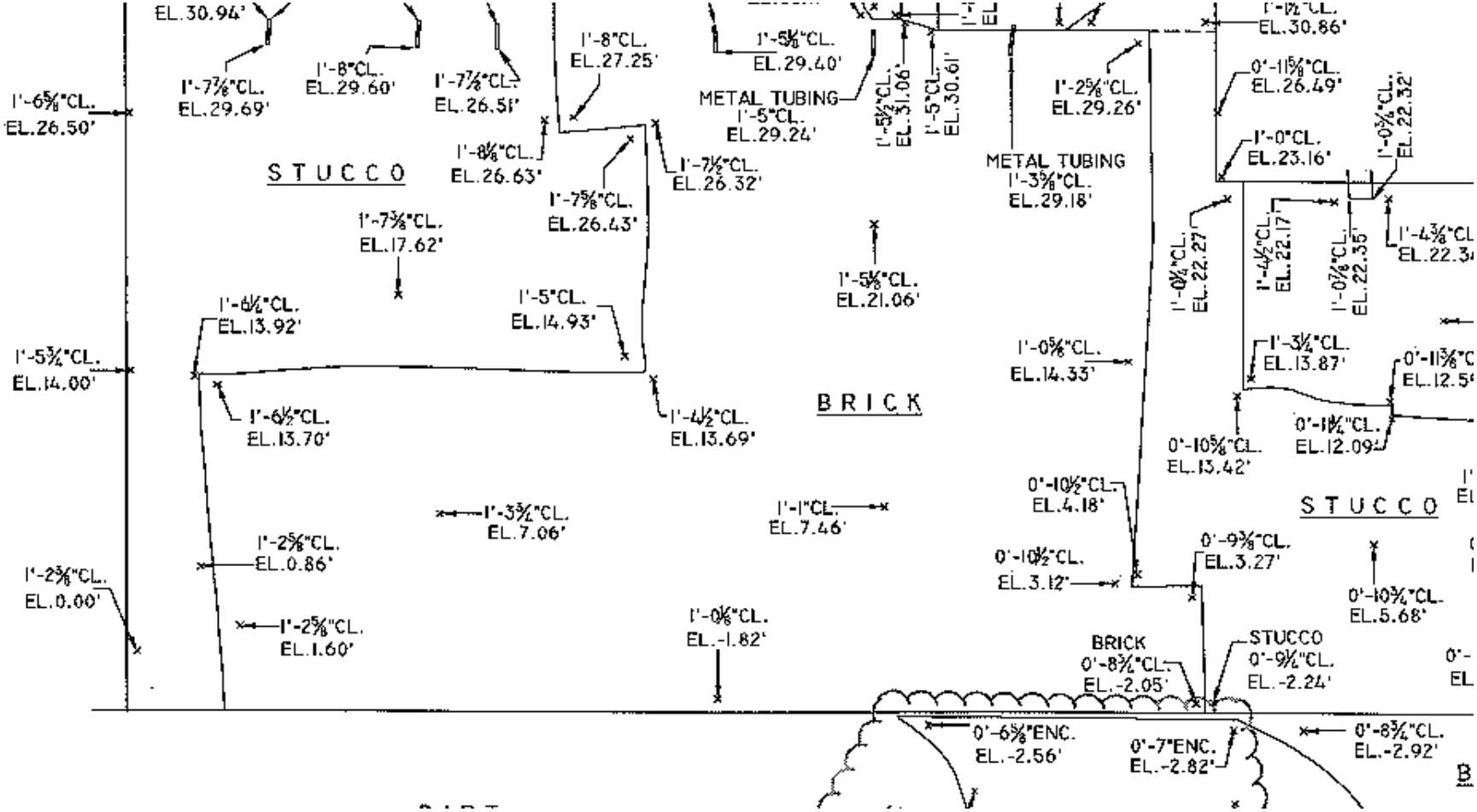
SAFE BUILDINGS
Walls in plane
Walls tied to joists
Foundations on stone
Wall thickness specified
Joists continuous
Relieving walls
Three bearing walls
All jobs filed

UNSAFE
> 50 % $$ value of building damaged – had to be demolished

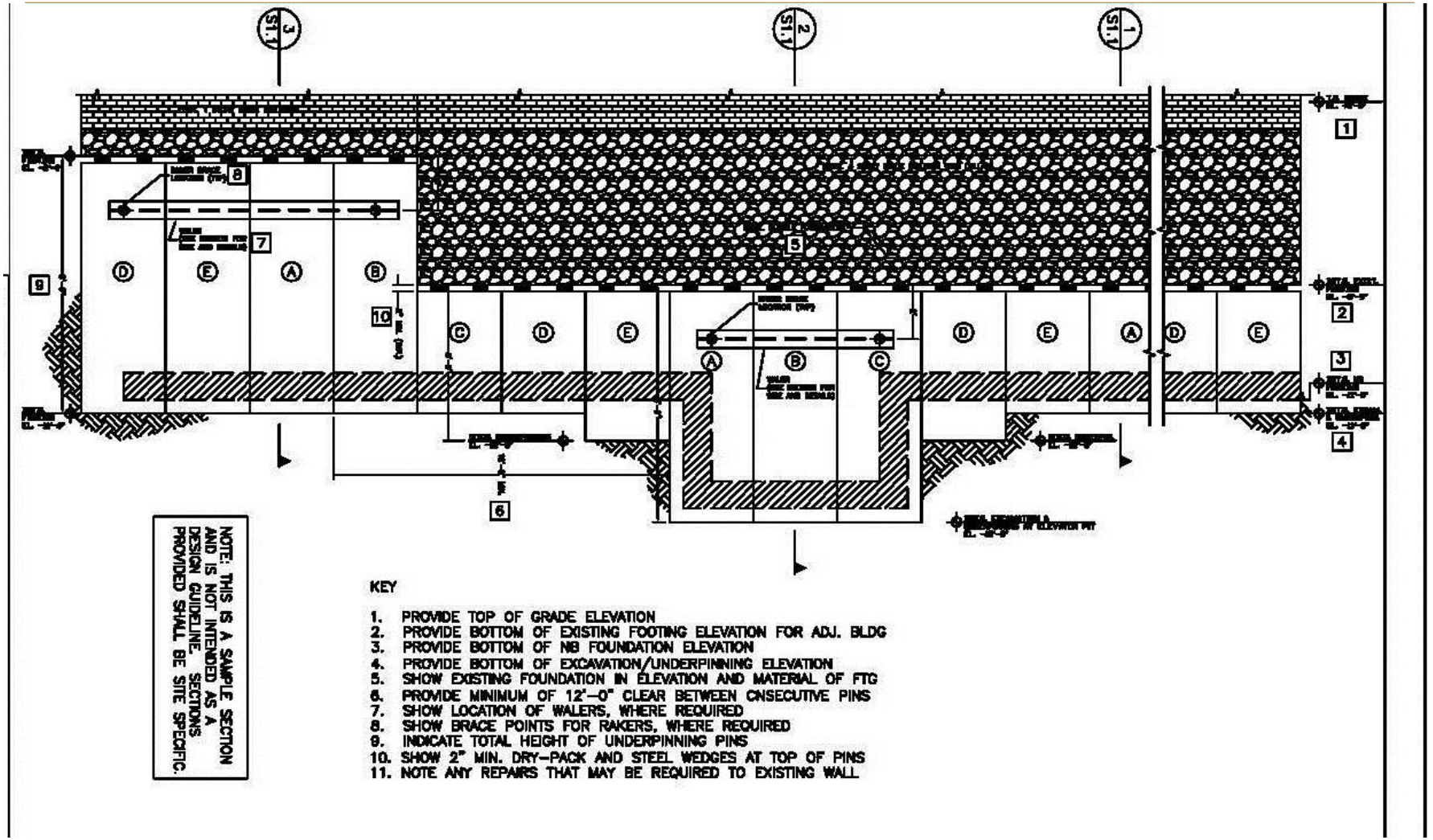
Prior Codes: Reality Today: 125 yrs. +



Offset Survey on Lot Line



Lot Line Mapping



Code Themes: Duty, Technical, Site Safety

Themes found within the code

- Duty = law/ administrative
- **Technical Provisions**
- Empirical Design vs. Engineering Design
- Work during construction
- Under Construction – Building Code: **permits**
- Under Occupancy – Admin code: **C of O's** – **technical**
- Material science issue – updating constantly
- Structural stability (engineering issues – consistent)

What We Know

- Nineteenth century buildings **were** governed by building and fire codes. This historical context is crucial in understanding the performance of the structure.
- Property owners are responsible for maintaining their buildings to prevent structural problems from developing.

Pre- and Post-permit: Code + Construction Themes

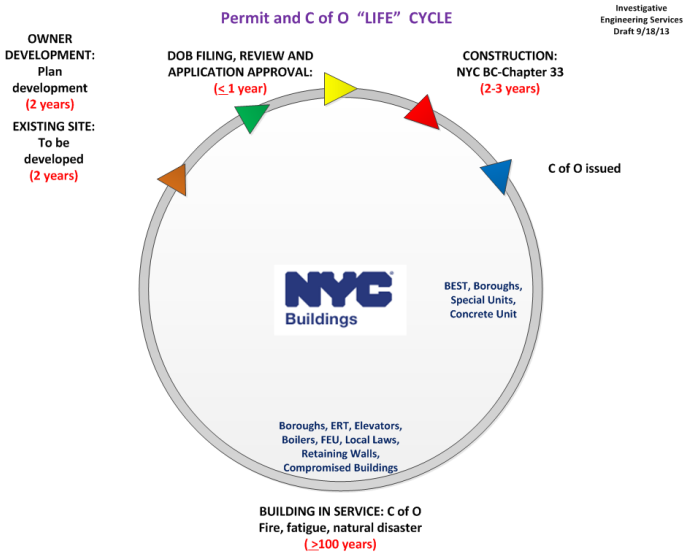
Themes found within the code

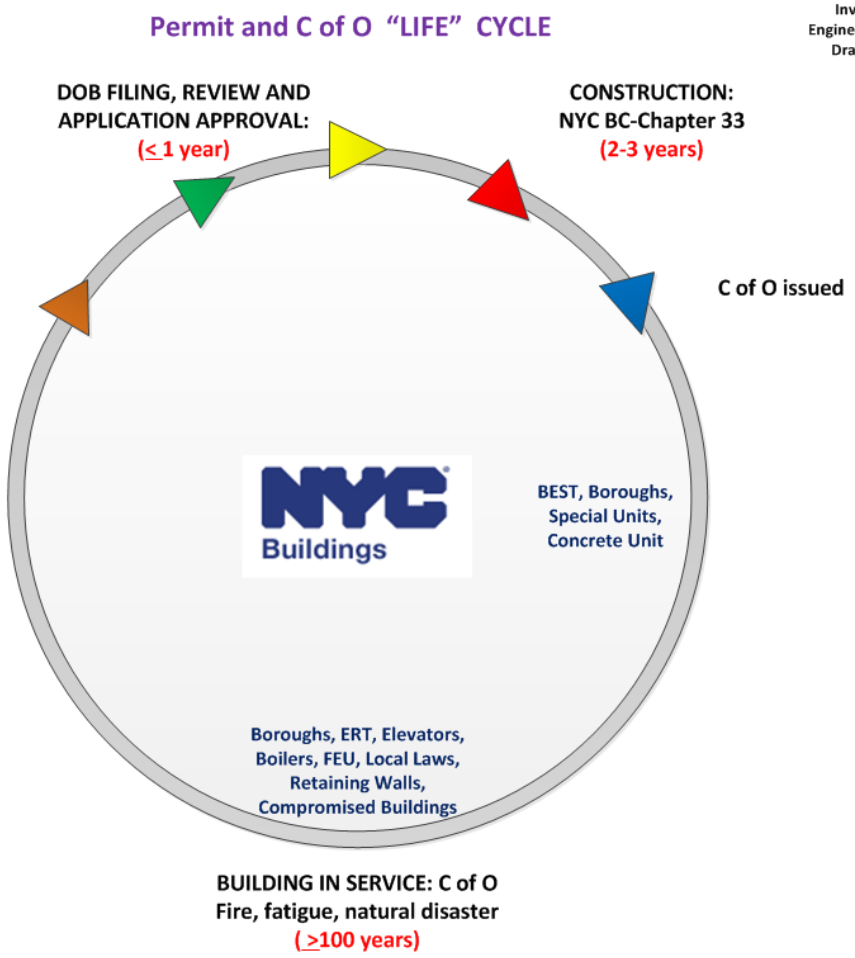
- Pre-permit - design, site investigation and engineering calcs
- Post-permit - Under Construction - Chapter 33
- Certificate of Occupancy : existing buildings - **technical**

- **Technical provisions:**
- **Engineering issues - pre-permit**
- **Construction issues - post-permit**

- Work during construction - generally post-permit

- Duty / administrative provisions - pre- and post-permit and Certificate of Occupancy


Permit and C of O "LIFE" CYCLE
Investigative Engineering Services Draft 9/18/13
OWNER DEVELOPMENT: Plan development (2 years)
EXISTING SITE: To be developed (2 years)
DOB FILING, REVIEW AND APPLICATION APPROVAL: (≤ 1 year)
CONSTRUCTION: NYC BC-Chapter 33 (2-3 years)
C of O issued
NYC Buildings
BEST, Boroughs, Special Units, Concrete Unit
Boroughs, ERT, Elevators, Boilers, FEU, Local Laws, Retaining Walls, Compromised Buildings
BUILDING IN SERVICE: C of O
Fire, fatigue, natural disaster
(≥100 years)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BUILDING IN SERVICE: C of O
Fire, fatigue, natural disaster
(≥100 years)

1851 : Violations, Civil Penalties, Misdemeanors

shall remain after notice to remove the same shall have been given; such notice may be signed by any of the trustees of the Fire Wardens of the Fire Department of the City of New York. Such notice may be given by leaving the same at the residence or place of business of such owner or owners, or builder or carpenter, or by serving the same personally, or by serving the same in the manner provided for in the twenty-ninth section of this act, and such additional penalty shall be computed and recovered up to the time of the trial of any suit for the recovery thereof, and in case such violation shall continue after the trial of such suit, such continuing, additional penalty, computing from the time of such trial, may be recovered in any other suit or suits to be brought by the Fire Department of the City of New York for that purpose.

2008 BC Chapter 16 Structural Design – Duty

1604.1 General.

Building, structures and parts thereof shall be designed and constructed in accordance with strength design, load and resistance factor design, allowable stress design, empirical design or conventional construction methods, as permitted by the applicable material chapters.

1604.4 Analysis.

Load effects on structural members. Shall be determined by methods of structural analysis that takes into account equilibrium, general stability, geometric compatibility and short and long term material properties. Any system or method of construction to be used shall be based on a rational analysis in accordance with well established principles of mechanics. Such analysis shall result in a system that provides a complete load path from origin to their load resisting elements.

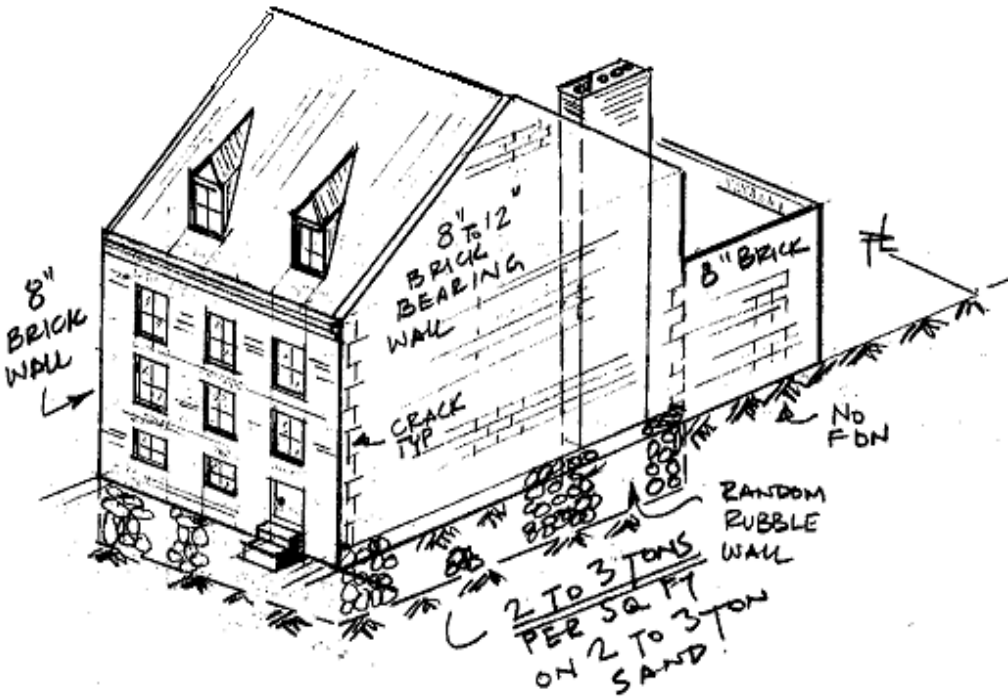
2014 Building Code Chapter 16
19th Century Design (empirical?)

1. Code requires load path	**not “defined”**
2. Code requires rational analysis	**not “rational”**
3. Code requires equilibrium	**equilibrium not defined (dependent on neighbor)**
4. Code requires general stability	**stability not defined (dependent on neighbor)**
5. Code requires geometric compatibility	**new building term**
6. Code requires lateral force resisting system	**undefined**
7. Code requires anchorage of roofs and floors	**anchorage of joists to walls specified**

"Engineered" Buildings vs. 19th Century Empirical Design (cont.)

8. Code requires structural drawings that show sizes, sections and relative locations for structural members	**drawings elective**
9. Code requires minimum wind loads resisting system	**wind load not defined**
10. Code does not specifically define bracing	**existing buildings were governed by bracing**
11. Code requires a seismic design and separation	**seismic wasn't a consideration**
12. Alternate load path and key element defined	**generally had this**
13. Structural Integrity (prescriptive requirements)	**new engineering concept; requires continuity and ties**
14. Peer review: Code can require complete load path.	

Federal Era



Federal Era Buildings

(1789 – 1850's)

1834 Code Required Wall Ties, 12” Walls

Plate irons and anchors.

§ 4. All plate irons shall be built into the end or party-walls, and the iron anchors used to secure plate pieces shall be at least two inches wide by half of an inch thick. The anchors so to be used at each end of any such plate piece shall be at least four feet long, and shall be worked or built into the side or end walls of the building, and the end of said anchor shall turn down not less than four inches.

Party-walls.

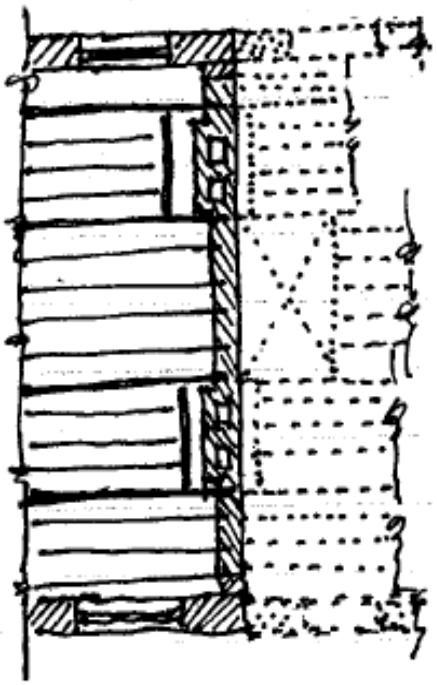
§ 1. The outside and party-walls of all dwelling-houses, store-houses, and other buildings, hereafter to be erected or built within the fire limits of the city of New York, as the same now exist and may hereafter be extended, which shall exceed thirty feet in height, from the level of the sidewalk to the foot of the rafter, shall not be less than twelve inches thick.

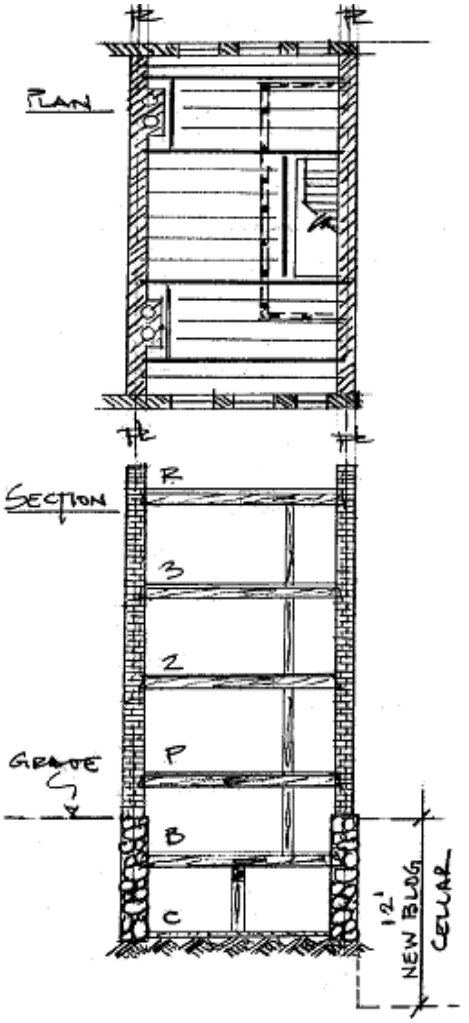
1968 Code = 1851 State Code

1968 : Sub Chapter 5: (d) Fire divisions shall be so constructed that the removal or collapse of construction on one side will not endanger the support of construction on the other side.

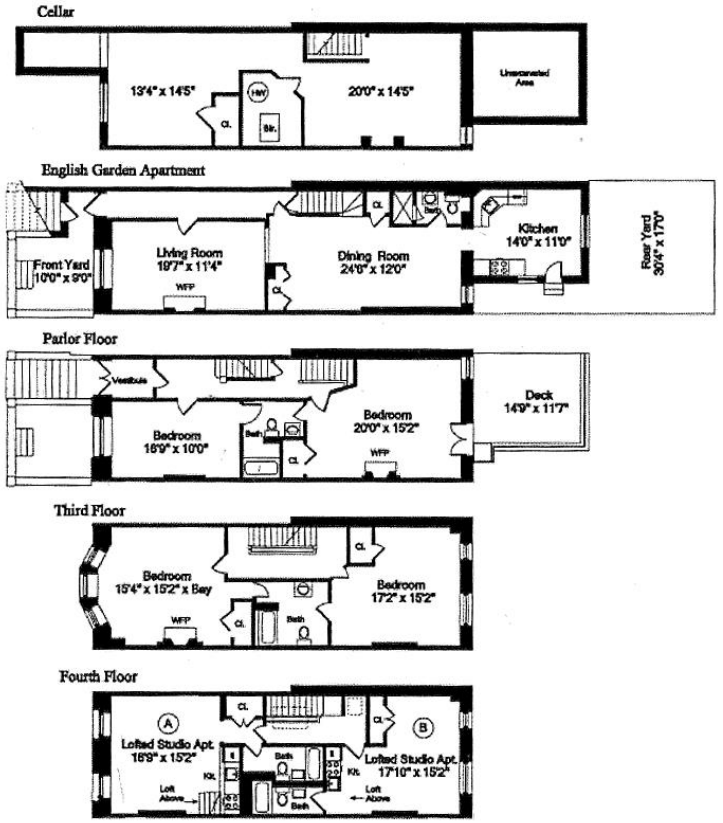
Every such store, or store-house, being more than thirty feet in width, shall be erected and built in such manner that all the floors thereof, throughout their whole extent, shall be supported by, and rest upon one more additional partition wall or walls, built of brick or stone, not less

Relieving Walls Required by Fire Codes





Row Houses



Row Houses

(1840's – 1900's)

Brick Bonding Specified 1860's

Faced brick bearing walls.

All bearing walls faced with brick laid in running bond shall be four inches thicker than the walls are required to be under any section of this title. In all brick walls, every sixth course shall be a heading course, except where walls are faced with brick in running bond, in which latter case every sixth course shall be bonded into the backing by cutting the course of the face brick, and putting in diagonal headers behind the same, or by splitting the face brick in half and backing the same with a continuous row of headers.

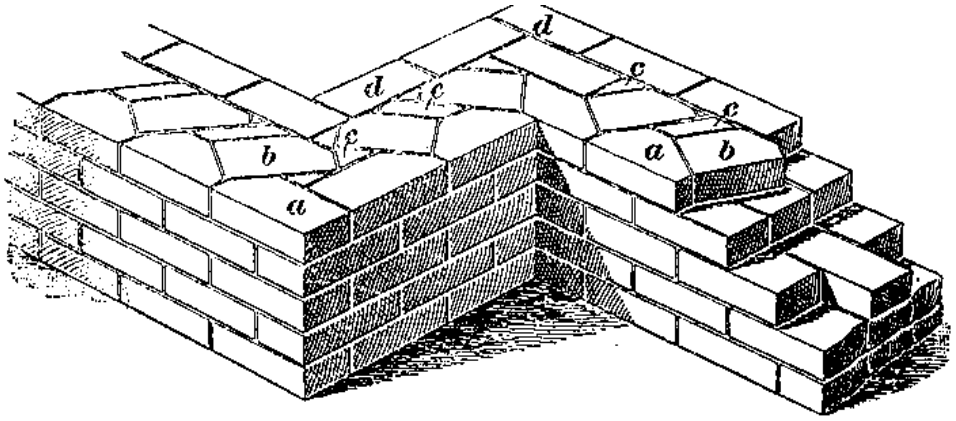
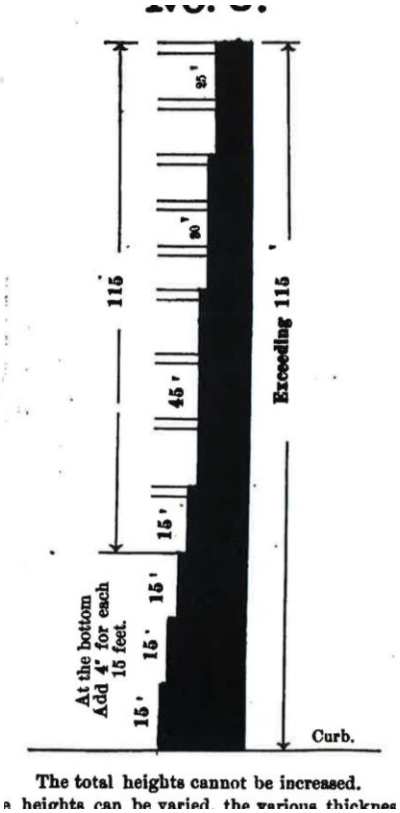


FIG. 80.

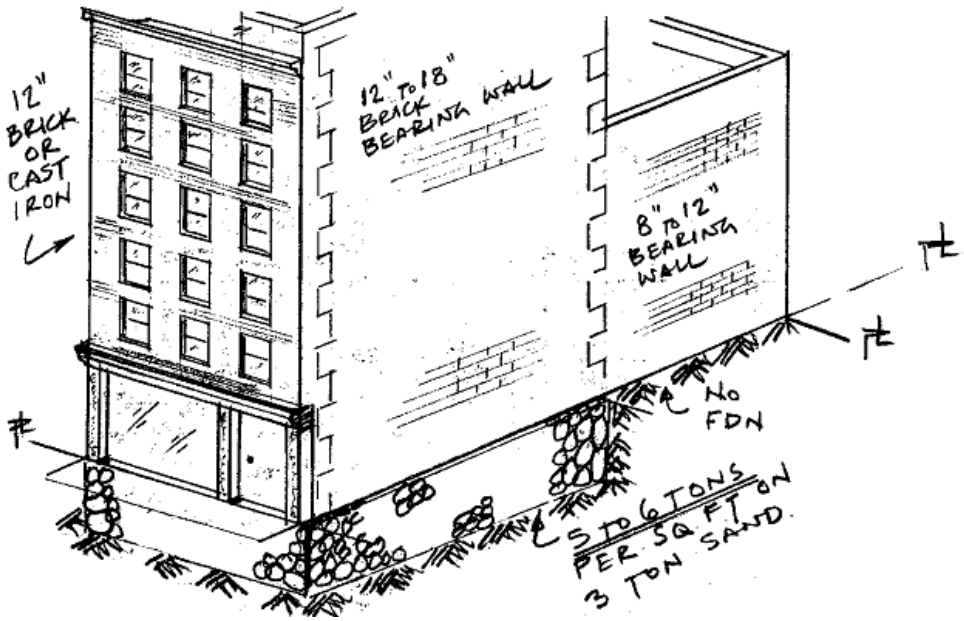
Walls to be Plumb, Straight and to a line: 1860s

be constructed of stone, brick or iron; and all walls shall be built to a line, and shall be carried up plumb and straight, and shall be built with close joints. No swelled brick or refuse brick shall be allowed in any wall; and all walls shall be started and built upon foundations of



The total heights cannot be increased.

Mercantiles



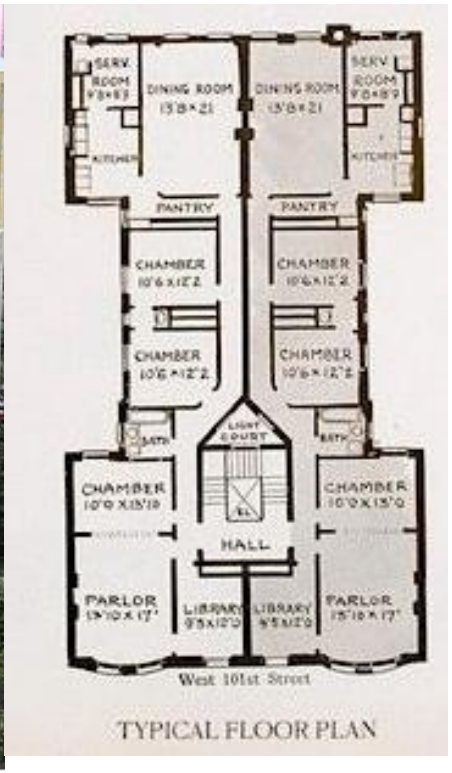
Mercantile Loft Buildings
(1850's – 1890's)

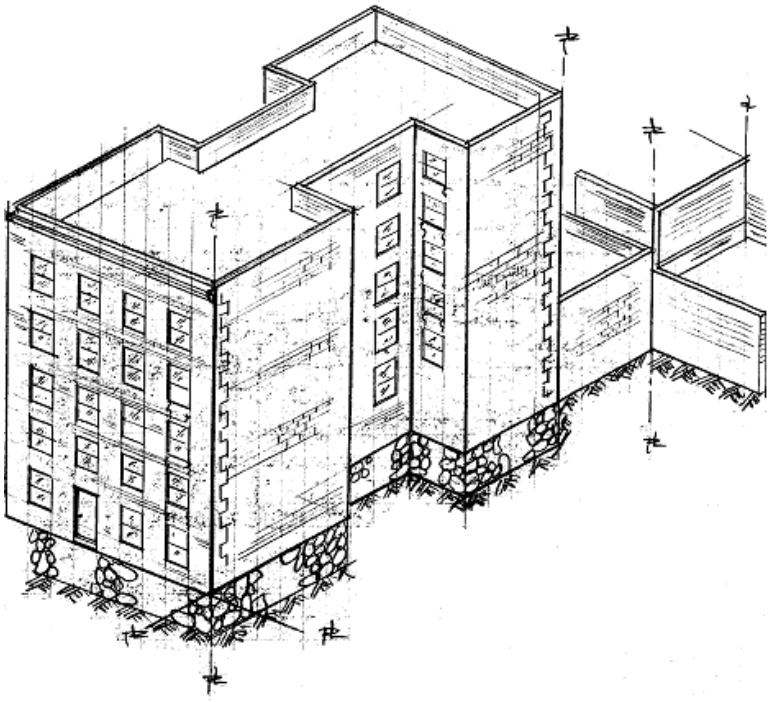
Facing Stones Anchored to Backup: 1860s

All stone used for the facing of any building, and known as ashlar, shall not be less than four inches thick.

Stone ashlar shall be anchored to the backing and the backing shall be of such thickness as to make the walls (independent of the ashlar) conform as to the thickness with

Old Law Tenement Buildings





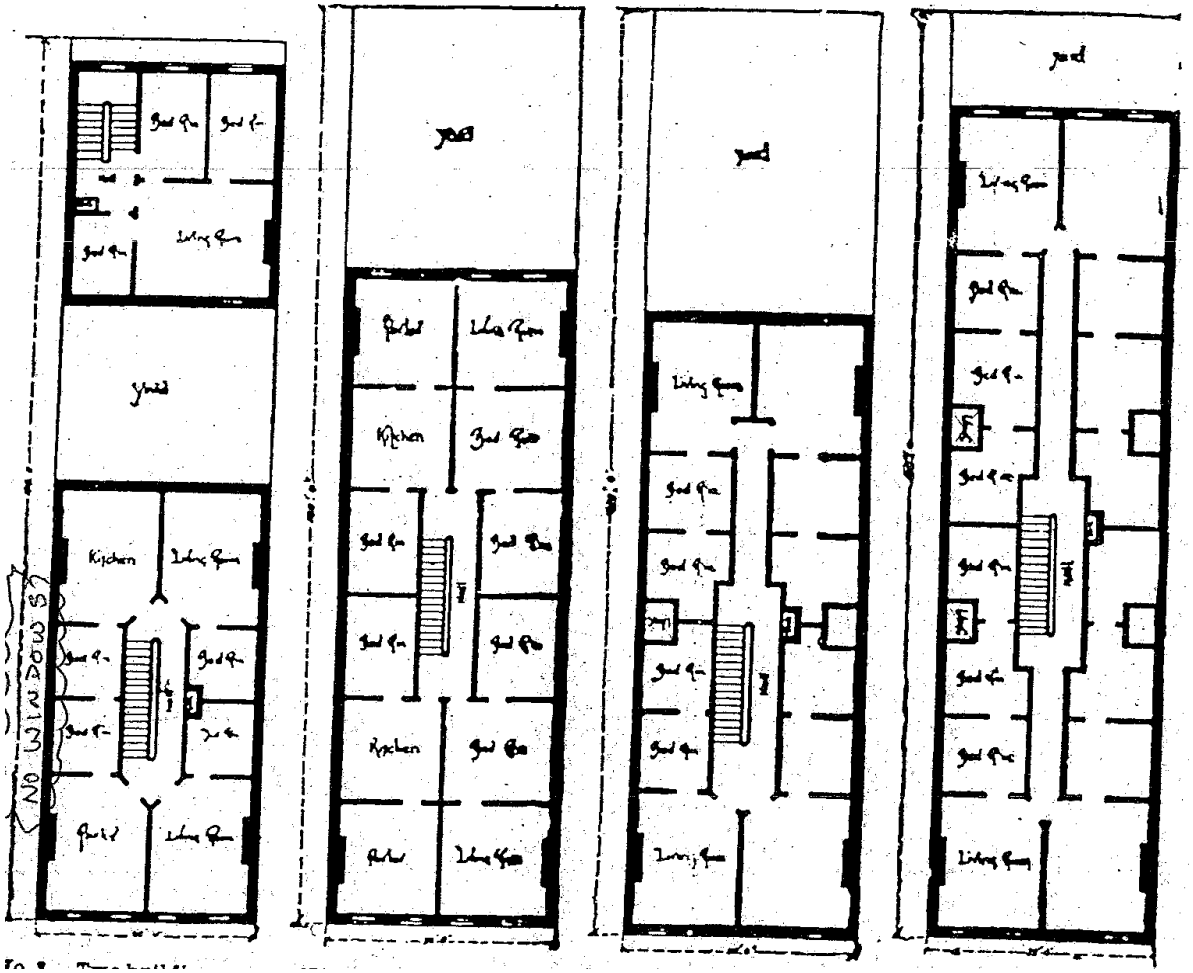
Old/ New Law Tenement

(1880 – 1920's)

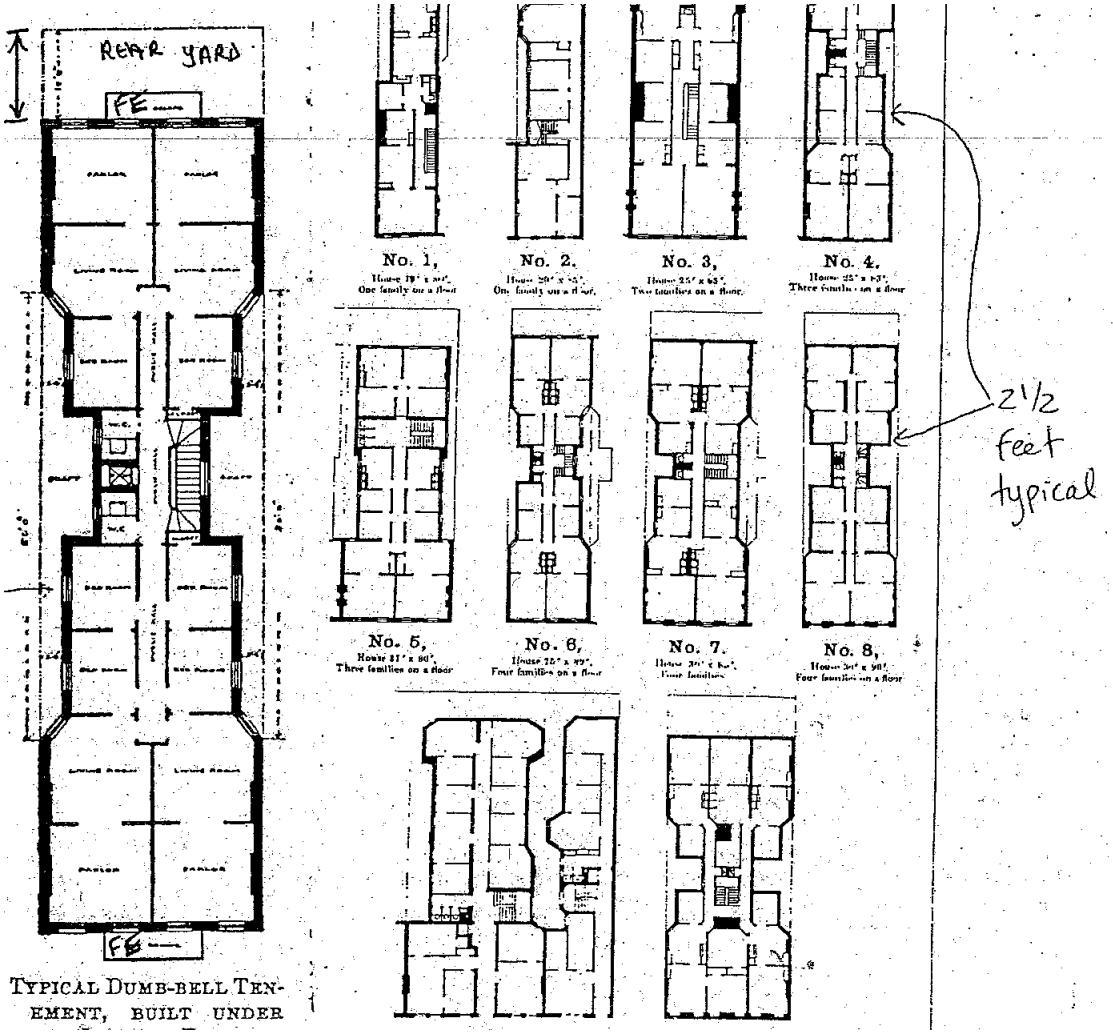
Tenement Lot Sizes Defined

No plan for light and ventilation of a tenement-house with apartments on five or more floors, and having more than twelve rooms on a floor, to be erected on an ordinary city lot, except a corner lot, will be approved by this Board, where more than sixty-five per centum of the lot is to be covered, unless the courts to light and ventilate the interior rooms thereof, shall have an area of at least two hundred and sixty-five square feet, and where there are to be twelve rooms on a floor, the area of such courts must be not less than two hundred and fifteen square feet.

Tenement Layouts: Specified in Codes 1850's +

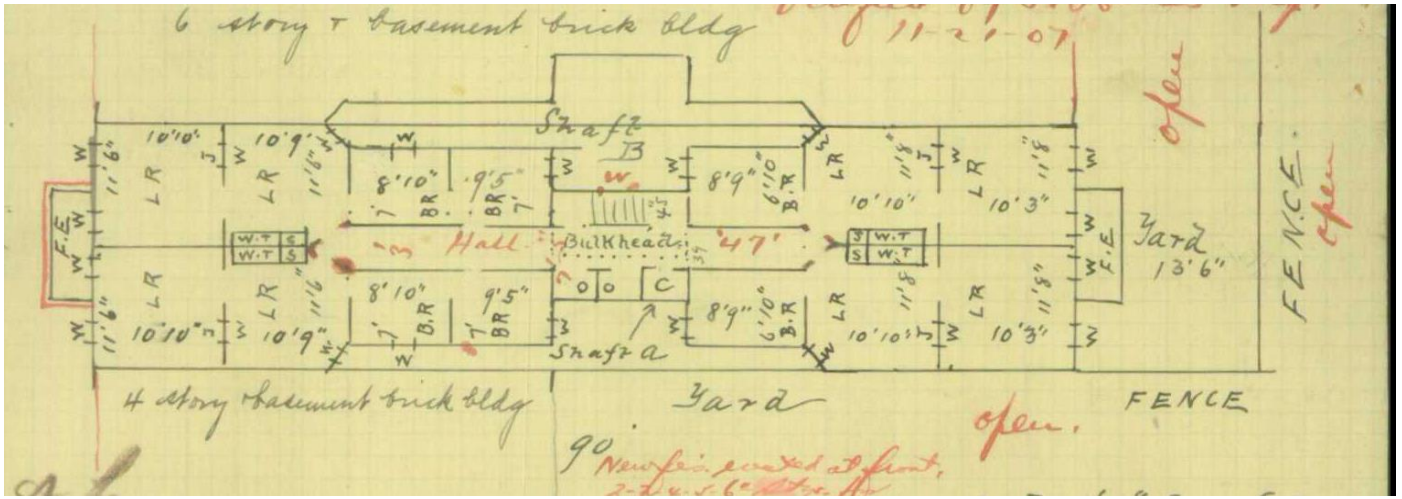


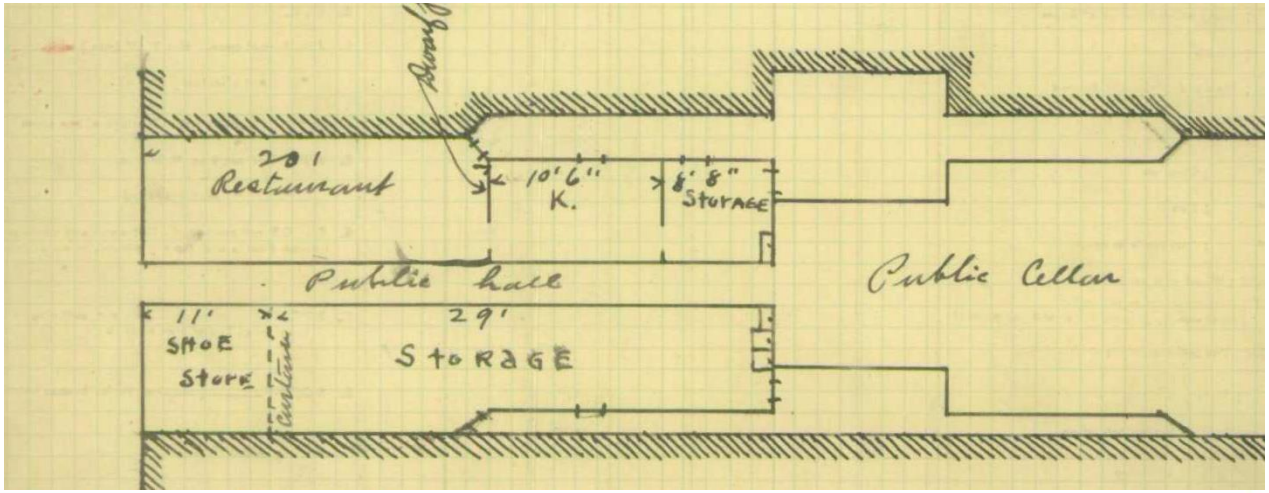
Tenement Layouts Defined



TYPICAL DUMB-BELL TENEMENT, BUILT UNDER

Actual Floor Plans: Comparable to Prescriptive





Source	Reverse Engineering	New Building Engineering (Linear)
Date of Construction	Y	N
Plans	Y	Y
Existing Conditions	Y	P
Violation History	Y	N
Construction History	Y	Y
Tax Lot Data	Y	N
Owner Data	Y	P
Historic Data Press	Y	N
Wall Thickness	P	Y
DOB BIS Violations	Yp	N
DOB BIS Filings	Yp	N
DOB BIS Actions	Yp	N
Engineer's Calculations	P	P
Old Codes	Y	N
Landmarks Data	Y	N
Tax Maps	Y	Y
HPD I cards	Y	N

Sourcing Historic Data: Public Websites

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

What's missing above? Building Codes

Excavation Safety

Robert D'Alessio

Senior Executive Director
Construction Safety

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Excavation

BC 3304.3.1: Notification of Commencement

3304.3.1 Notification of the department. No soil or foundation work within the property line shall commence unless the permit holder, or where there is no permit holder the person causing the soil or foundation work to be made, notifies the department, via phone or electronically, at least 24 hours, but no more than 48 hours prior to the commencement of such work. The notification shall state the date that such soil or foundation work is to commence. Should the notification date fall on a weekend or official holiday, the permit holder shall notify the department on the last business day before the commencement date.

Common Problems/General Site Safety

- Construction Fences/ Missing and/ or Inadequate
- Guardrails/ Missing and/ or Inadequate
- Egress From Site Inadequate
- Poor Construction Housekeeping
- Inadequate Vehicle Ramps

Common Problems/Excavation Specific

- Support of Excavation (SOE) Missing or Inadequate
  - No stable angle of repose
  - No shoring
- Underpinning Not Provided or Inadequate
- Box Pit Shoring Not Provided
- Survey Monitoring of Adjoining Properties/ None or Inadequate
- Pre-Construction Survey Not Performed
- Special Inspections by Professionals Not Performed or Inadequate
- No Excavation Notification Made To Department

Common Problems/Construction Documents

- Work Executed Contrary to Design Documents
- Design Documents Not on Site
- Design Documents Inadequately Detailed
- Design Does Not Take Into Account Adjoining Property Structure or Condition

Site Condition Photograph Fencing

BC 3307.7.5: Construction Fence Design

3307.7.5 Design of fences. Fence installations shall be designed by a registered design professional. The effect of wind on the fence shall be considered in the design in accordance with Chapter 16.

Exceptions:

1. Fences installed in connection with the construction or demolition of a one- two- or three- family building.

2. Fences that conform to a standard design approved by the commissioner provided the fence is installed at the site in accordance with the standard design.

Site Condition Photographs Water In Excavation

BC 3304.4: Guardrails

3304.4.4 Guardrail system. All open edges of an excavation that are 6 feet (1829 mm) or greater in depth shall be protected by a guardrail system meeting the requirements of Sections 3308.7.1 through 3308.7.5, or by a solid enclosure at least 3 feet 6 inches (1067 mm) high. For the purpose of a guardrail system installed in accordance with this section to protect the open edge of an excavation, the term “floor” in Sections 3308.7.1 through 3308.7.5 shall mean “ground.”

BC 3304.10: Excavation Dewatering

3304.10 Dewatering. The person causing the soil or foundation work to be performed shall dewater the site, as needed, for the progress of the work. Measures shall be taken to prevent settlement, slope failure, and damage to adjacent buildings, structures, and property affected by dewatering operations.

Site Condition Photographs
Unstable Angle of Repose/ No Shoring

Site Condition Photographs
Underpinning/ Box Pits

Site Condition Photographs
Unstable Angle of Repose

Site Condition Photographs
Shoring/ Improper Construction Sequencing

Site Condition Photographs
Shoring/ Raker-Whaler Connection

BC 3304.2: SOE Design and Drawings

3304.2 Support of excavation drawings. The sides of all excavations, including related or resulting embankments, shall be supported as specified on drawings. Such drawings shall be site specific and shall clearly illustrate all related protection and support of the excavation, including but not limited to sloping, stepping, sheeting, shoring, bracing, guardrail systems, and fences as required by Section 3304.4, with all dimensions indicated. Such drawings shall also indicate any utilities or public infrastructure impacted by the excavation. The drawings shall be prepared by a registered design professional who has demonstrated knowledge or experience in the design of retaining structures or bracing systems for the support of excavation.

Site Condition Photographs
Egress From Excavation

BC 3304.7: Excavation Access

3304.7 Access. Every excavation shall be provided with at least one safe means of ingress and egress that is kept available at all times.

Site Condition Photographs
Cantilever Design/Inadequate Embedment Depth

Site Condition Photographs
Sheetpiling/Driving Obstruction

Underpinning Failure

Site Condition Photographs
Underpinning Failure/ Poor Soil Evaluation

Site Condition Photographs
Underpinning/Lateral Failure

BC 3309.4.1:
Excavation: Safeguards For Adj. Property

3309.4.1 Additional safeguards during excavation. The following additional requirements shall apply during excavation:

1. The person causing the excavation shall support the vertical and lateral load of the adjoining structure by proper foundations, underpinning, or other equivalent means where the level of the foundations of the adjoining structure is at or above the level of the bottom of the new excavation.

BC 3309.6:
Subsurface Operations--Precautions

3309.6 Subsurface operations affecting adjacent properties. Whenever subsurface operations, other than excavation or fill, are conducted that may impose loads or movements on adjoining property, including but not limited to the driving of piles, compaction of soils, or soil solidification, the effects of such operations on adjoining property and structures shall be monitored in accordance with Section 3309.16.

Exception: Monitoring during underpinning shall be in accordance with Section 1814.

BC 3309.4.4:
Excavation- Movement Monitoring

3309.4.4 Monitoring. During the course of excavation work the following shall be monitored in accordance with Section 3309.16:

1.Buildings that are within a distance from the edge of the excavation that is equal to or less than the maximum depth of the excavation.

2. Historic structures that are contiguous to or within a lateral distance of 90 feet (27 432 mm) from the edge of the lot where an excavation is occurring.

Exception: Monitoring is not required for excavations to a depth of five feet (1523 mm) or less, provided:

1. The excavation occurs more than 5 feet (1524 mm) from all footings and foundations; or

2. Where the excavation occurs within five feet (1524 mm) or less from a footing or foundation, such excavation does not occur below the level of the footing or foundation.

BC 3309.16:
Excavation- Movement Monitoring Design

3309.16 Monitoring plan. Where monitoring is required by Section 3309, such monitoring shall be in accordance with a monitoring plan developed by a registered design professional and acceptable to the commissioner. The monitoring plan shall be specific to the structures to be monitored and operations to be undertaken, and shall specify the scope and frequency of monitoring, acceptable tolerances, and reporting criteria for when tolerances are exceeded.

BC 3304.12:
Excavation- Slurry Operations

3304.12 Slurry. Where slurry is utilized to support an excavation, trench, or drill or bore hole, slurry mix proportions and installation procedures shall be provided by a registered design professional on signed and sealed design and installation procedures. The installation procedures shall account for all imposed loads, including those from the earth, adjacent structures, and adjacent equipment. The use of slurry to support excavations shall be subject to special inspection in accordance with Section 1704.20. Where such construction methods are used to install foundation elements, the new foundation elements installed as part of such operations shall be subject to special inspection as a permanent installation in accordance with the applicable sections of this chapter, including but not limited to special inspection for concrete, and welding.

The 2015 Code Engineering Provisions for the Protection of Adjoining Structures During Excavation

A Discussion of Underpinning and Other Solutions

Dan Eschenasy, PE, F.SEI
Department Chief Structural Engineer

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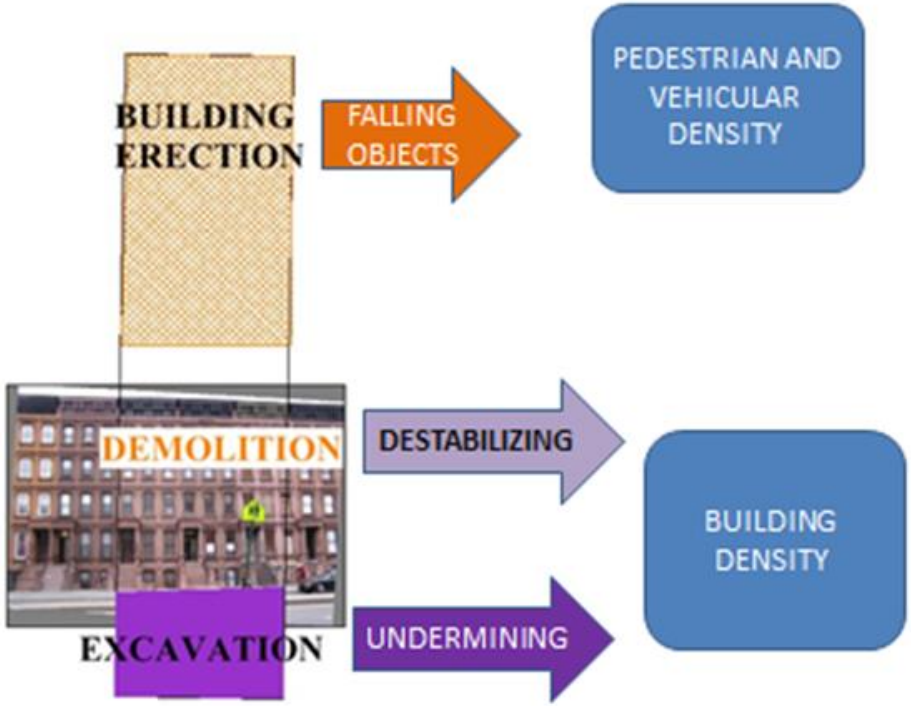
NYC Buildings

Construction in NYC & Density



CODE PROVISIONS

- Ch. 33 Soil Work & Protection of Adjoining Property
- Ch. 18 Underpinning & Protection of Adjoining Property
- Ch. 17 Structural Safety

Underpinning and Support of Adjacent Property – Section BC 1814

2014 Code

1814.1 General. Where the protection and/ or support of a structure or property adjacent to an excavation is required, an engineer shall prepare a preconstruction report summarizing the condition of the structure or property. The preconstruction report shall be prepared based on an examination of the structure or property, the review of available documents and, if necessary, the excavation of test pits. The engineer shall determine the requirements for underpinning or other protection and prepare site and **structure-specific plans**, including details and sequence of work for submission to the commissioner. Such protection may be provided by underpinning, sheeting, and bracing, or by other means acceptable to the commissioner.

1814.1.1 Underpinning and Bracing (cont.)

2014 Code

The design shall take in account the effects on foundation and structure produced by the lateral earth pressure exerted on the underpinning. Lateral support for underpinning, if needed, shall be accounted for during the design of the new construction. The design and construction sequence of temporary lateral supports used prior to the installation of the foundation walls shall be included on the design drawings.

Note" NYCBC2014 does not allow anymore increase in allowable soil pressure for temporary foundations

1814.1.1 Underpinning and Bracing (cont.)

2014 Code

The design shall take in account the effects on foundation and structure produced by the lateral earth pressure exerted on the underpinning. Lateral support for underpinning, if needed, shall be accounted for during the design of the new construction. The design and construction sequence of temporary lateral supports used prior to the installation of the foundation walls shall be included on the design drawings.

1704.20 Structural Stability

1704.20.1 Structural stability of existing buildings.

1704.20.1.1 Construction operations influencing adjacent structures.

1704.20.2 Excavations

1704.20.2.1 Slurry

1704.20.3 Underpinning.

1704.20.4 Demolition.

1704.20.5 Raising and moving of a building

1704.20.6 Inspection program.

1704.20.7 Design documents.

1704.20.7.1 Monitoring.

1704.20.1.1 Construction Operations Influencing Adjacent Structures

2014 Code

Where construction operations have the potential to affect structurally the condition or occupancy of the subject structure and/or an adjacent structure, the structural stability of the such structures shall be subject to special inspections in accordance with Sections 1704.20.6 through 1704.20.10.

Specific to the Building

- Inspect adjoining building to assess condition
- Determine weak/ deteriorated elements
- Lateral load path
- Potential of distress due to movement or vibration

The Engineer is not expected just to create a preconstruction survey, but to assess the capability of the existing structure in its present condition to sustain forces or displacements.

1704.20.7.1 Monitoring

2014 Code

The design documents shall include any requirements for monitoring of the subject structure and/ or adjacent structures, as determined by the registered design professional responsible for the design. The monitoring plan shall be specific to the buildings to be monitored and operations to be undertaken, and shall specify the scope and frequency of monitoring, acceptable tolerances, and reporting criteria for when tolerances are exceeded.

Monitoring - Protocol of Actions

- The monitoring program shall include necessary actions to address exceedence of pre-established thresholds
- Notification protocol
- Adjust construction operations
- Re-evaluate construction operations

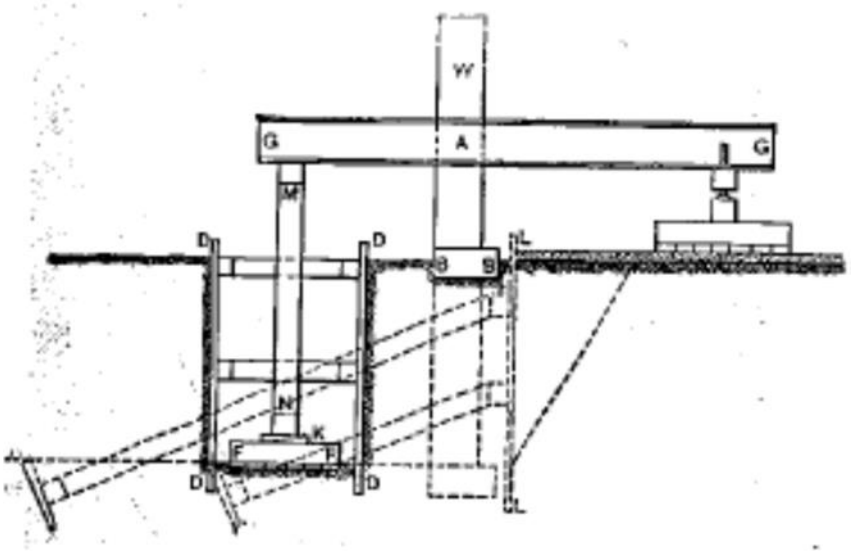
PIN - Underpinning

- Underpinning consists of the installation of a new foundation under an existing one (to transfer the loads at a lower stratum)
- During soil and foundation work for new buildings, such new permanent foundations are installed to support “adjoining walls” or “adjoining buildings”
- Pin-underpinning is a particular method of underpinning that includes support of excavation – sometimes a temporary function. This method is so commonly used in NYC for **adjoining masonry buildings** that it is usually referred to as underpinning

Underpinning a Wall

DISTINCT PURPOSES

- Support of Vertical Loads
- Support of Excavation Cut



FOUNDATION UNDERPINNING AS IT WAS RECOMMENDED IN MANUALS AROUND 1910

Risks

In the absence of engineering design, PIN underpinning becomes in many cases only a bet on the short term stability of the soil cut.

FHWA-RD-75-130
Lateral Support Systems and Underpinning

- Shoring presents some special problems. First, when old walls are encountered, it is often not possible to shore these walls without reinforcing the footing. In some cases the entire footing must be rebuilt prior to both shoring and underpinning. In extreme cases entire walls have to be rebuilt.
- A second consideration is the moment and shear capacity of the walls being underpinned. Asymmetric loading or load concentrations (such as from high capacity underpinning piles) are typical concerns.
- Lateral support and/or reinforcement is often necessary to alleviate this type of problem.

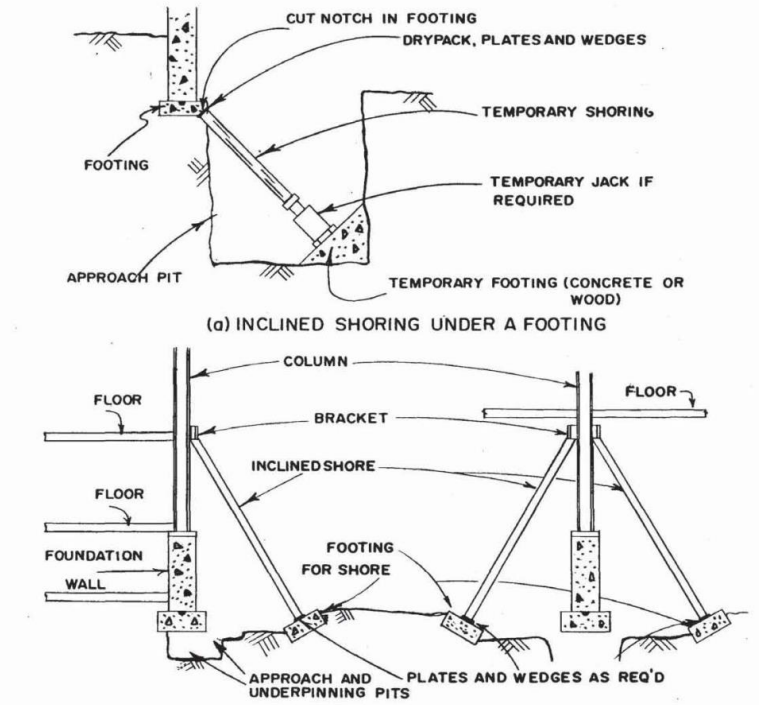


Figure 125. Inclined shoring details.

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Sources of Settlements

- **Structural Elements**. Settlements may be elastic in nature due to an increase in load. Non-elastic deformations may stem from creep and shrinkage of the concrete used for underpinning, as in pit underpinning.
- **Bearing Stratum**. Settlements are caused by strain within the bearing stratum.
- **Construction Procedures**. The two main sources of settlement during construction are loss of ground during excavation and the strain associated with load transfer.
- **The Structure**. The integrity of the existing structure must be considered. Of special interest are old masonry walls, in which brick and mortar may have seriously deteriorated, and structural members (both walls and columns) that might not withstand the bending moments induced during load transfer.

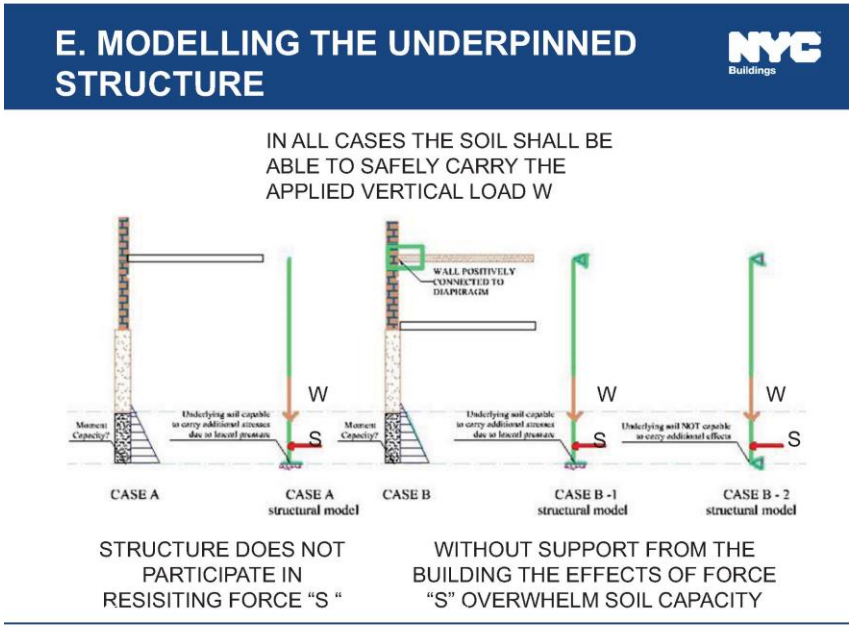
FROM FHWA-RD-75-130

Assess Feasibility

http://www.nyc.gov/html/dob/downloads/pdf/NYSSPE_presentation_underpinning.pdf

Discussion about:

- Underpin + building modeling
- Active or at rest soil pressure
- Loads on existing buildings

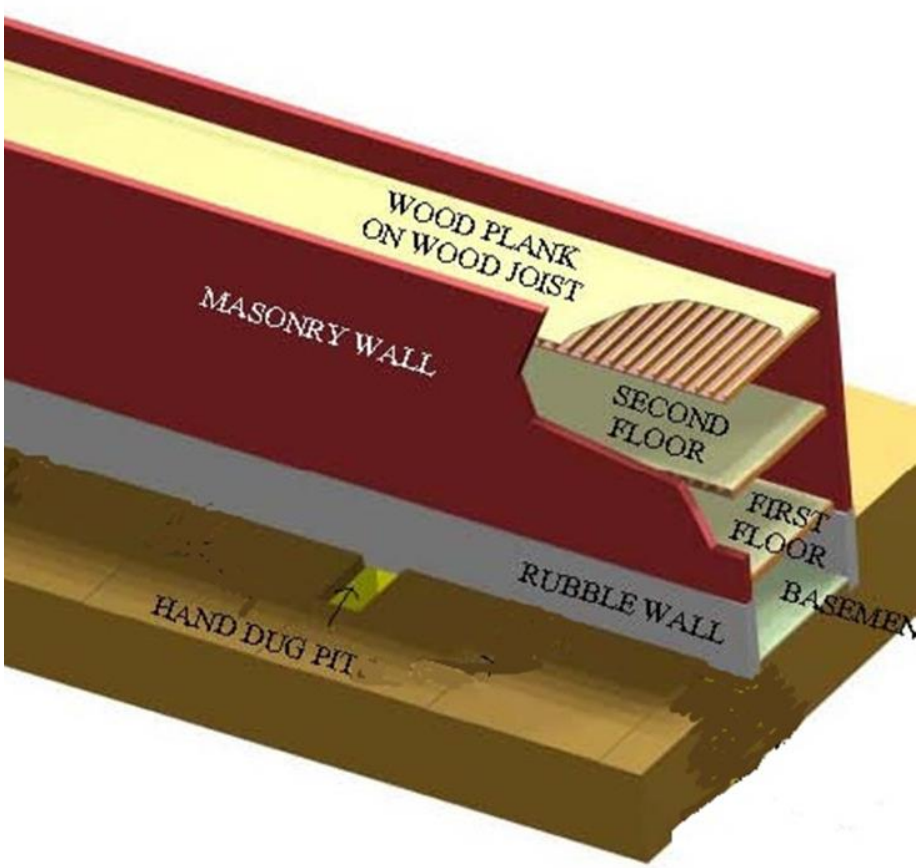


Steps for Evaluating Feasibility of Pin Underpinning

- Determine soil bearing capacity and other properties
- Existing Building (to be underpinned)
  - Determine condition of existing building
  - Determine potential response of existing building
- Determine vertical loads on existing foundation
- Evaluate dimension of pin (for each phase)
- Determine the structural model of the underpinned structure that satisfies the known building and soil conditions
- Verify strength, sliding and overturning for each element at each phase, including soil carrying capacity

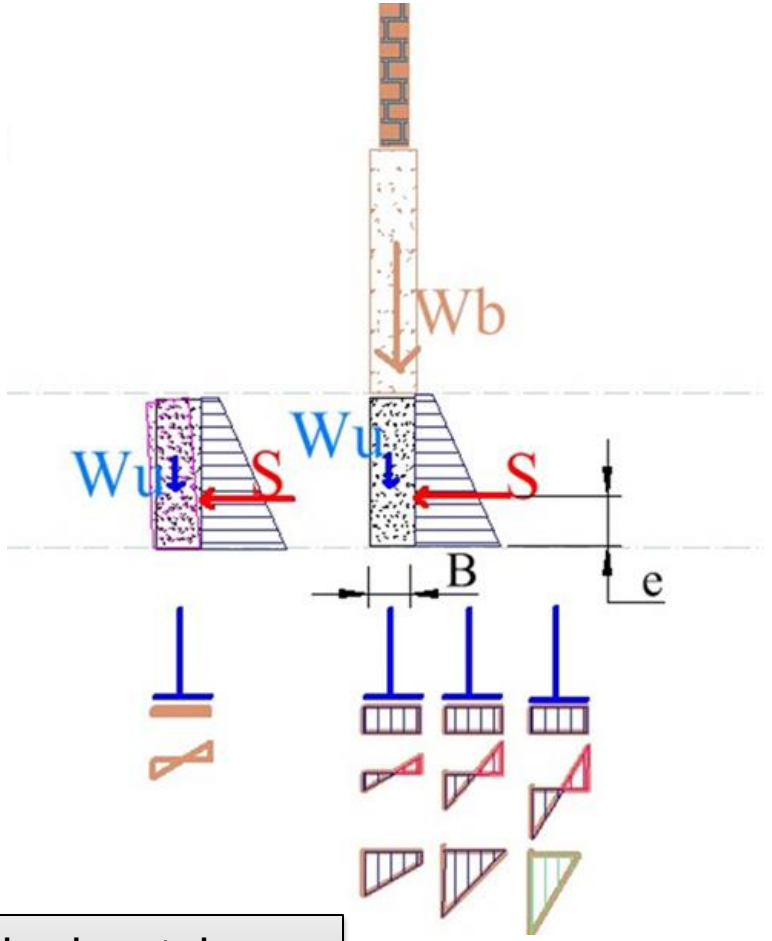
Installation of a Single Pin

- The installation of a single pin is mostly an execution problem. One needs to consider how much the existing foundation can span unaffected when a hole is dug underneath, how to protect the sides of the approach pit, how to pour and connect the pin to the existing foundation. etc.
- The loads introduced by the installed pin will induce only local effects.
- The removal of soil for just one pin is not likely to affect the overall pressure on nearby soil.



Single Pin w/o shim – A small retaining wall

- As the depth and the corresponding lateral soil pressure S increase, a single pin, will fail by overturning
- The conditions are such that the contractor will not seek to stabilize the pin by increasing the depth of the pin beyond the depth of the existing foundation, B
- When connected at the top the pin will be stabilized by the weight transmitted down from the existing building



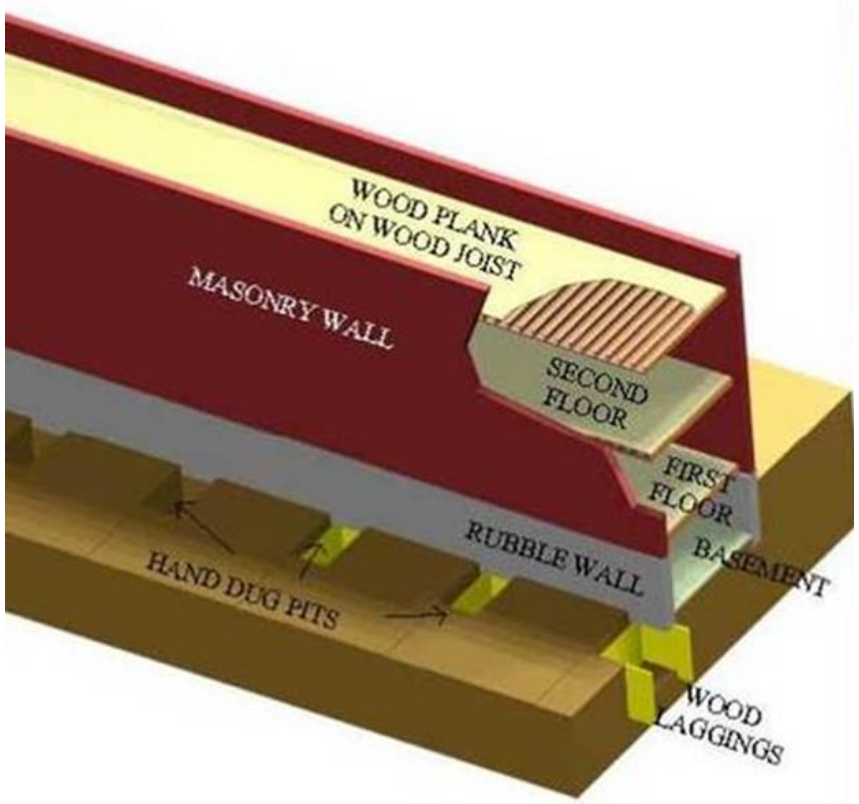
When shim is introduced a portion of the horizontal loads will travel to the existing building

Repeated Installation of a Single Pin?

In many projects the underpinning of an entire wall is viewed as a repeated installation of a single pin.

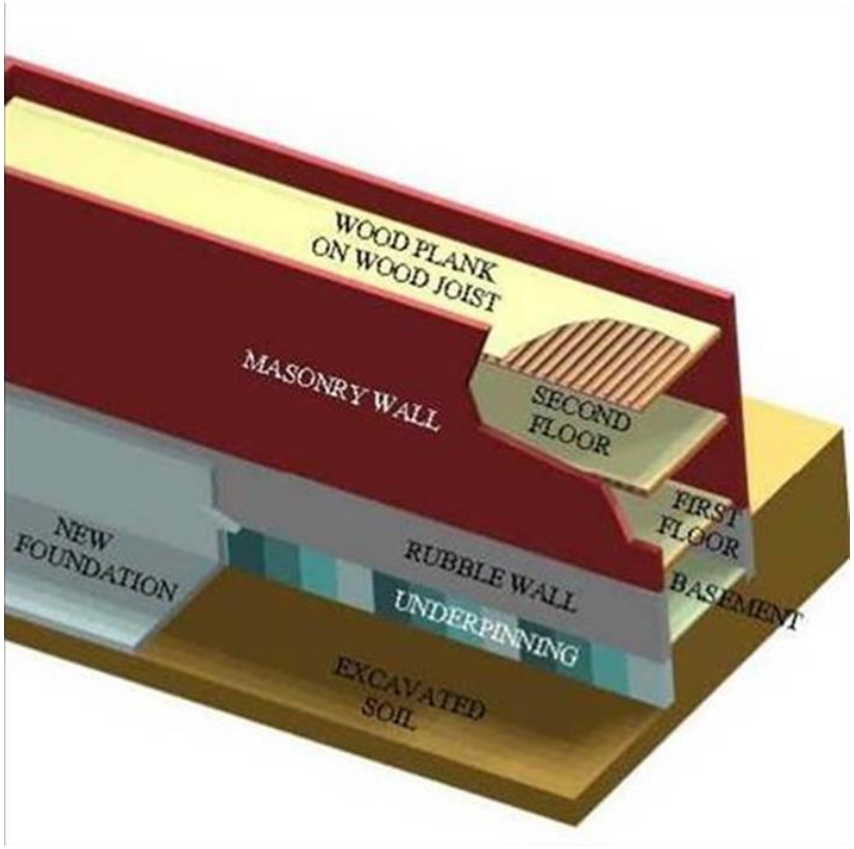
Unless based on engineering, the simultaneous removal of soil and installation of pins might lead to:

- Increase in the vertical pressure exerted on the underlying soil, sometimes beyond allowable values
- Effects of the lateral soil pressure will additionally increase the vertical pressure on the underlying soil
- The soil lateral pressure which will affect the existing building



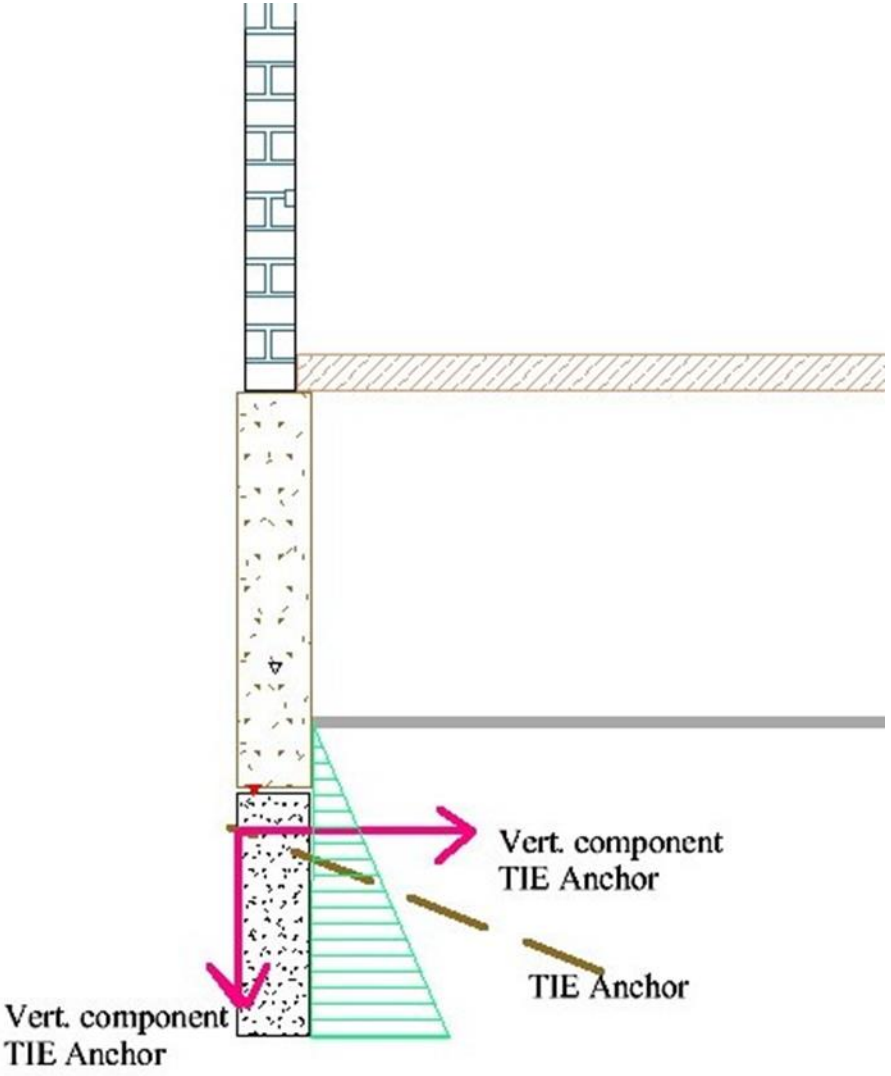
Underpinning as Support of Excavation

- The “repeated one pin” approach might miss considering the larger effect on the entire wall or building produced by the installation of a “support of excavation” system
- The sketch shows clearly that at some point in the execution process a support of excavation system is in place
- Lateral loads exerted on this support system will induce forces in the existing building wall above and in the foundation bellow

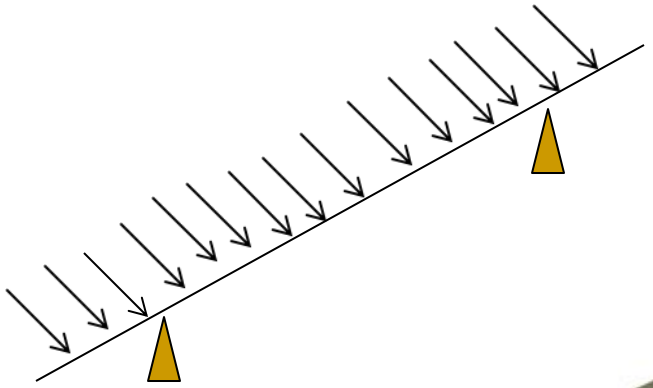


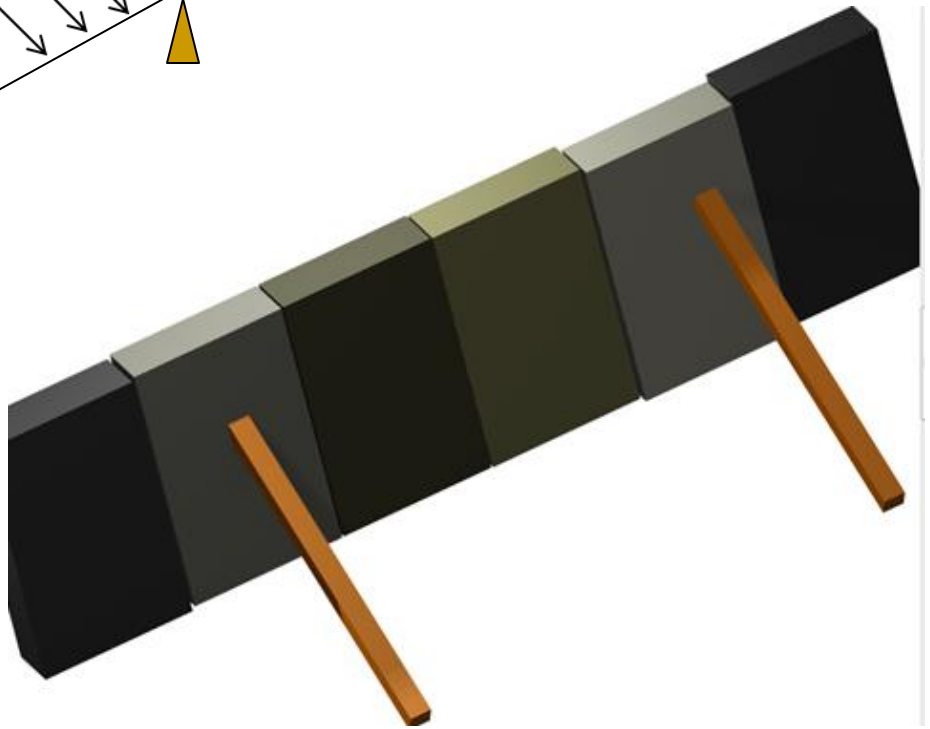
The Anchors

- The installation of a tie anchor introduces loads that need to be considered in detail
- The vertical load can be substantial and will increase the pressure on the soil. Also it might weaken any shimming (already installed)
- The horizontal loads shall not negatively influence the base of the existing foundation



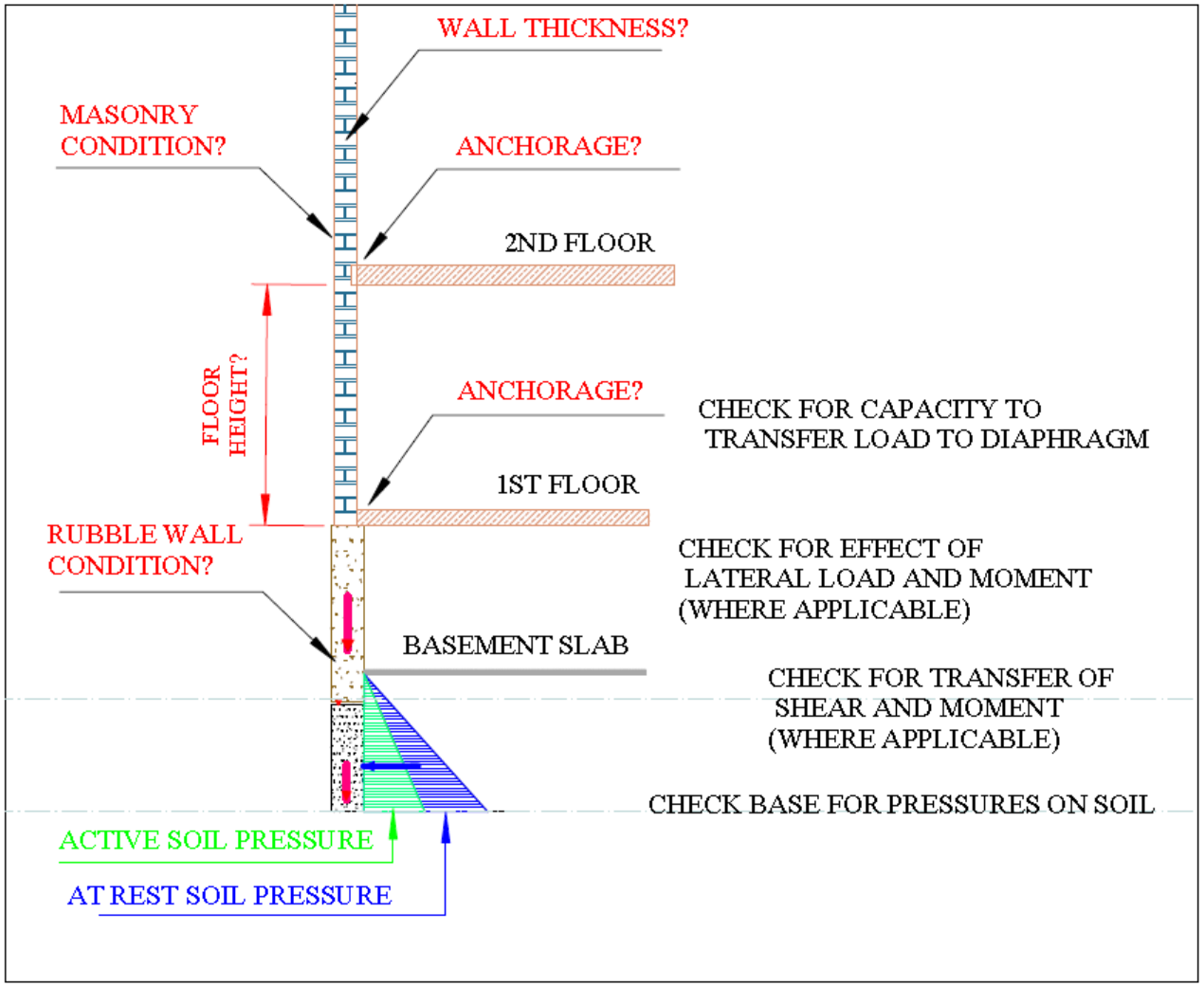
Transfer Lateral Pressure to Support Points





The lateral forces exerted on the pins that are not supported need to be transferred to the brace (or anchor) via reinforcing and/ or shear keys

Existing Building

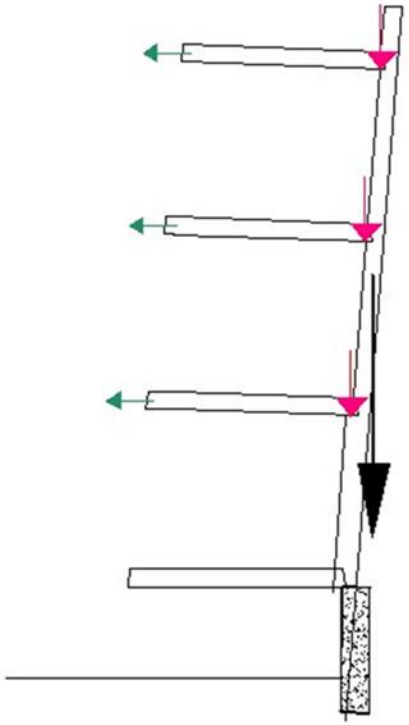


Condition Assessment of Existing Buildings

- Building lean
- Wall cracks
- Wood deterioration
- Evidence of foundation settlement
- Eroded mortar joints

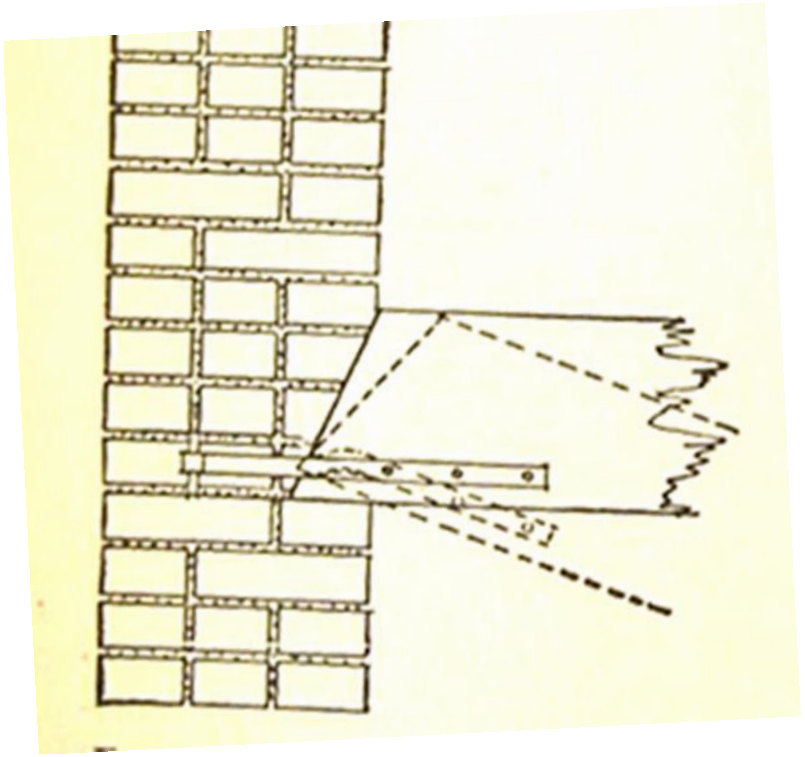
Wall Leaning Outward

- The weight of the wall itself increases the wall's tendency to rotate. The forces induced by the lean might exceed the capacity of the diaphragm.
- One of the probable causes of the lean is poor condition of foundation. This will be further destabilized by underpinning.
- The lean of the building can increase and reach collapse even under only service loads.



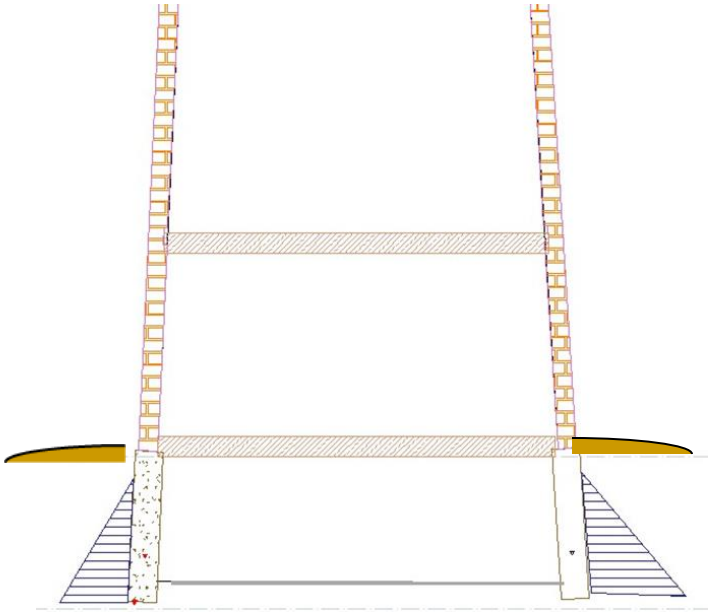
Elements Influencing Stability and Load Path

- Floor to floor height vs. wall thickness
- Floor and joists anchorage to walls
- Wall to wall anchorage
- Interior walls
- Number of floors

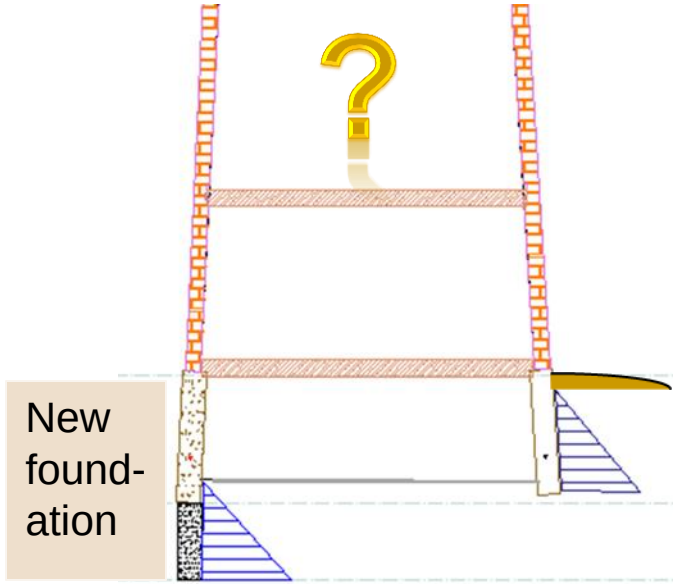


Change in Forces and Stresses?

- The original intent of better masonry builders was to keep the floor diaphragm in compression. Soil pressure on foundation walls as well some inclination of the foundation bottom contributed to this. When in compression, the capacity of the wall to joist connection is less important.



- Underpinning might change the general distribution of forces. The lateral soil pressures might not balance. In the new condition the capacity of the diaphragm to wall connection becomes important. It is essential to prevent the raking of the building.



Evaluation of Pin Underpinning

- If the steps for evaluating pin underpinning show overstress or if there is insufficient data to perform the evaluation use other solutions.

Shoring

British Standards – BS 8004

9.8.1.1 Feasibility. Before underpinning is resorted to, the fullest possible investigation should be carried out by an experienced and competent person to determine whether an underpinning procedure will achieve the object intended.

Before considering the system of underpinning to be employed, the loads to be carried, the sensitivity of the structure and the ground and working conditions should be determined .

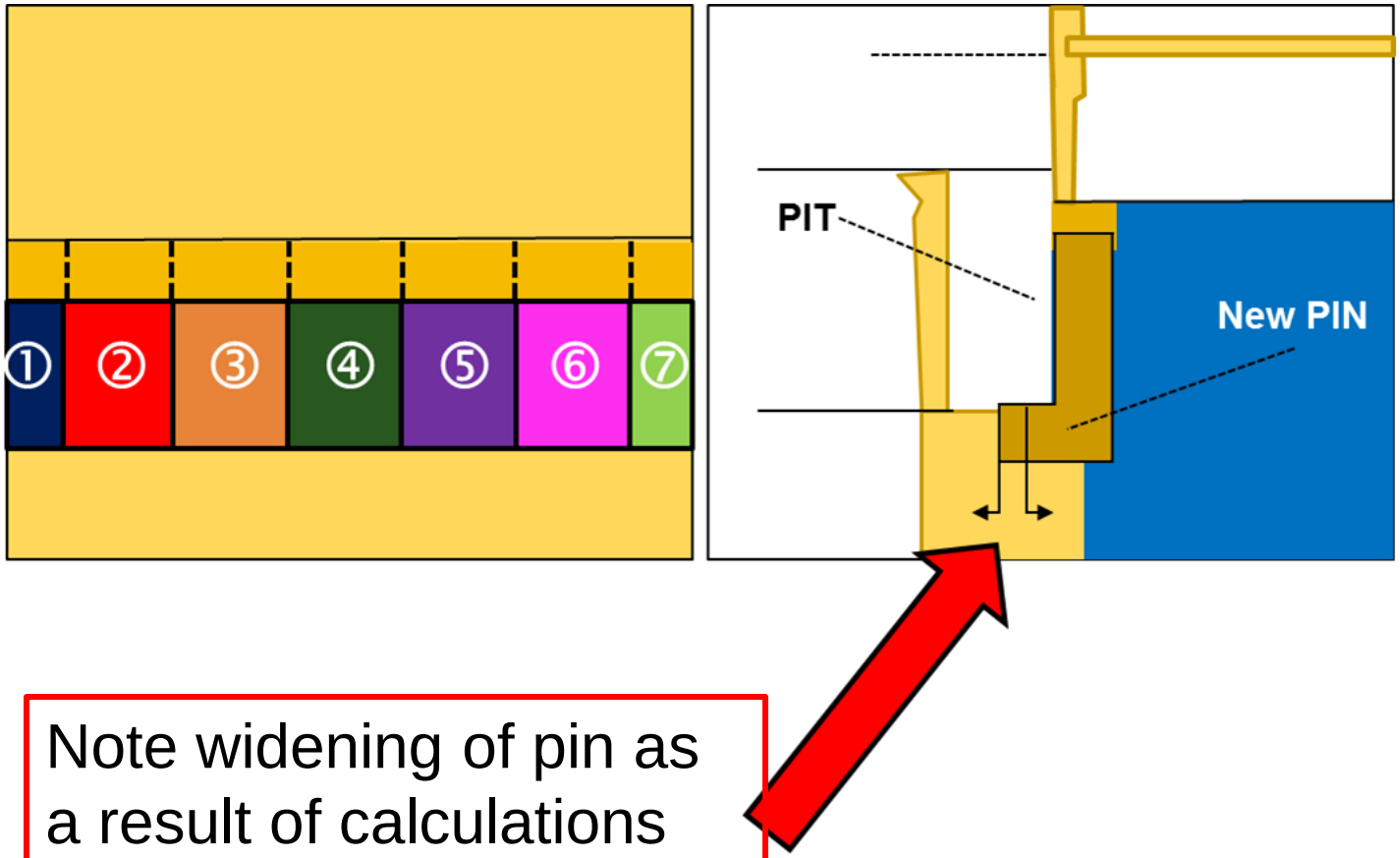
British Standards – BS 8004

9.8.1.3 Structural stability. The structure to be underpinned should be carefully examined for indications of differential foundation movement and for inherent weaknesses which may be accentuated during the process of underpinning, and the structure should be temporarily supported or strengthened.

BS- 8004 -9.8.3 Types of Underpinning

a) Extended strip footings (continuous underpinning constructed in sections usually not exceeding 1.2m);
b) Piles drilled through the foundations;
c) Ground beams beneath walls formed by stooling or needling and supported by piers or piles;
d) Ground beams beside walls supported by piers or piles with needles and/ or load transfer by stressing or other details to transfer the load to the new support.

DIN 4123 – German Standards



Note widening of pin as a result of calculations

Partial Solutions

Vertical Support

- Push Piles
- Helical Piles
- Micropiles
- Pale Radici

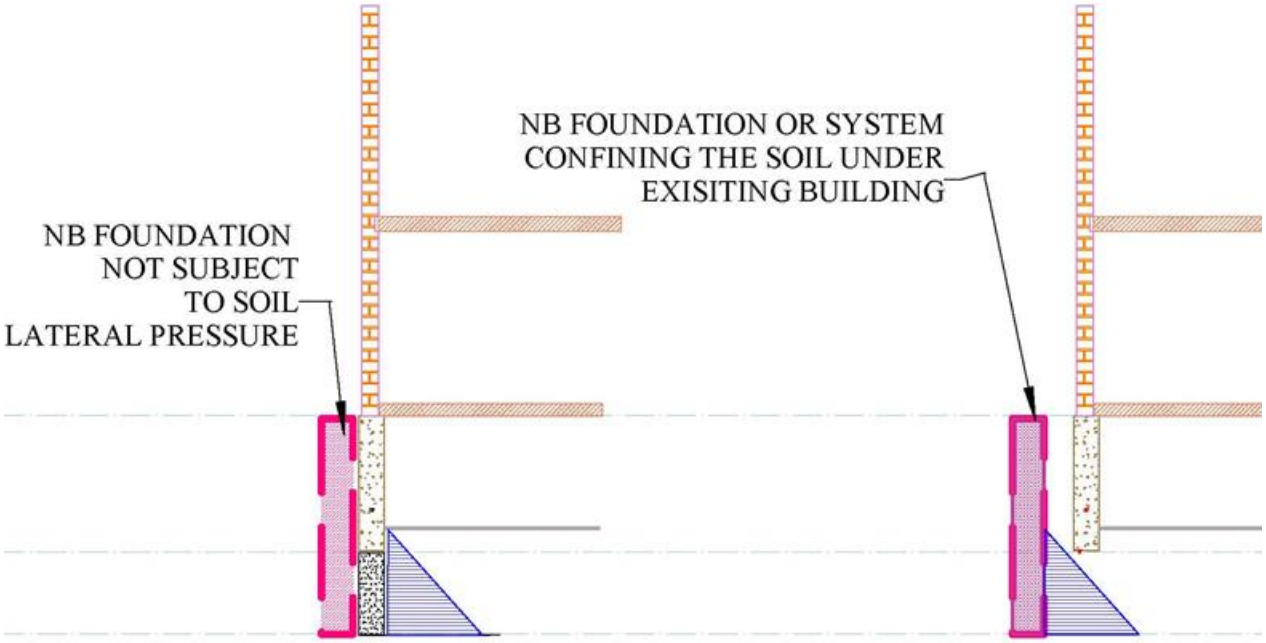
Lateral Support

- Secant Piles
- Tangent Piles
- Slurry Walls
- Grouting

Jet Grouting

http://www.nyc.gov/html/dob/downloads/pdf/seaony_presentation2.pdf

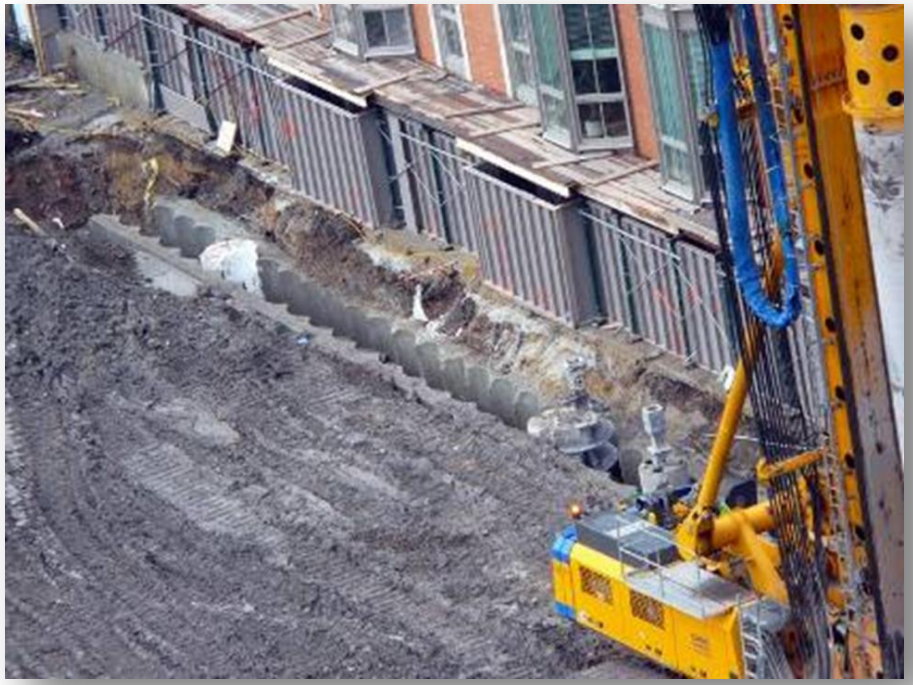
Controlling Lateral Loads



Pin Underpinning

Secant Piles

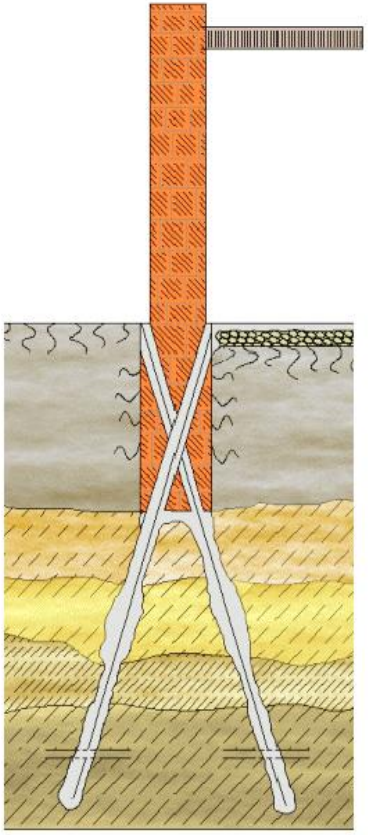
Secant Piles – Rigid Support Walls

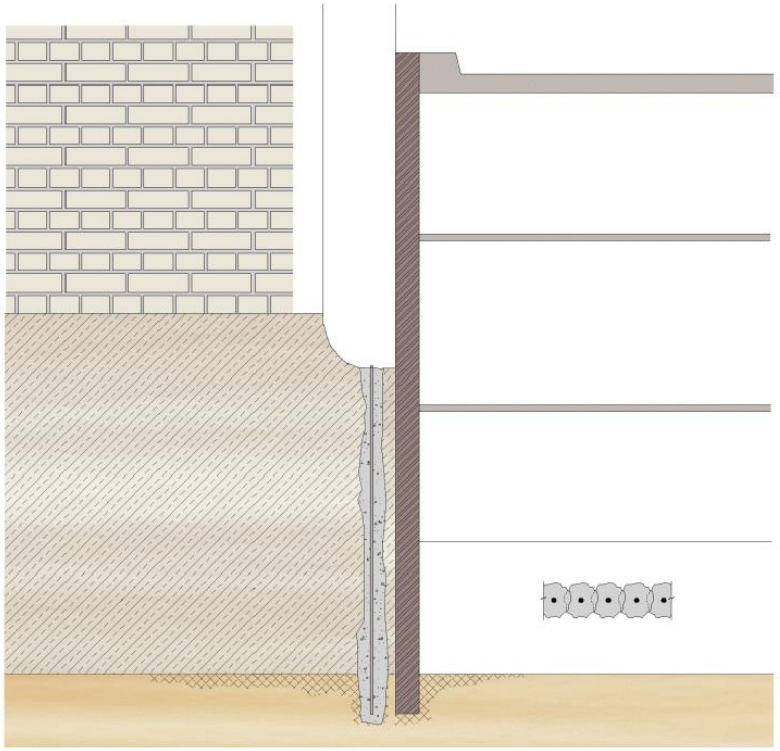


Controlling Vertical Loads

Pile Support System

FHWA NHI-05-039 Micropiles





FHWA NHI-05-039

Conclusion

- Engineering solution should be specific to the building being underpinned
- Consider effect of both vertical and horizontal loads
- Evaluate feasibility of pin underpinning
- Evaluate other potential solutions

Safety of people and adjoining buildings must be the deciding factor.

Concrete Enforcement

Yegal Shamash, PE
Executive Engineer
Investigative Engineering Services

2015 BUILD SAFE | LIVE SAFE CONFERENCE

NYC Buildings

Concrete Enforcement Unit

Description

- Under Investigation Engineering Services
- Enforcement in all five boroughs
- Unit comprised of specially trained inspectors, engineers and administrators
- Number of annual inspections in 2014 = 2,064
- Number of annual drawing audits in 2014 = 135

Concrete Enforcement Unit

Legislative Responsibilities

Field Inspections

- Structural inspections and site safety inspections of all buildings nine stories and under
- Structural inspections of all buildings ten stories and up (BEST responsible for site safety of Major Buildings)
- Parallel Testing – compressive cylinders taken on site and tested at Port Authority Lab. CEU Engineers compare test results from PA with testing lab results
- TR-2/ TR-3 forms, referrals from industry and other DOB agencies

Concrete Enforcement Unit

Legislative Responsibilities (cont.)

Concrete Lab Inspections

- Random twice annual inspections of all NYC registered concrete testing labs

Engineering Audits

- Review of Structural and Architectural Drawings
- Pre-permit reviews
- Post-permit reviews

Incident Response

Concrete Enforcement Unit

Engineering Audit

Lack of Special Inspections

- Incomplete TR-1 form. Complete lack of special inspections
- Partial Inspections. Special Inspector not inspecting entire structure

Construction Issues

- Design Documents are correct, construction contrary to approved plans
- Errors with major structural elements

Concrete Enforcement Unit

Engineering Audit (cont.)

Incorrect Design

- Lateral system incomplete or no lateral system. Building serviceability
- Building Separation
- Under designed structural elements; cantilevers and transfer beams

Concrete – Special Inspections BC 1704.4

BC 1704.4 Concrete Construction

Special Inspections for Concrete Construction is required except:

- Nonstructural concrete slabs on grade
- Concrete foundation for lightweight fences and recreational equipment
- Concrete patios, site furnishings, garden walls, driveways, sidewalks and similar construction

Concrete – Special Inspections BC 1704.4

BC 1704.4 Concrete Construction

Testing of Concrete Construction at the time fresh concrete is required except:

- Where total concrete placement on a given project is less than 50 cubic yards
- Isolated spread footings of 1 or 2 family buildings, three stories or less supported on earth or rock
- Continuous concrete spread footings supporting walls of 1 or 2 family buildings, three stories or less supported on earth or rock

BC 3305.3.2.1: Form Work - New Design Triggers

3305.3.2.1 Design drawings. (New Design Triggers Only)

1. For concrete formwork is in a structure classified as a major building; *or*

6. Wherever the slab thicknesses or beam heights equal or exceed 10 inches; *or*

7. Wherever there are concentrated loads exceeding 2000 lbs. imposed on the formwork; *or*

8. Wherever there are loads imposed on existing structures in accordance with Section 3305.3.1.2.1.

BC 3305.3.1.2.1: Concrete Load on Existing Structures

3305.3.1.2.1 Use of existing structures to support vertical or lateral loads.

The use of existing structures to support vertical or lateral loads imposed by concrete construction operations shall require an evaluation of the existing structure for the loads imposed by a registered design professional. The registered design professional shall prepare design drawings documenting the findings of the evaluation, indicate the location of formwork elements, and the interface between the formwork and the existing structure.

BC 3305.3.3.2: Form Work Observation

3305.3.3.2 Formwork observation.

In addition to the inspections by the contractor required pursuant to Section 3305.3.3.1, visual observations of the formwork for the general conformance with the design intent shall be performed by the form work designer or his designee.

BC 3305.3.6.8: Concrete Formwork Reshoring

3305.3.6.8 Reshoring Schedule.

A signed and sealed reshoring schedule shall be provided and maintained at the construction site whenever reshoring is employed.

Exception:

A separate reshoring schedule is not required when the required reshoring information is covered on the approved construction documents prepared by the applicant of record.

Concrete Enforcement Unit

Field Inspection – BC 1906.3.2

Concrete Enforcement Unit

Field Inspection – BC 1906.3.2

Concrete Enforcement Unit

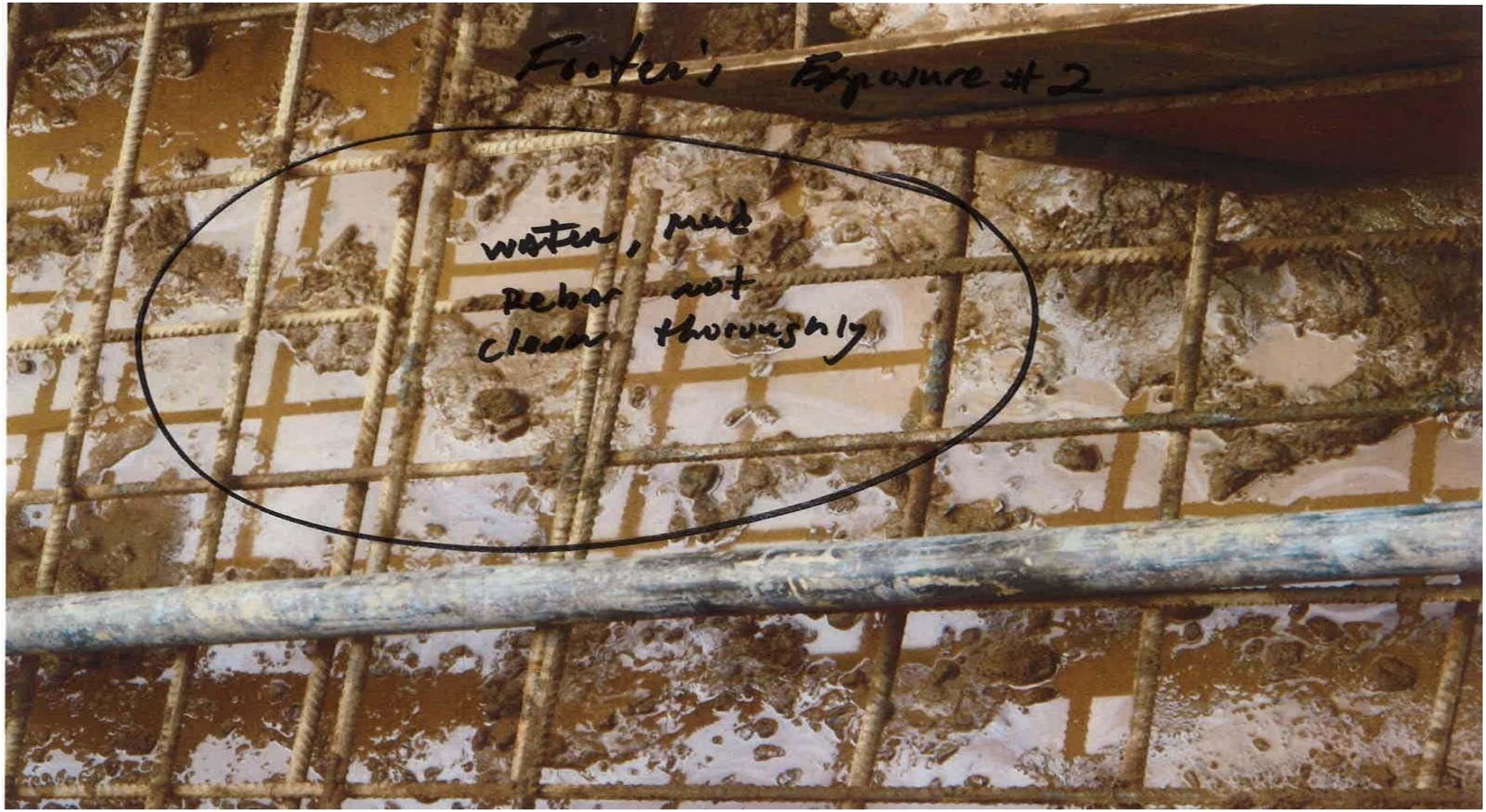
Field Inspection – BC 1906.3.2

Concrete Enforcement Unit

Field Inspection – BC 1906.3.2

Concrete Enforcement Unit

Field Inspection – BC 1704.4 – BC 1905.7

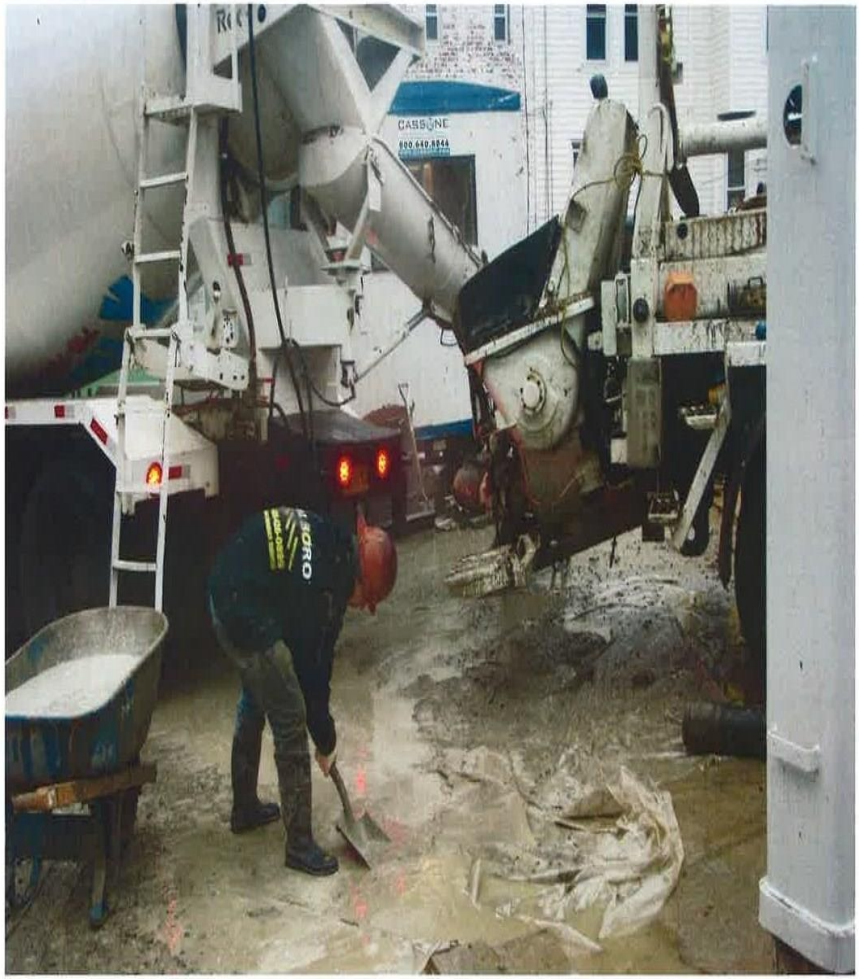


Concrete Enforcement Unit

Field Inspection – BC 1905.6.3.2

Concrete Enforcement Unit

Field Inspection – BC 3303.15.1



Concrete Enforcement Unit

Field Inspection – BC 3301.7

Concrete Enforcement Unit

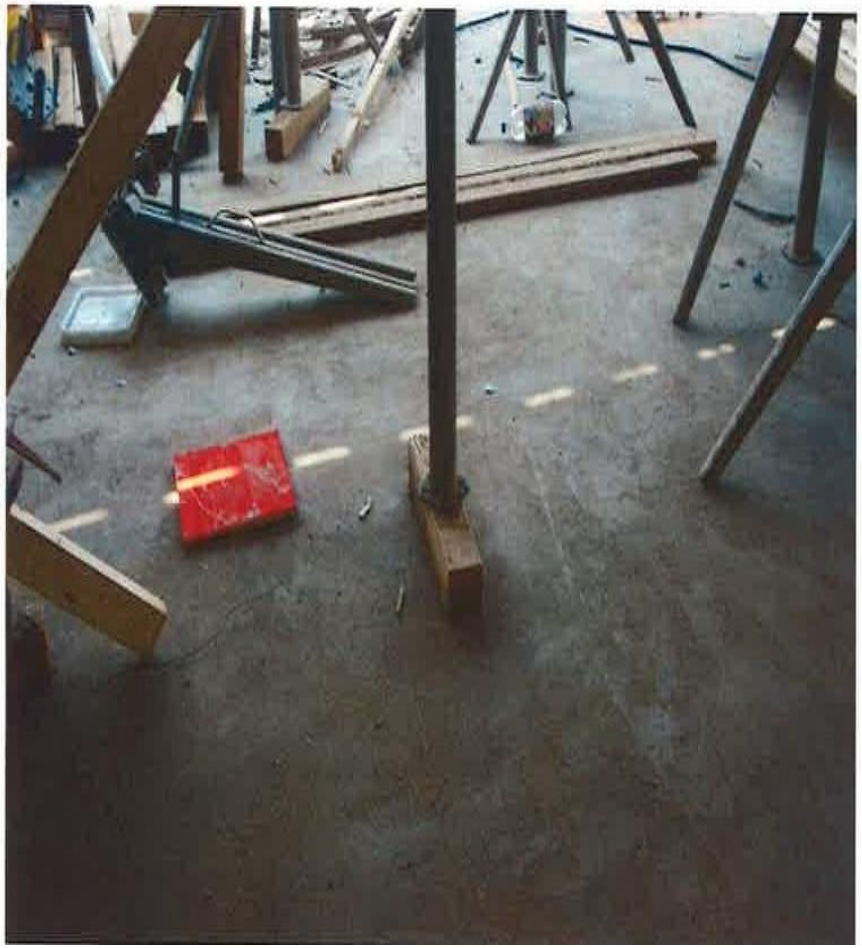
Field Inspection – BC 28 - 105.12.2

Concrete Enforcement Unit

Field Inspection – BC 3301.2

Concrete Enforcement Unit

Field Inspection – BC 28-105.12.2



Concrete Enforcement Unit

Field Inspection – BC 3307.3.1

Concrete Enforcement Unit

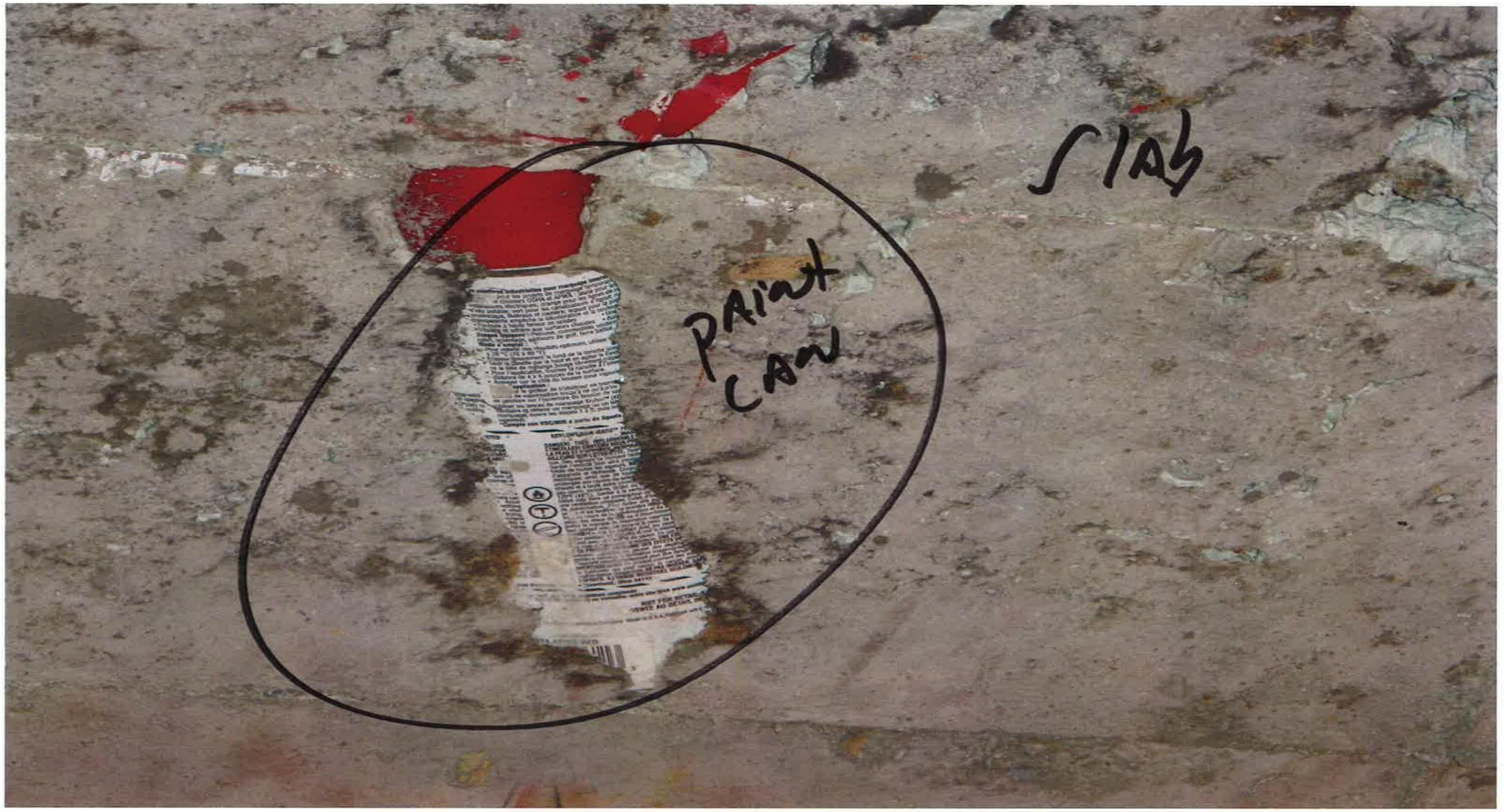
Field Inspection – BC 28-105.12.2

Concrete Enforcement Unit

Field Inspection – BC 3301.7

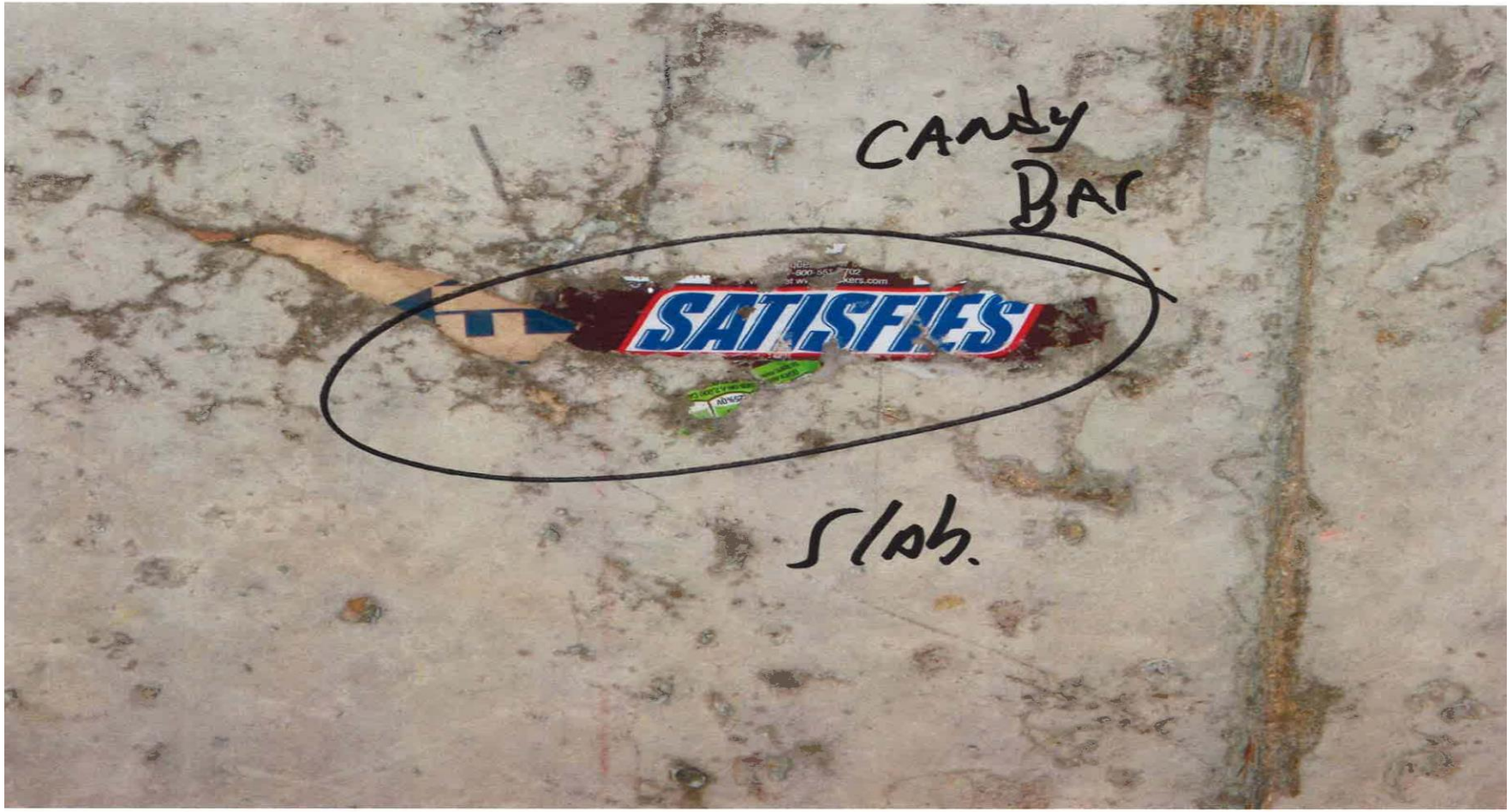
Concrete Enforcement Unit

Field Inspection – BC 3301.7



Concrete Enforcement Unit

Field Inspection – BC3301.7



Concrete Enforcement Unit

Field Inspection – BC 28.105.12.2

Questions?

This concludes the American Institute of Architects Continuing Education Systems Course.

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212.393.2167