



STRUCTURAL CONDITION ASSESSMENT AS A TOOL FOR SAFE CONSTRUCTION

presented by

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DESCRIPTION

The presentation reviews the methods of structural condition assessment of existing buildings as they relate to issues faced by engineers during the design and construction in a dense building neighborhood. The use of condition assessment findings in the design of demolition and underpinning activities will be reviewed.

LEARNING OBJECTIVES

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

1. Discuss the principles and methodologies of structural condition assessment as a tool for the design of construction operations and monitor building response.
2. Learn about the NYC Building Code Chapters 17 and 33 requirements to protect adjoining structures during construction.
3. Review how structural condition assessment can be structured to respond to specific project conditions and construction activities.
4. Discuss and will be able to identify use of structural condition assessment for demolition and underpinning design.

NYC ADMINISTRATIVE CODE

CHAPTER 3 MAINTENANCE OF BUILDINGS

CONDITION ASSESSMENT

RETAINING WALLS

§28-305.4.3 Condition assessment requirements. A condition assessment of a retaining wall shall be conducted at periodic intervals as set forth by rule of the commissioner, but such assessment shall be conducted at least once every 5 years.

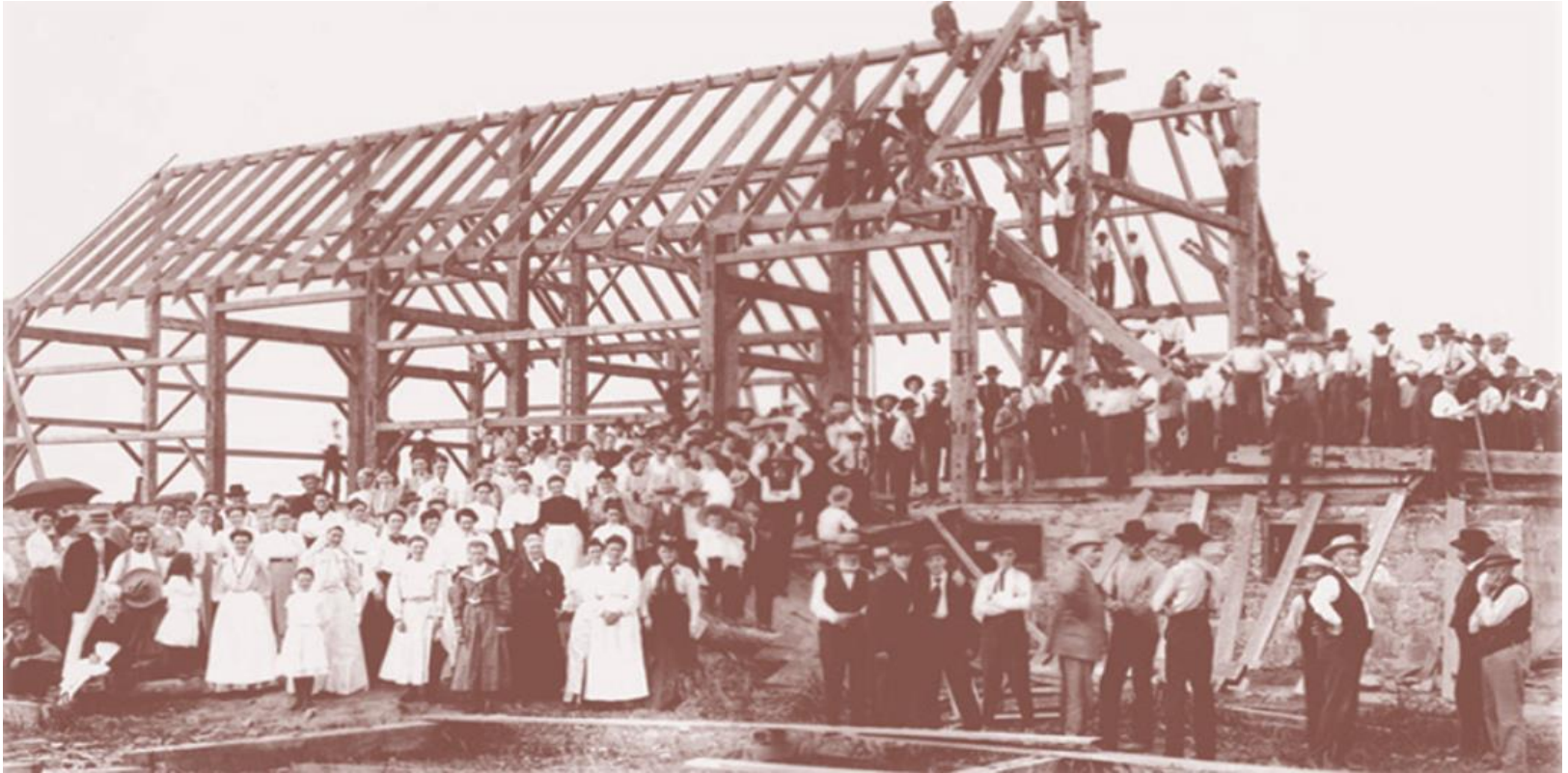
NOTE: NYC Building Code does not use the term 'Condition Assessment' often

FACADES 1 RCNY §103-04

Critical examination. An examination conducted to review the exterior of a building and all parts thereof to determine whether the exterior walls (façades) and the appurtenances thereto are either safe, unsafe, or safe with a repair and maintenance program and whether, in the judgment of a Qualified Exterior Wall Inspector, they require remedial work.

The QEWI shall utilize a professional standard of care to assess the building's condition, including splitting or fracturing of terra cotta on buildings,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.

ENTIRE VILLAGE



The entire community participated in the erection of a building.

CURRENT DENSITY



Construction often occurs in tight lots next to very old buildings.

STANDARDS AND REFERENCES

- *ASCE 11 Guideline for Structural Condition Assessment of Existing Buildings*
- *ASCE 30 Guideline for Condition Assessment of the Building Envelope*
- *Masonry Society – Guide for Condition Assessment of Masonry Façades*
- *ASCE 31 Seismic Evaluation of Existing Buildings*

STANDARDS AND REFERENCES

(continued)

- *ATC-45 Safety Evaluation of Buildings after Windstorms and Floods*
- *ASTM E2018 Standard Guide for Property Condition Assessments*
- *ACI 562 - Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures*

ASCE/SEI 11 - DEFINITION

Systematic collection and analysis of data, evaluation, and recommendations regarding the portions of an existing structure which would be affected by its proposed use.

PURPOSE OF ASSESSMENT

Per **ASCE 11** condition assessment of an existing building envelope may be undertaken for a number of purposes

- a performance report
- establishing building serviceability
- planning for maintenance or repair
- Code compliance
- life safety, durability
- historic preservation
- or a number of special purposes based on the specific building and its current or proposed occupancy or function

CONCRETE POURED AGAINST MASONRY



BUILDINGS BULLETIN 2009-011 requires 'Evaluation' of Supporting Structure When Placing Concrete

EVALUATION

- The emphasis of the evaluation is directed by the **PURPOSE** of the investigation
- Safety/integrity of existing buildings or work area
 - during construction
 - as a result of construction
- **TO MAKE INFORMED DECISIONS**

TYPES OF ASSESSMENT

Cursory Assessment: This is a visual overview of the general condition of the building envelope. It is often used for screening multiple buildings to establish priorities for maintenance and repair or further study.

Preliminary Assessment: The preliminary condition assessment is usually limited in scope. It will consist of a site visit for familiarization and to identify problem areas, a review of available documents, an interview of involved parties, and a preliminary report of findings and recommendations.

Detailed Assessment: This is an expansion of the preliminary assessment. It will include a review of documentation, component classification, field investigation, testing, analysis, and report.

Safety: There are numerous types of circumstances that present a potential hazard to the safety of the personnel involved.

ASSESSMENT PURPOSE AND CRITERIA

ASTM-E-2018-15

The goal is to identify and communicate physical deficiencies to a user. The term physical deficiencies includes the presence of conspicuous defects and material deferred maintenance of a subject property's material systems, components, or equipment as observed during completion of the property condition assessment . This definition specifically excludes deficiencies that may be remedied with routine maintenance, miscellaneous minor repairs, normal operating maintenance.

CONDITION REPORTS: CRITERIA LIST REQUIRED

Good Condition – in working condition and does not require immediate or short term repairs above an agreed threshold.

Fair Condition – in working condition, but may require immediate or short term repairs above an agreed threshold

Poor Condition – not in working condition or requires immediate or short term repairs substantially above an agreed threshold

*From ASTM E 2018 – 15 Standard Guide for Property Condition Assessments:
Baseline Property Condition Assessment Process*

ACI 562 - CODE REQUIREMENTS FOR ASSESSMENT, REPAIR & REHABILITATION OF EXISTING CONCRETE STRUCTURES

- Unsafe structural conditions for gravity and wind loads
- Substantial structural damage to vertical members of the lateral-force resisting system
- Substantial structural damage to vertical members of the gravity-load resisting system
- Damage less than substantial structural damage, deterioration and faulty construction with capacity increase
- Damage less than substantial structural damage, deterioration and faulty construction without capacity increase

PERSONNEL QUALIFICATIONS

All personnel involved in the assessment shall possess the technical qualifications, including practical experience, education and professional judgment required to perform the individual technical tasks assigned. Interpretation of results and conclusions shall be performed by a design professional qualified in the appropriate discipline.

DEFECT vs. DETERIORATION

- A defect is the nonconformity of a component with a standard or specified characteristic. Defects may be introduced through poor design, manufacturing, fabrication, or construction before a structure begins its service life and (less frequently) by inappropriate operations and maintenance during its service life.
- Deterioration is the gradual adverse loss of desired material properties. Eventual deterioration is normal for most construction materials owing to aging and weathering processes.

from *Structural Condition Assessment* by Robert T. Ratay

EXAMINATION AND EVALUATION

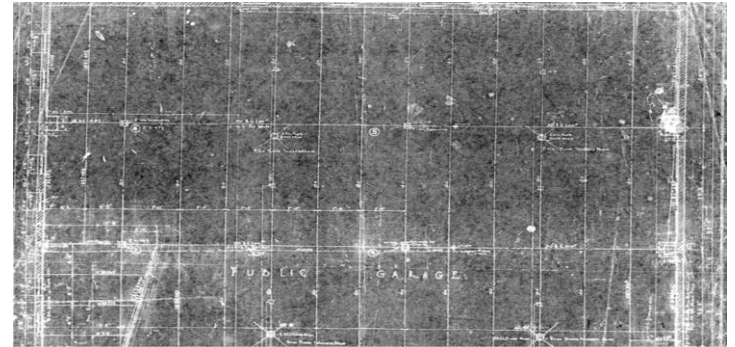
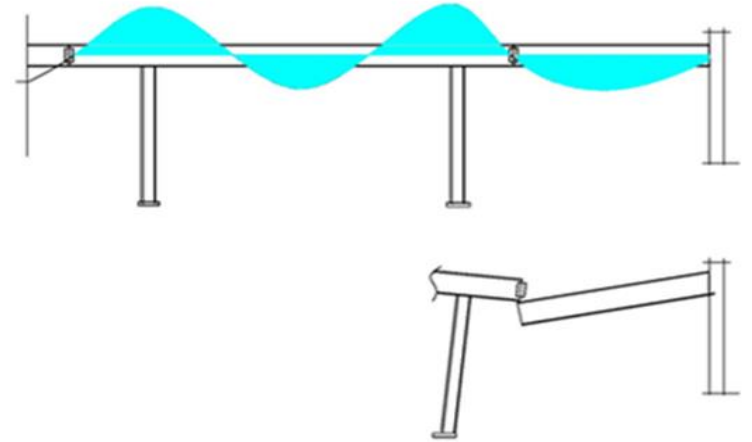
Structural condition assessment is the physical examination and diagnosis of the **health** of a structure. It may include one, several, or all of the activities of

- visual observation
- measuring
- photographing
- probing and sampling
- field and laboratory testing
- numerical analyses
- record keeping
- documentation
- report preparation

FACADE ASSESSMENT – NEEDS PROBE



CONSULT EXISTING DRAWINGS: POSITION OF CONNECTIONS



GENERAL PHYSICAL CONDITION

- Is there any visually discernable damage, deterioration, or defects present that indicates a compromised structural integrity of the building or of local elements?
- Is there a visually discernable deformation that may indicate existing or developing instabilities?

BOWING AND BULGING



CRACK SIGNIFICANCE



CRACK SIGNIFICANCE

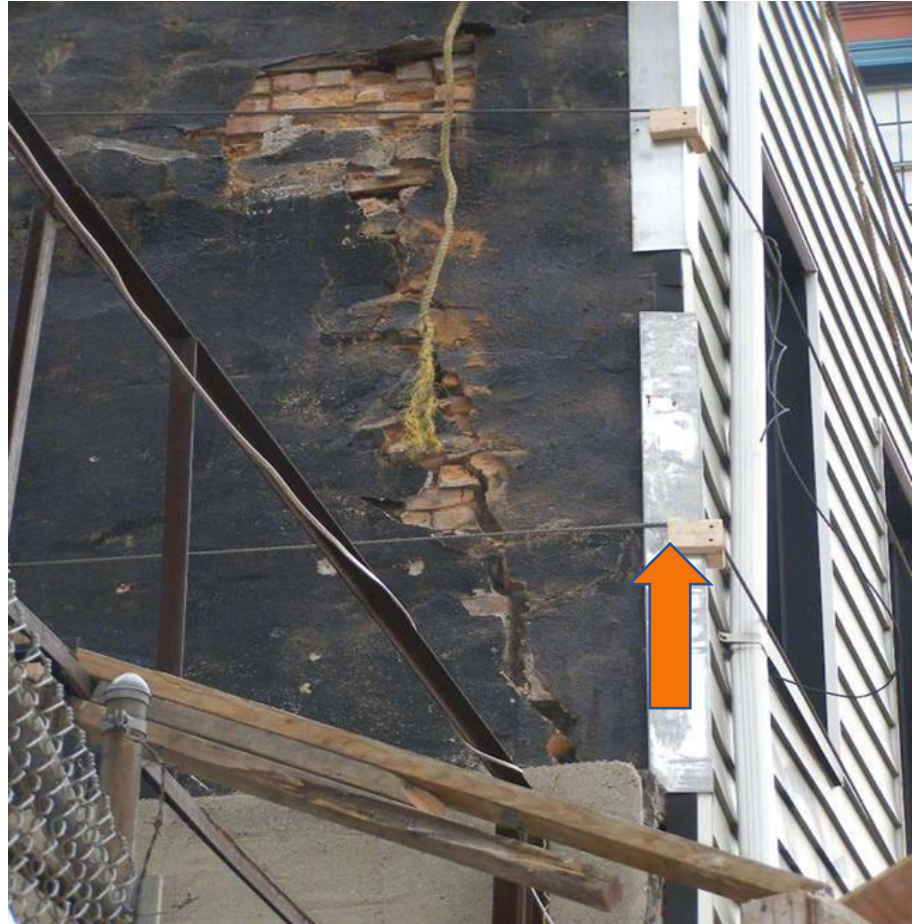


LOADING

- Will the structure be exposed to loads that it had not previously been subjected to?
- Will the structure be exposed in the future to, environmental conditions that can cause deterioration such as moisture?

LOAD PATH

Does the structure have well-defined load paths for gravity, lateral, and applied loads?



KNOWN CAUTIONARY CONDITIONS



- Are there existing members or structural systems with known limitations?
- Are there unbraced conditions?

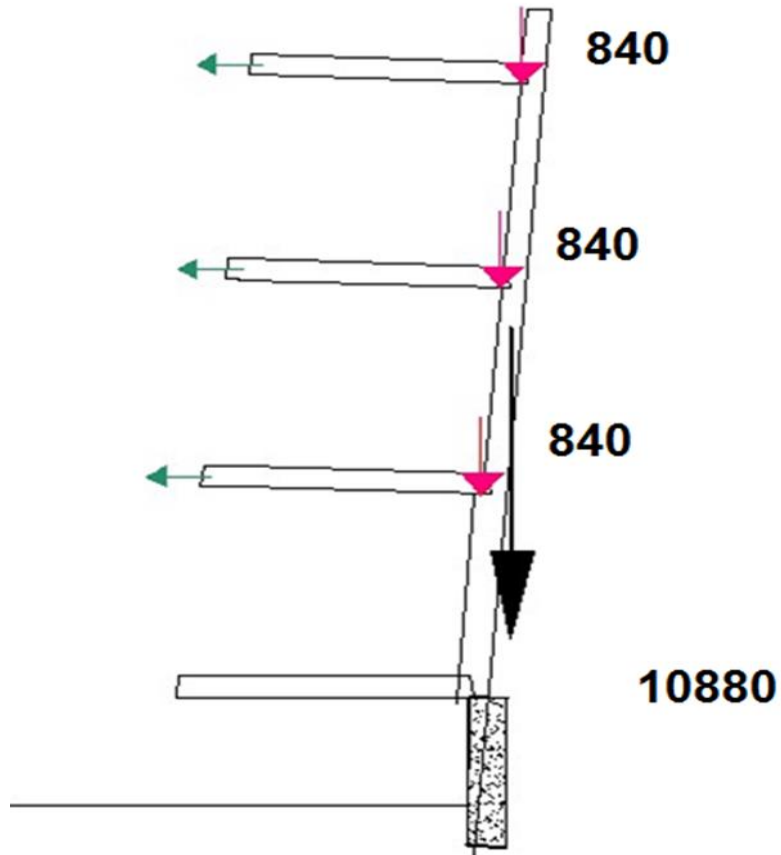
WALL STABILITY



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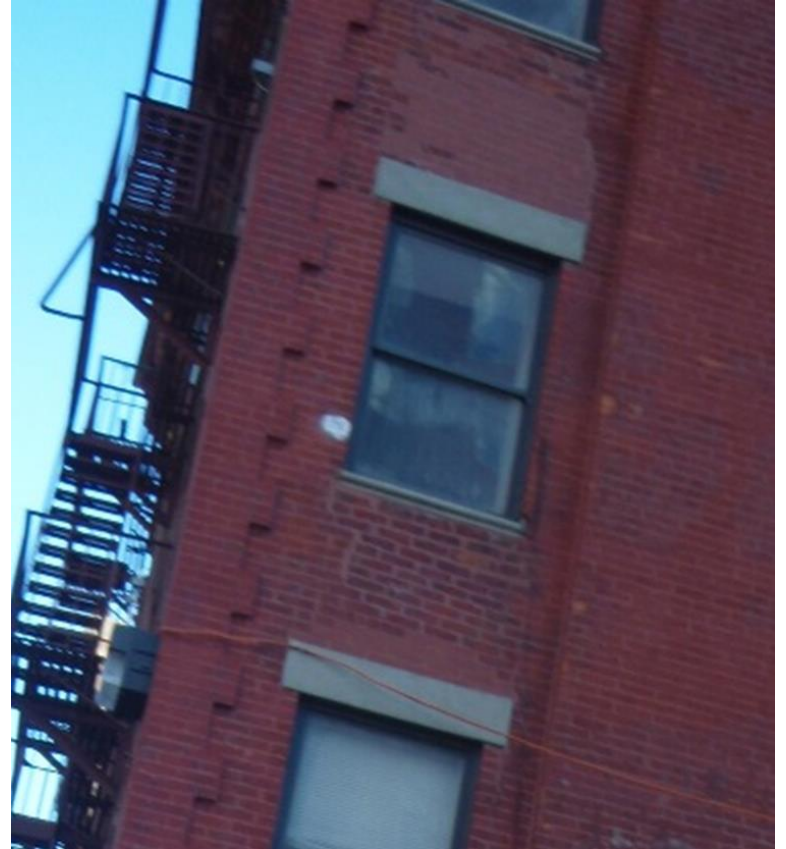
LEANING STRUCTURES



OTHER ISSUES

- Occupancy
- Design Quality Confidence
- Construction Quality Confidence
- Concealed Defect Potential

REPAIR OUTSIDE WYTBE ONLY



PREVIOUS REPAIR MISSED RUSTED WELD



CONSEQUENCE OF FAILURE



- Could the failure of the considered system result in a more wide spread or progressive collapse?
- Could there be a sudden failure without warning signs?

STRUCTURAL STABILITY PARTY WALLS



Stability and condition of remaining party walls shall be monitored and protected by the owner of the demolished building.

BUILDING SYSTEM SCREENING PER ASCE 31

- Load Path
- Adjacent Buildings
- Weak Story
- Vertical Discontinuities
- Deterioration of Wood Masonry Joints
- Unreinforced Masonry Wall Cracks
 - Diagonal cracks greater 1/16"
 - Out of plane offsets 1/8"
 - Not form an X pattern

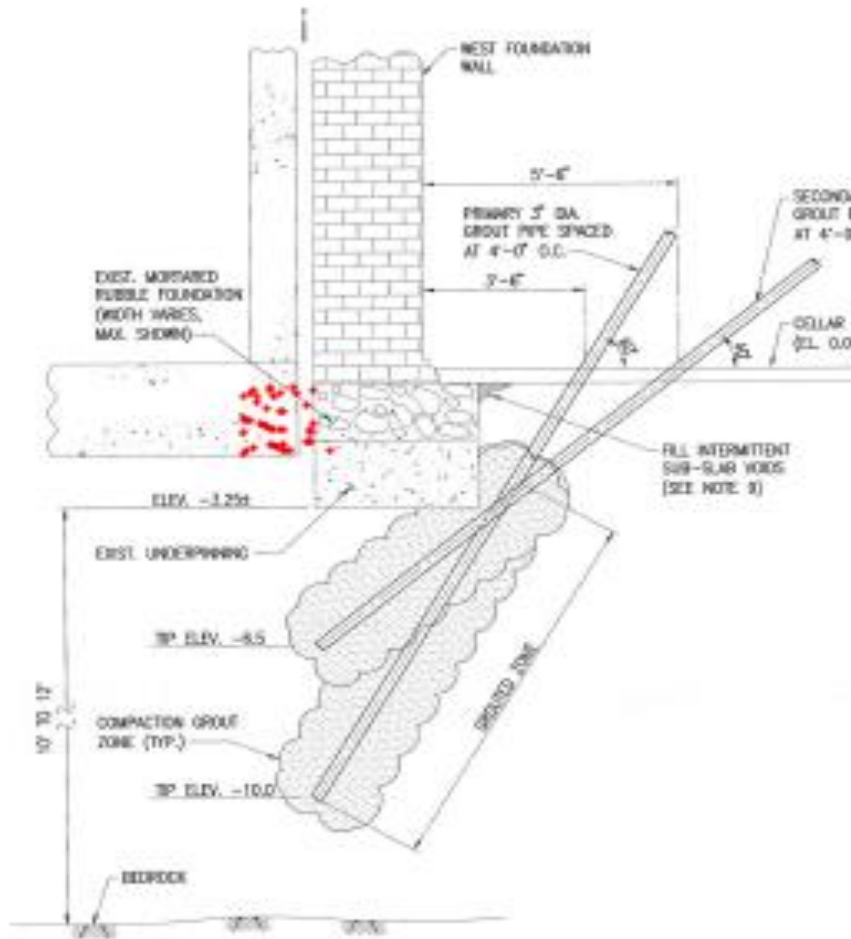
RAPID INSPECTION FORM ATC 46

CONDITION	YES	NO
1. Collapse, partial collapse, or building off foundation		
1. Building or story noticeably leaning		
1. Severe racking of walls, obvious severe damage/distress		
1. Chimney, parapet/Cornice or other falling hazard		
1. Severe ground or slope movement present		
1. Other hazard present/specify		

LEANING BUILDING



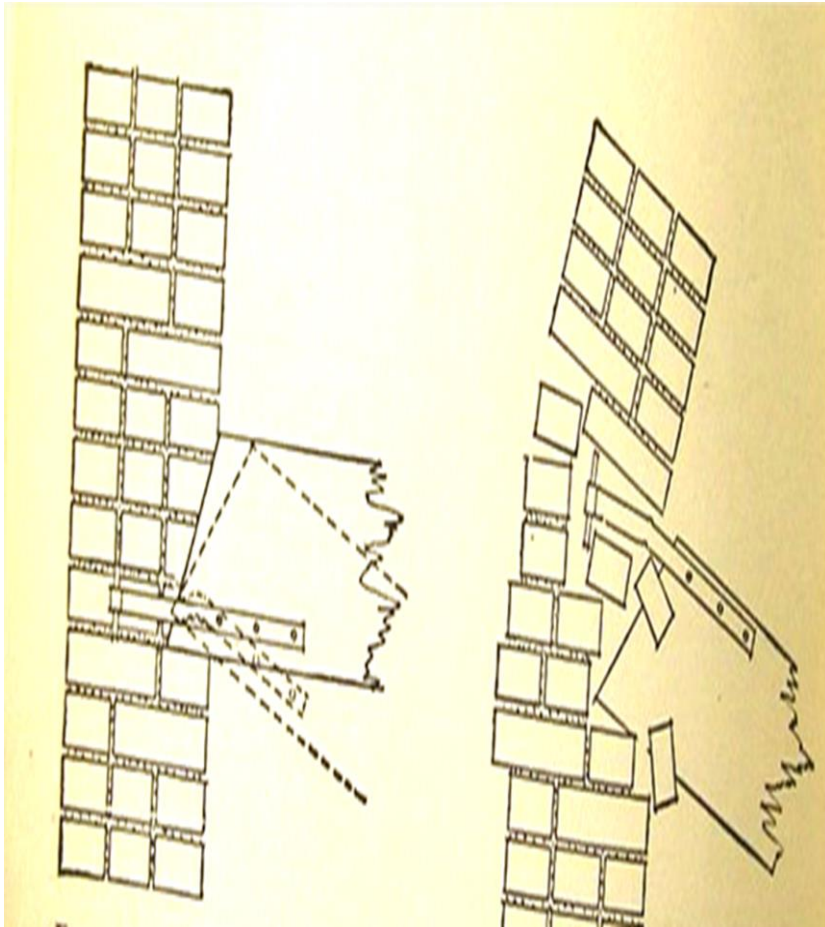
PARTY FOUNDATION CUT



GRAVITY SUPPORT

- Vertical load bearing capacity, lateral forces from masonry arches
- Removal of load bearing wall
- Settlement or movement of foundation
- Internal changes from volume changes of masonry (thermal, moisture, etc.)
- Adjoining excavation
- Movement, corrosion, poor design, poor detailing

WIND ANCHORAGE



- Inadequate capacity of anchors that connect the masonry to the structure
- Failure of masonry around metal ties or lateral anchors (mechanical deficiencies, deterioration)
- Failure of masonry headers or metal ties
- Insufficient anchorage to the roof.

WOOD

- **NEED TO KNOW WOOD SPECIES** – there is a need to know the wood species to better understand shrinkage and swelling behavior, density for determining connector capacity, or ability of the wood to resist biological deterioration.
- **MOISTURE CONCERNS** – there is a need to assess moisture stains or high moisture content to determine if wood provides a favorable environment for active wood decay or insect attack, and identify sources of moisture.
- **DETERIORATION CONCERNS** – there is a need to determine whether biological deterioration may be present, to locate and quantify the extent of deterioration, and assess its impact on material properties.

WOOD

- **STRENGTH OR STIFFNESS QUESTIONS** – there is a need to determine the capacity and grade of individual wood members or components.
- **CONNECTIONS** – there is a need to verify the presence of connectors; determine whether metal, wood, adhesive, or other fastener types that form joints between wood and/or other types of structural members are deteriorated; or assess the capacity of the connection.
- **FIRE** – there is a need to understand the effects of fire or elevated temperature on wood members. Fire affects wood construction through combustion and elevated temperature. Wood members may lose section due to combustion but may also lose strength due to elevated temperatures for a sustained period of time. Additionally, connections may be weakened due to differential thermal expansion relative to the wood, resulting in loose connections.

WOOD CONDITION & CONNECTION ISSUES



SECTION BC 1714 IN-SITU LOAD TESTS

Whenever there is a reasonable doubt as to the stability or load-bearing capacity of a completed building, structure or portion thereof for the expected loads, an engineering assessment shall be required. The engineering assessment shall involve either a structural analysis or an in-situ load test, or both. The structural analysis shall be based on actual material properties and other as-built conditions that affect stability or load-bearing capacity, and shall be conducted in accordance with the applicable design standard. If the structural assessment determines that the load-bearing capacity is less than that required by the code, load tests shall be conducted in accordance with Section 1714.2. If the building, structure or portion thereof is found to have inadequate stability or load-bearing capacity for the expected loads, modifications to ensure structural adequacy or the removal of the inadequate construction shall be required.

3309.4.3 PRECONSTRUCTION SURVEY

No excavation work to a depth of 5 feet to 10 feet within 10 feet of an adjacent building, or an excavation over 10 feet anywhere on the site shall commence until the person causing an excavation to be made has documented the existing conditions of all adjacent buildings in a preconstruction survey.

PRECONSTRUCTION SURVEY?



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TTPN 10/88

Procedures for the Avoidance_ of Damage to Historic Structures Resulting from Adjacent Construction When Subject to Controlled Inspection by Section 27-724 and for Any Existing Structure Designated by the Commissioner.

BLAST EFFECT



BC 1704.20 STRUCTURAL STABILITY

1704.20.1 Structural stability of existing buildings. Alterations to existing structures in which loads are transferred from one structural system or structural elements to another, such as installation of columns or girders, replacement of existing bearing walls, the creation of openings or slots in existing walls, girders or floors, alteration of arches, rigid frames, trusses in frame buildings, where the stability or integrity of a structural system is to be temporarily diminished, or where otherwise required by the commissioner, shall be subject to special inspections in accordance with Sections 1704.20.6 through 1704.20.10.

BC 1704.20 STRUCTURAL STABILITY

1704.20.1.1 Construction operations influencing adjacent structures. 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 such structures shall be subject to special inspections in accordance with Sections 1704.20.6 through 1704.20.10.

STRUCTURAL STABILITY & CONSTRUCTION

- A. Building actually modified during the construction process.
- B. Building adjoining to construction.
- C. Damaged buildings/ structures supported by temporary structural installations.

BUILDING ACTUALLY MODIFIED DURING CONSTRUCTION PROCESS

- Demolition (1704.20.4)
- Partial demolition (1704.20.1)
- Lifting buildings/ building elements (1704.20.5)
- Underpinning (1704.20.3)
- ALTERATIONS – an **intentional** modification of structural system needs to be engineered.

UNKNOWN LOADS

The exact load or displacement potentially imposed on the existing building is not known nor can one calculate with precision the existing building response. One can set specific controls on the construction actions and establish parameters that guarantee movement of building elements will not constitute an impairment. Special inspection is not dictated in all cases but it should be required when it becomes apparent that construction activities had affected...

WHAT ARE THE LOADS?



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CONSTRUCTION OPERATIONS THAT MIGHT IMPAIR ADJOINING BUILDINGS

Vibrations (driving of piles or of sheeting , blasting, soil compactors, anchor or caisson drilling, etc.)

Changes in soil condition or capacity

(dewatering, excavation removing overburden, soil loss at caisson drilling, soil movement when sheeting, soil grouting, etc.)

Loss of lateral support (demolition of party wall or demolition that initiates/allows lean of adjoining building.)

REQUIRED ENGINEERING STEPS

- **Condition Assessment.** Identify capacity and weak points of the structure
- Control/understand the forces developed during the procedure
- Understand the stresses existing in the structure and the additional effect of construction imposed forces and displacement
- Mitigate/Shore to reduce stresses
- Monitoring of building movement
- Develop action plan

CONDITION ASSESSMENT

Based on physical observations, probes and calculations determines how far the structure is from instability point.

Based on such analysis parameters are established that assure the equilibrium condition is maintained stable.

We observe the building to insure that it is still in a condition of stable equilibrium.

BC 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.

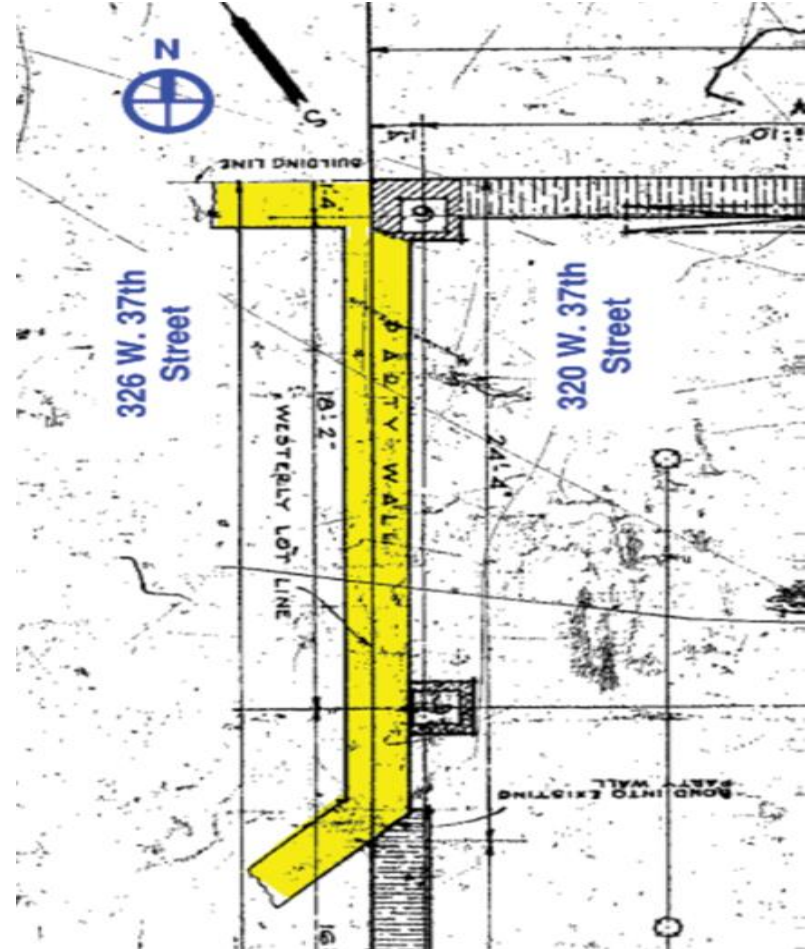
The engineer shall determine the requirements for underpinning or other protection and prepare site and structure-specific plans, including details and sequence of work for submission to the commissioner. Such protection may be provided by underpinning, sheeting, and bracing, or by other means acceptable to the commissioner.

TEXT UNDER REVISION

BC 3306.9.11.4 EXAMINATION OF PARTY WALLS

Party walls shall be carefully examined by a competent person designated by the permit holder to ascertain the condition and adequacy of the party wall prior to the placement of any material that will impose a load upon such party wall. If the party wall is to be found to be in poor condition or inadequate to support the stored material, no material shall be deposited on the floor until the party wall is shored or otherwise strengthened as determined by a registered design professional to safely support such material.

EXAMINATION PARTY WALLS & DRAWINGS



COLLAPSE OF OLD PIN



BC 3309.2 LICENSE TO ENTER ADJOINING PROPERTY

The responsibility of affording any license to enter adjoining property shall rest upon the owner of the adjoining property involved; and in case any tenant of such owner fails or refuses to permit the owner to afford such license, such failure or refusal shall be a cause for the owner to dispossess such tenant through appropriate legal proceedings for recovering possession of real property.

Nothing in this chapter shall be construed to prohibit the owner of the property undertaking construction or demolition work from petitioning for a special proceeding pursuant to Section 881 of the Real Property Actions and Proceedings Law.

BC 3309.3 PHYSICAL EXAMINATION

When permission to enter upon adjoining property has been obtained, a physical examination of such property shall be conducted by the person causing the construction or demolition operations prior to the commencement of the operations and at reasonable periods during the progress of the work. Observed conditions shall be recorded by the person causing the construction or demolition operations, and such records shall be made available to the department upon request.

BC 3306.9.11.1 EXAMINATION OF CONNECTIONS

Before any material is stored on any floor, the existing flooring adjacent to bearing walls, shear walls, beams and columns shall be removed and the connections of the floor framing system to the bearing walls, shear walls, beams and columns shall be carefully examined by a competent person designated by the permit holder to ascertain their condition and adequacy to support such material. If the connections are found to be in poor condition or inadequate to support the stored material, no material shall be deposited on the floor until these connections are shored from the cellar floor through each successive floor or otherwise strengthened to safely support such materials.

BC 1814.3 MONITORING

When excavation, foundation construction, or underpinning is required, adjacent structures and properties shall be monitored in accordance with a plan prepared by the engineer. The engineer shall develop the scope of the monitoring program, including location and type of instruments, frequency and duration of readings, and permissible movement and vibration criteria.

This scope shall take into account the structures or property to be monitored **and the conditions thereof**. The monitoring program shall include necessary actions to address exceedances.

Monitoring of historic and landmarked structures shall be subject to special requirements as determined by the department.

MONITORING REQUIRED

Monitoring (BC 1704.20.7.1) – Structural stability design documents include monitoring requirements where applicable

- Building specific
- Operation specific
- Specify monitoring frequency, tolerances, and reporting criteria
- TPPN 10/88 may not be sufficient for your specific case

MONITOR RESPONSE TO CONTROL CONSTRUCTION OPERATIONS

EXCEEDS LIMITS



MODIFY ACTIVITY

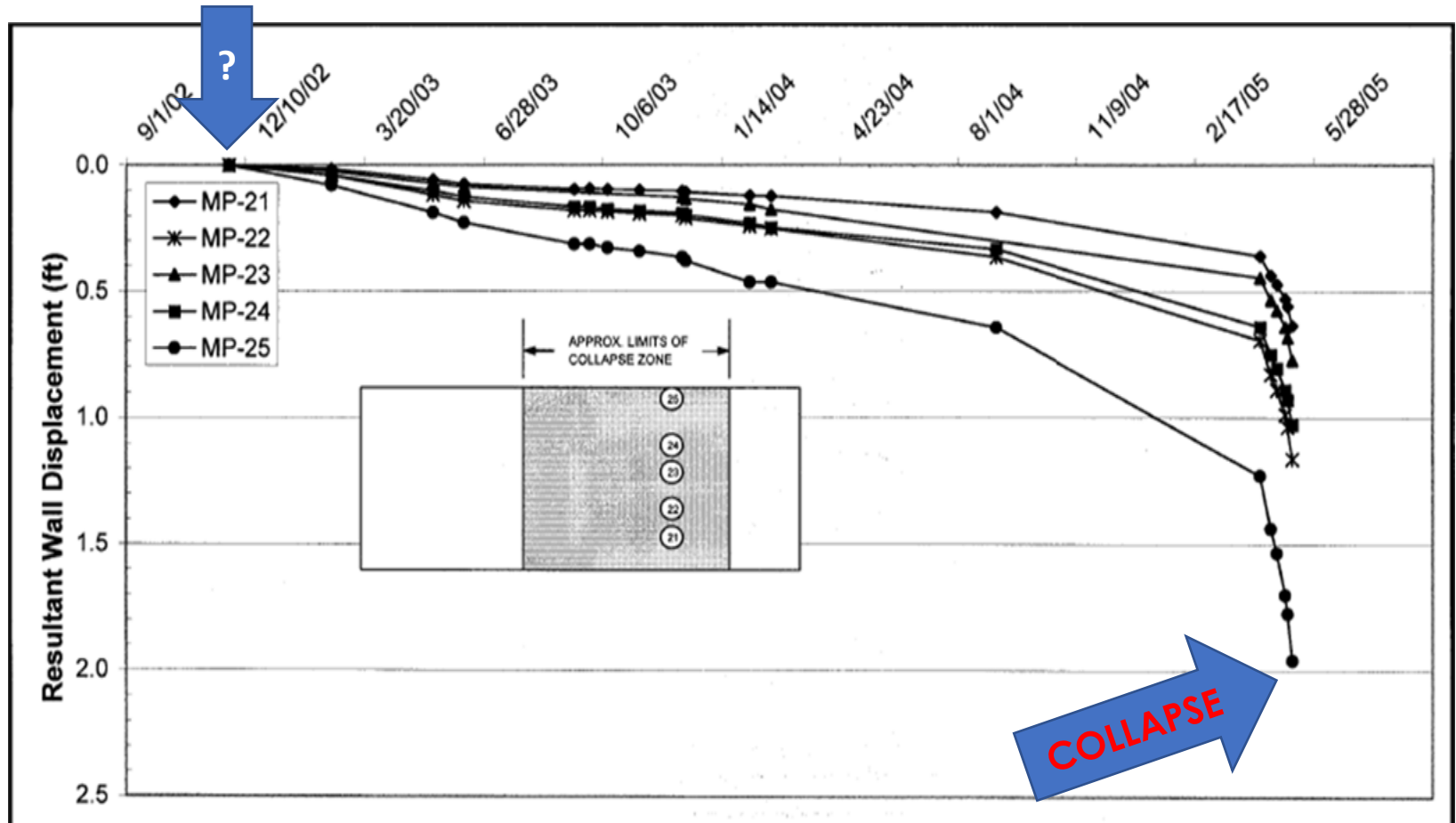
Monitor Response

- Movement
 - Vertical
 - Out of Plumb
- Vibration
- Deterioration
 - Interior
 - Exterior
- Changes in Water Level

Control Construction Activities

- Excavation
- Pile driving
- Lot Line Excavation
- Demolition
- Blasting

MONITORING NEEDS PLAN OF ACTION



STRUCTURAL STABILITY – EXISTING CRACKS



DANGEROUS CONDITION – IEBC

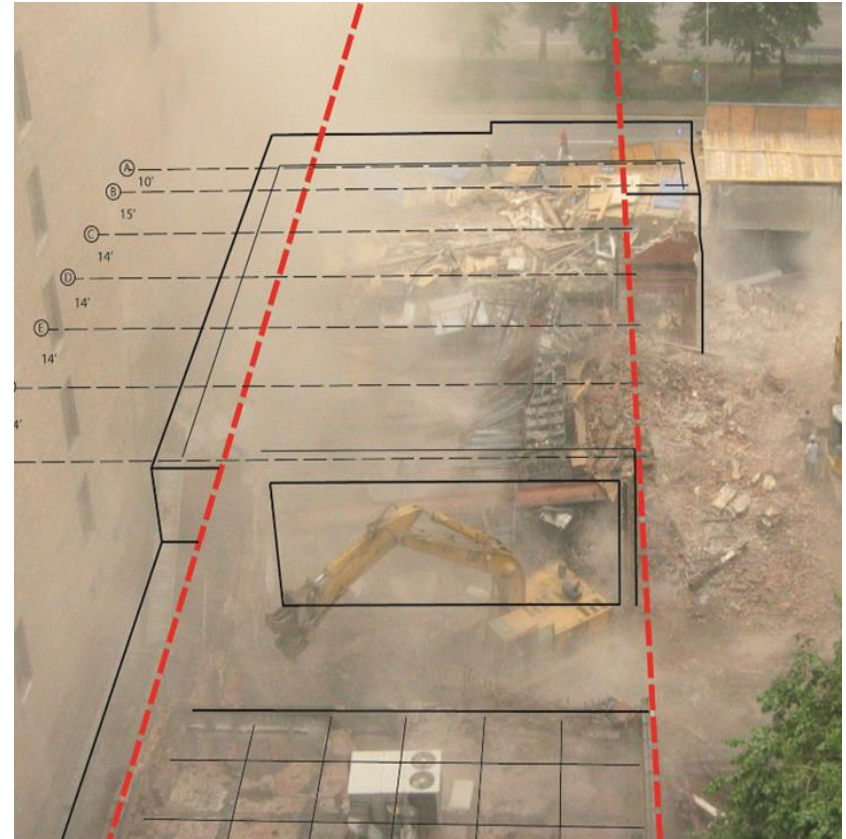
Any building, structure or portion thereof that meets any of the conditions described below shall be deemed dangerous:

1. The building or structure has collapsed, has partially collapsed, has moved off its foundation, or lacks the necessary support of the ground.
2. There exists a significant risk of collapse, detachment or dislodgement of any portion, member, appurtenance or ornamentation of the building or structure under service loads.

DEMOLITION (BC 1704.20.4)

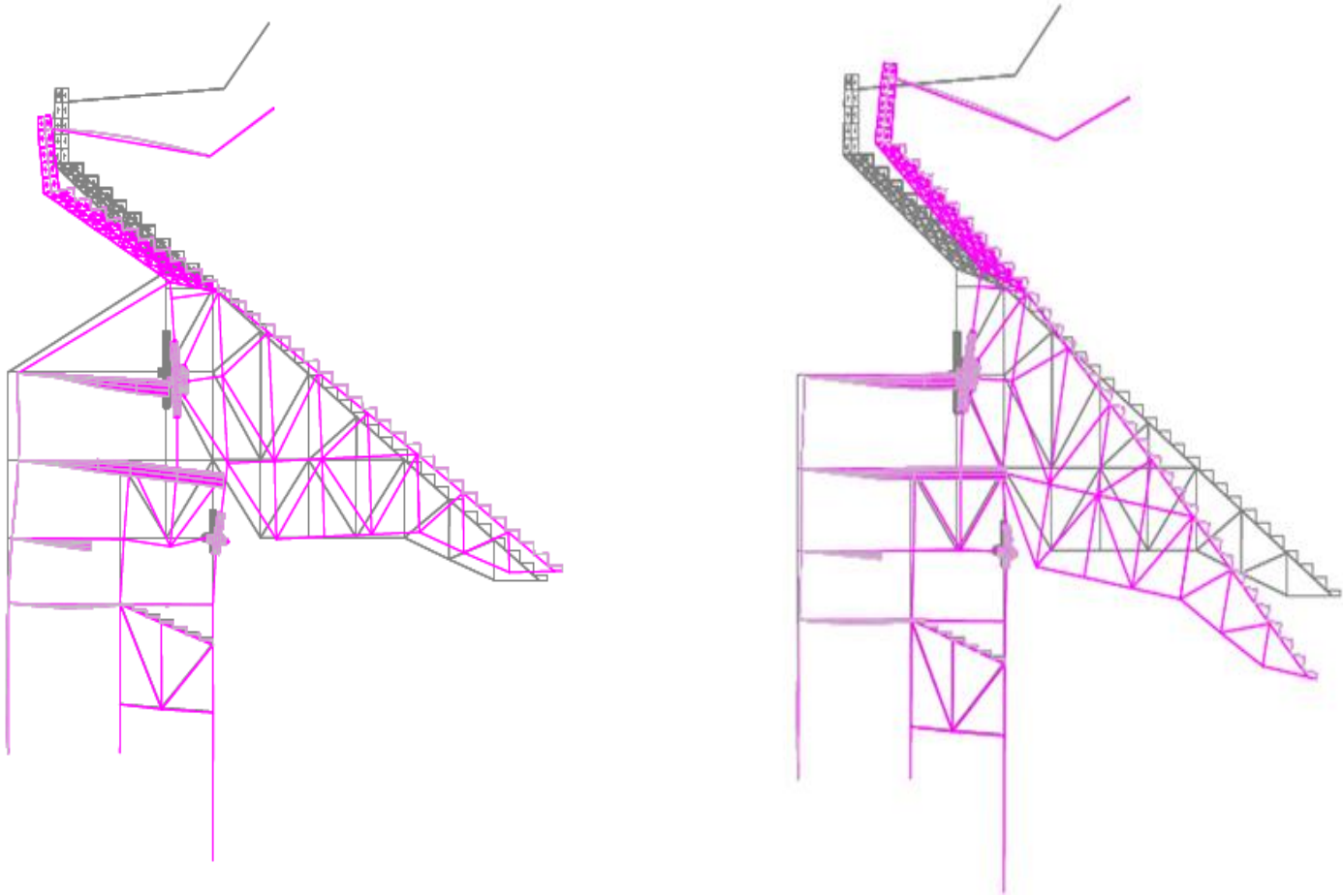
- Site specific plans required prepared by licensed professional
- Plans **must** indicate:
 - Details of the building demolished clearly showing the extent and sequence of demolition;
 - Details of Bracing and shoring
 - Listing and description of all mechanical equipment (other than handheld)
 - Scope of equipment work and positioning of equipment
 - Calculations showing the adequacy of the existing structure to support loads
 - Description of protective methods

IMPOSED LOADS DURING DEMO



Structures were not built with demolition in mind

DESIGN OF DEMOLITION



HIGHLY ENGINEERED



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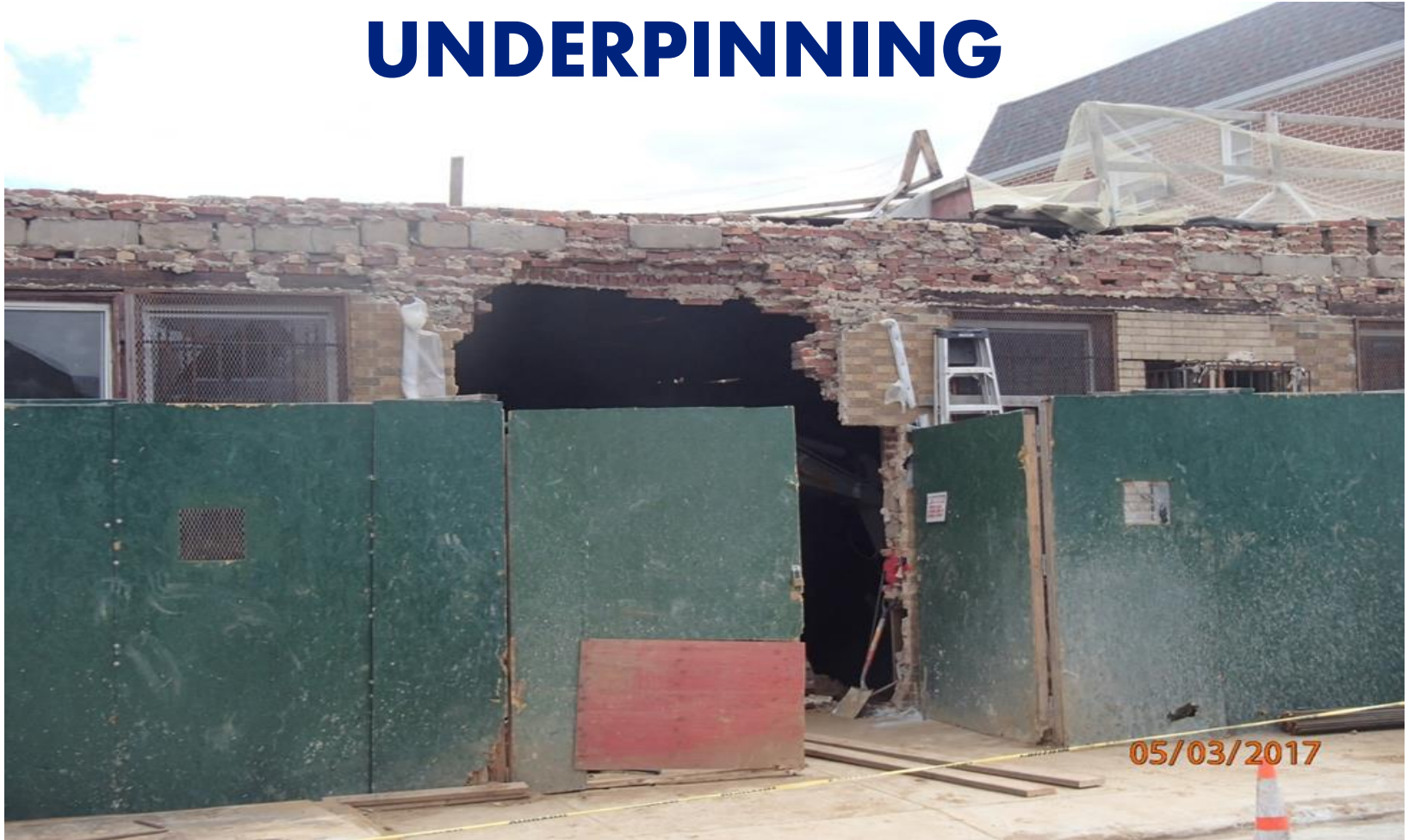
CONDITION ASSESSMENT



Observe

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

UNDERPINNING



One-story structure – most likely to fail

WALL+FOUNDATION+UNDERPIN-STABILITY?



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UNDERPINNING FAILURE

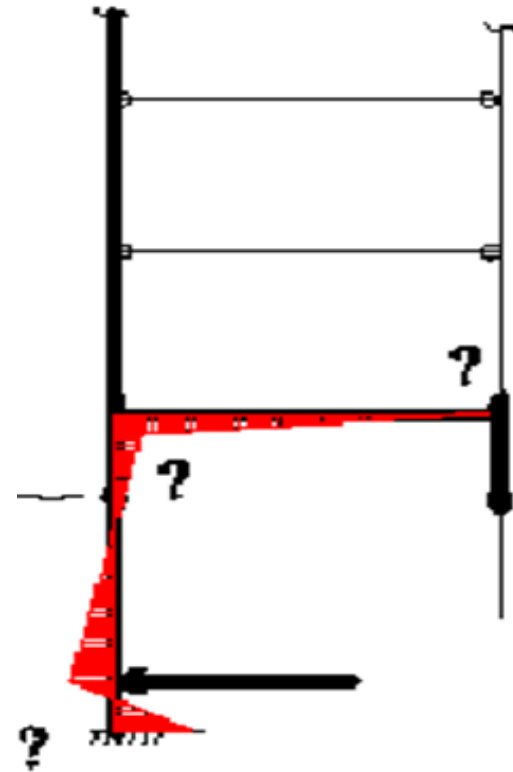
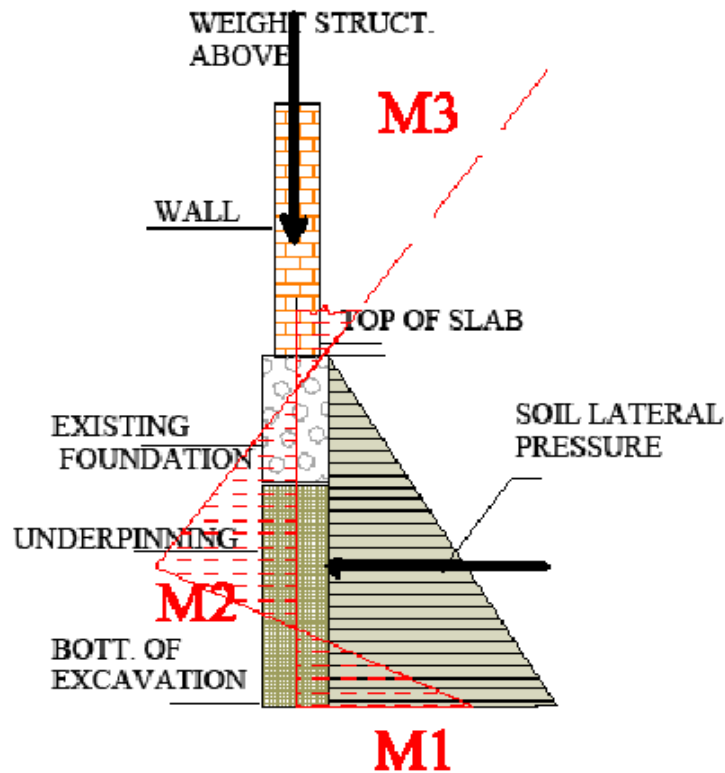


SIMILAR UNDERPINNING FAILURE

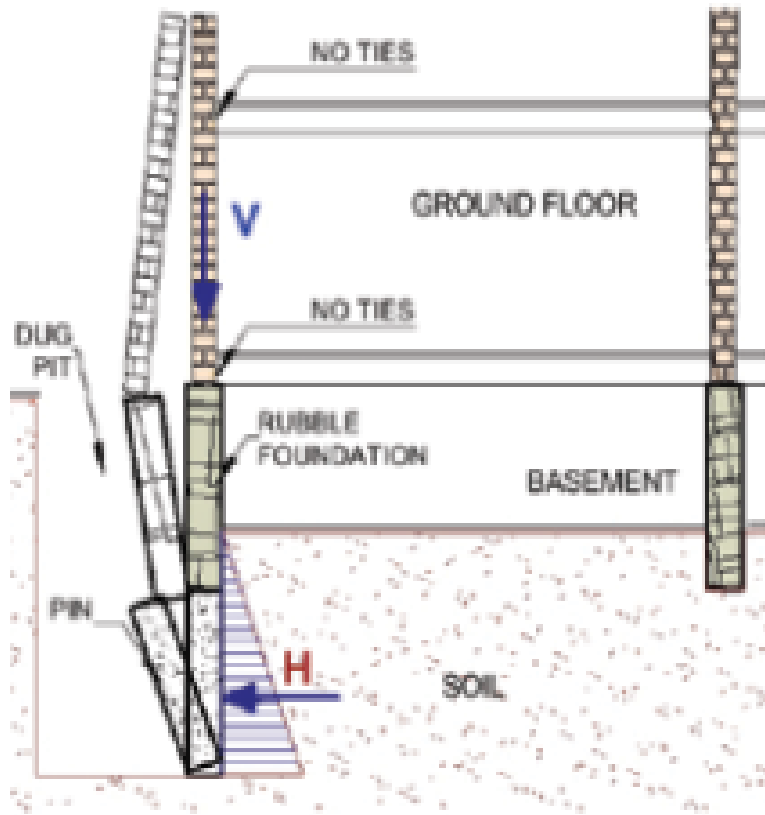


Wall along fire exit too unstable to underpin

VARIOUS POSSIBLE STATIC SCHEMES



ESTABLISH LIMITS FOR STABILITY



BLASTING MONITORING CRITERIA

Building Address	DOB Classification per MOU	Contract Building Condition	Contract Response Values							
			Horizontal Movement (in)			Settlement (in)			Vibration (in/sec)	
			Threshold*	Limiting*	Current Maximum**	Threshold*	Limiting*	Current Maximum	Threshold	Limiting
94 th to 95 th St – West Side										
1831 2 nd Ave	Group A	Not Fragile	0.5	0.7	0.40	0.3	0.5	0.36	N/A	N/A
94 th to 95 th St – East Side										
1838 2 nd Ave	Group A	Not Fragile	0.5	0.8	0.35	0.7	1.0	0.21	N/A	N/A
95 th to 96 th St – West Side										
1849 2 nd Ave	Group B	Not Fragile	0.5	0.7	0.47	0.3	0.5	0.32	1.5	1.92
95 th to 96 th St – East Side										
1840 2 nd Ave	Group C	Fragile	0.6	0.9	0.75	1.3	2.0	1.42	0.3	0.5
1842 – 46 2 nd Ave	Group A	Not Fragile	0.5	0.8	0.37	0.7	1.0	0.37	1.5	1.92

- Where to place geophones?
- Are USBM criteria valid for NYC buildings?
- Tall Buildings?

PLAN OF ACTION

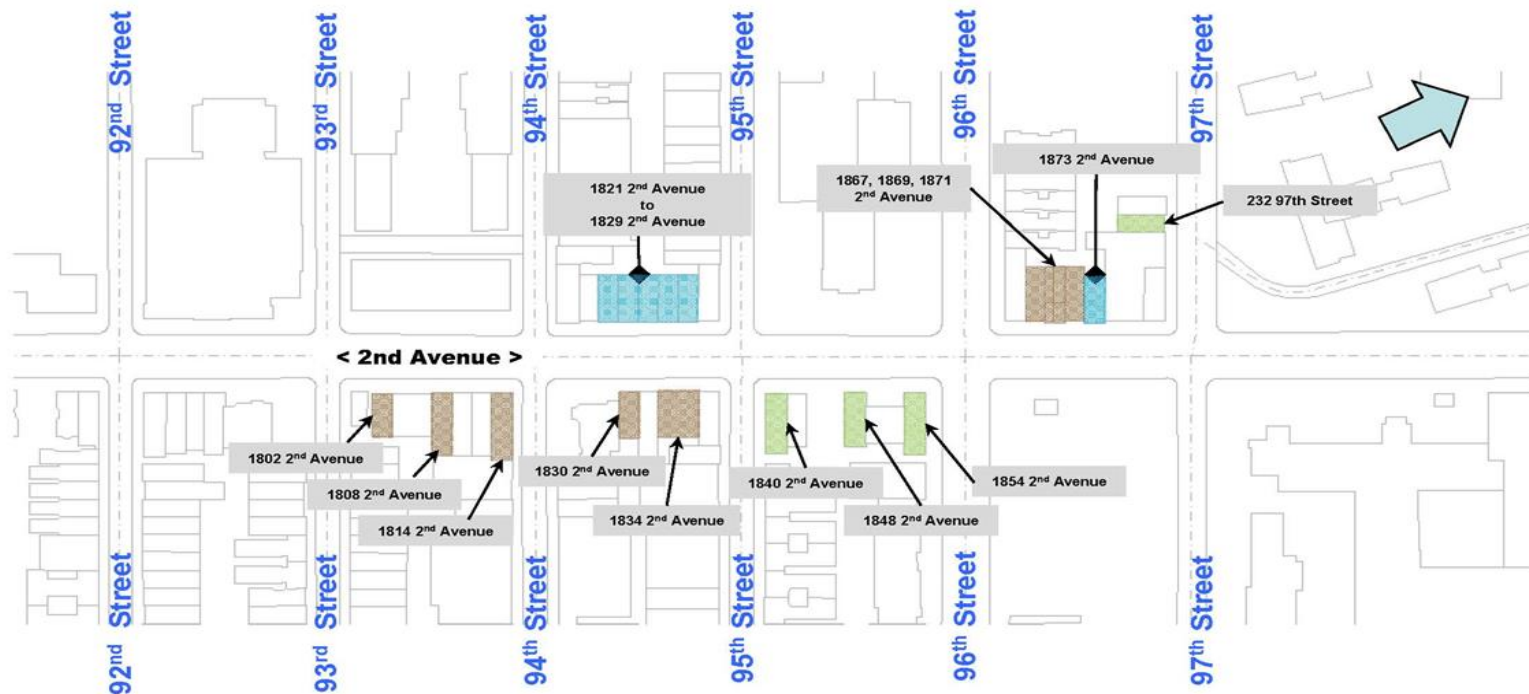
	Type A	Type B	Type C w/shed	Type C	Type D
Vibration Limiting	1.9	0.5	0.5	0.5	TBD
One Time Reached Report By Engineer Next Day	3	1.5	1.5	0.75	same as TBD
Value reached more than 3 times Same Day	2	0.75	0.75	0.5	
Displacement real-time notification and Report by Engineer					
	0.4	0.4	x	0.4	TBD
Cumulative Horizontal	0.4	0.5	x	0.5	same as TBD
One Time Horizontal or vertical	0.33	0.5	x	0.4	

REMEDIATION

SECOND AVENUE CORRIDOR – LAUNCH BOX AND 96TH STREET STATION AREA

18 Total Buildings

- REMEDIATION WORK COMPLETED – 4 BUILDINGS
- REMEDIATION WORK IN PROGRESS - 6 BUILDINGS
- FUTURE REMEDIATION WORK – 8 BUILDINGS



FIX BEFORE CONSTRUCTION STARTS



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STRUCTURAL CONDITION ASSESSMENT

Structural condition assessment is an evaluation of a structure or part of it to verify its capability to meet a stated purpose.

The purpose of a condition assessment needs to be clearly stated and may be safety, capacity to sustain code prescribed or environmental loads, specific loads or displacements, long term performance.

In addition to visual observations a structural condition assessment may require testing, probing or calculations.



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