



N.Y. City Department of
Buildings

Safety Week

May 3rd, 2005:

An Underpinning Symposium

Presented by the Structural Engineers
Association of New York and The
American Society of Civil Engineers, Met
Section



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Presenters:

Joseph F. Tortorella, Vice President of Robert Silman Associates, Structural Engineers;
President Elect of the Structural Engineers Association of New York (SEAoNY)

- Over 26 years experience in N.Y. City
 - Firm has consulted on over 10,500 projects
- Firm specializes in Historic Preservation as well as new construction
- Chair of the SEAoNY committee on the Improvement of Underpinning Practices



Presenters:

George J. Tamaro, Partner at Mueser Rutledge
Consulting Engineers
(Geotechnical and Structural Engineers)

- Over 46 years experience in N.Y. City
- Firm has consulted on over 10,000 projects
- Firm specializes in the design and construction inspection of foundation and marine structures
- Member of SEAoNY



Why is SEAoNY here?



Public Safety



Lawsuits and costly repairs





Facts and Figures:

- Improper Underpinning procedures results in more frequent failures/ costly lawsuits than any other construction failure event
- 1 to 2 Failures per month in N.Y. City and surrounding boroughs
- Most of the failures are occurring in Brooklyn, typically on small sites/small projects, 1 to 6 stories.
- **EVERYONE** involved in the process needs to be educated about the inherent problems



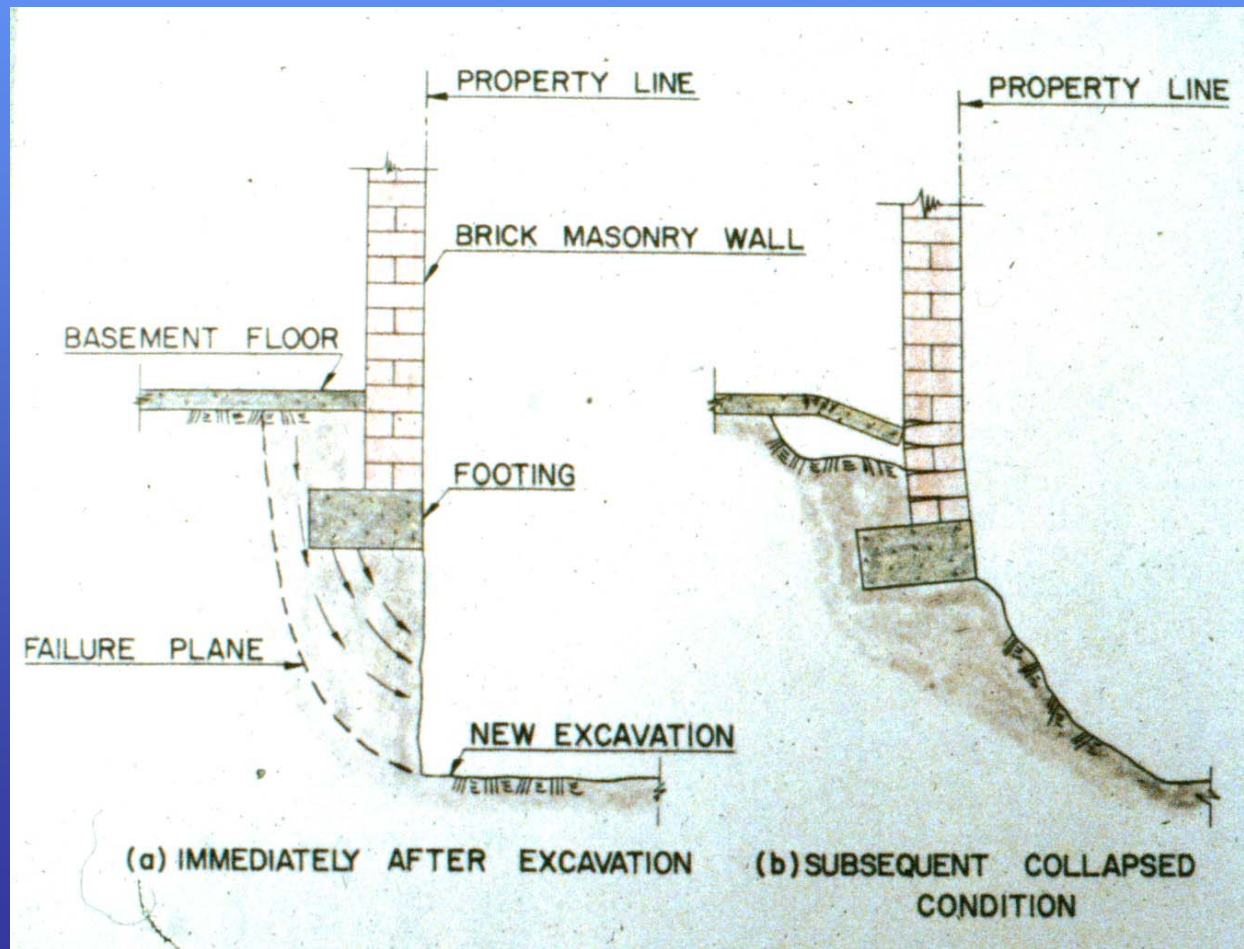
When is underpinning required in N.Y. City and the boroughs?

- “Where support of adjacent structures is required” (NYCBC)



Why is underpinning required in N.Y. City and the boroughs?

- To prevent damage to adjacent structures



How is underpinning provided in N.Y. City and the boroughs?

- Underpinning piers
- Sheeting and bracing
- Cofferdams
- On hard rock in lieu of underpinning
- Other means acceptable to the Commissioner



Who is responsible to provide underpinning required in N.Y. City and the boroughs?

- The developer of the new structure, unless prevented from doing so by the owner of the affected structure, then the owner of the affected structure is responsible to protect his structure



What can be done to improve the practice of underpinning in N.Y. City and the boroughs?

- Prior to design
- During Design

III. During Construction



- Prior to design

When should the engineer become involved in the process?

After the owner has purchased a site?

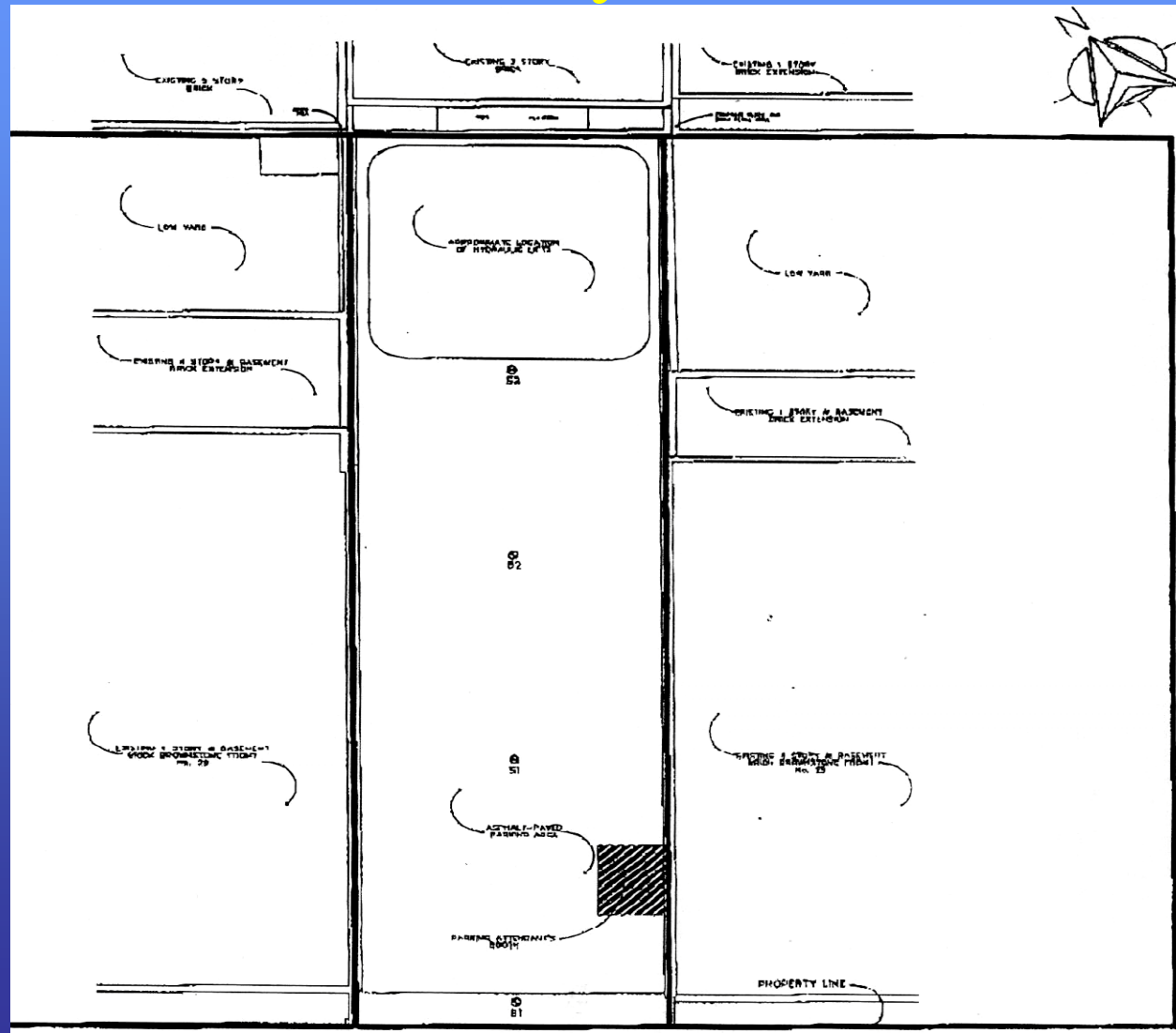
After the owner interviews architects?

After the first architect is released because he expressed his/her concern for the feasibility of doing the project due to underpinning issues?

NO...NO...NO!!!



Involve the engineers early on



The structural engineer and geotechnical engineer should be brought on board as early in the process as possible...even if on an advisory role.

The engineers can evaluate the site using their knowledge of the location to advise the owner even before purchasing a property, of the potential for problems.

Once it is established to continue....the selection of the consultants is completed and the design begins....



Structural engineers role:

Due Diligence

The engineer of record should make all efforts to evaluate the adjoining site conditions for the following:

I. Adjacent foundation construction type and projections

- Adjacent building construction type
- Historical significance of adjoining properties



Geotechnical engineers role:

Site investigation, borings and test pits

- Review existing information on area
- Perform site reconnaissance
- Perform adequate number of borings
- Perform test pits to determine/verify foundations for adjacent structures
- Make recommendations for foundations for new structure and protection of adjacent structures.
- Make recommendations for monitoring adjacent structures



Why are borings important to the protection of adjacent structures?

Because they help identify:

- Soils supporting adjacent structures
- Soils susceptible to settlement from vibrations
- Existing ground water conditions
- “Running sand” conditions



Why are test pits important to the protection of adjacent structures?

Because they help identify:

- Condition of foundations of adjacent structures
- Depth of foundations of adjacent structures



How does soil conditions and/or groundwater impact the underpinning design?

- Weak and sensitive soils and a high ground water table can make pit underpinning difficult to execute safely
- Underpinning may be necessary even if new foundation is above level of existing foundations if soils are susceptible to consolidation or vibration settlement
- Dewatering may cause consolidation of soils and/or exposure of existing piling to deterioration



How can an excavation of overburden on our site, affect a neighboring site?

Sequence is important, put in the sheeting
before you excavate!



How can vibrations on our site, affect a neighboring site?

Even if you do not go below the adjacent
foundation pile driving vibrations can cause the
building to settle and tilt!

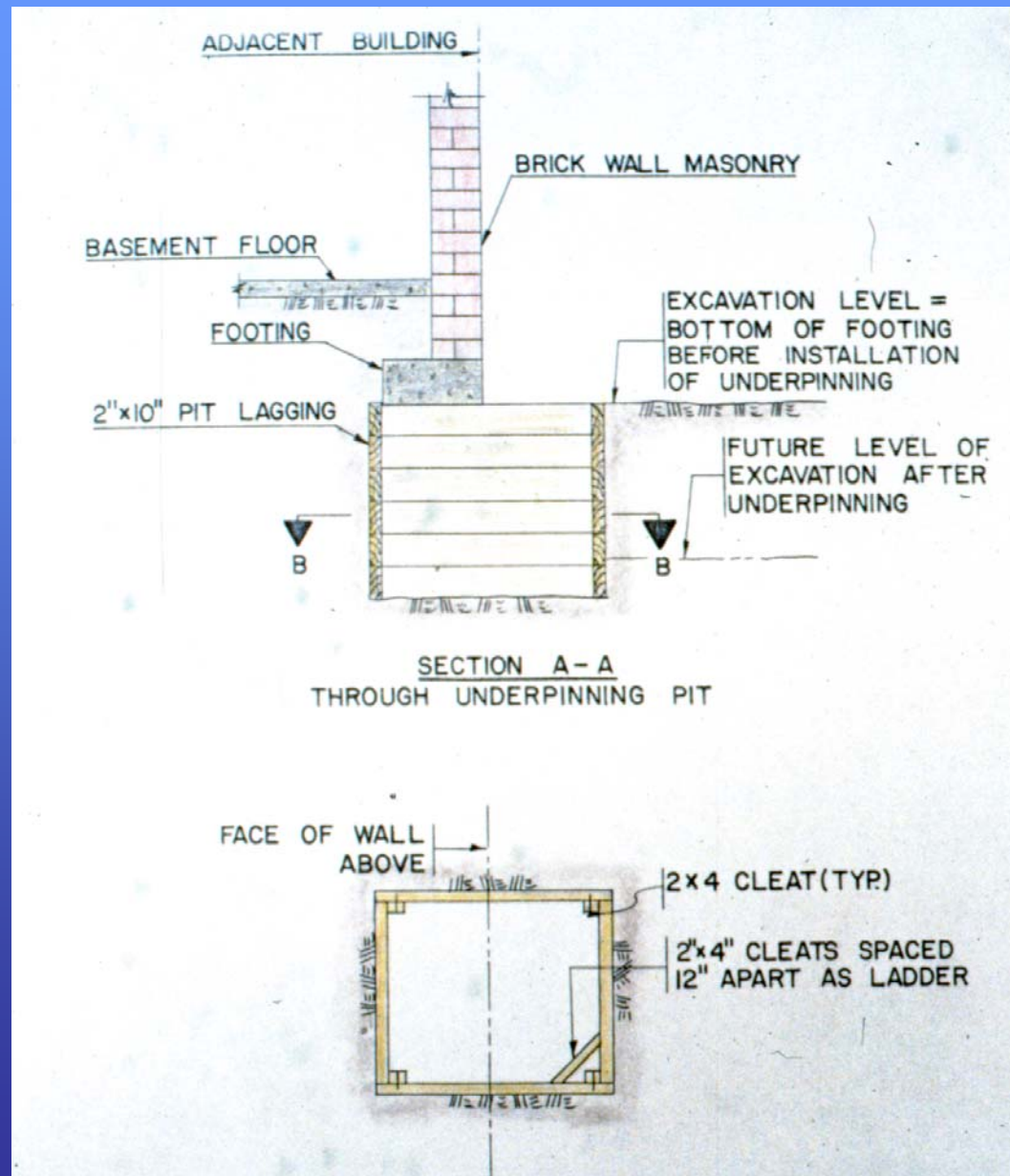


Available underpinning methods:

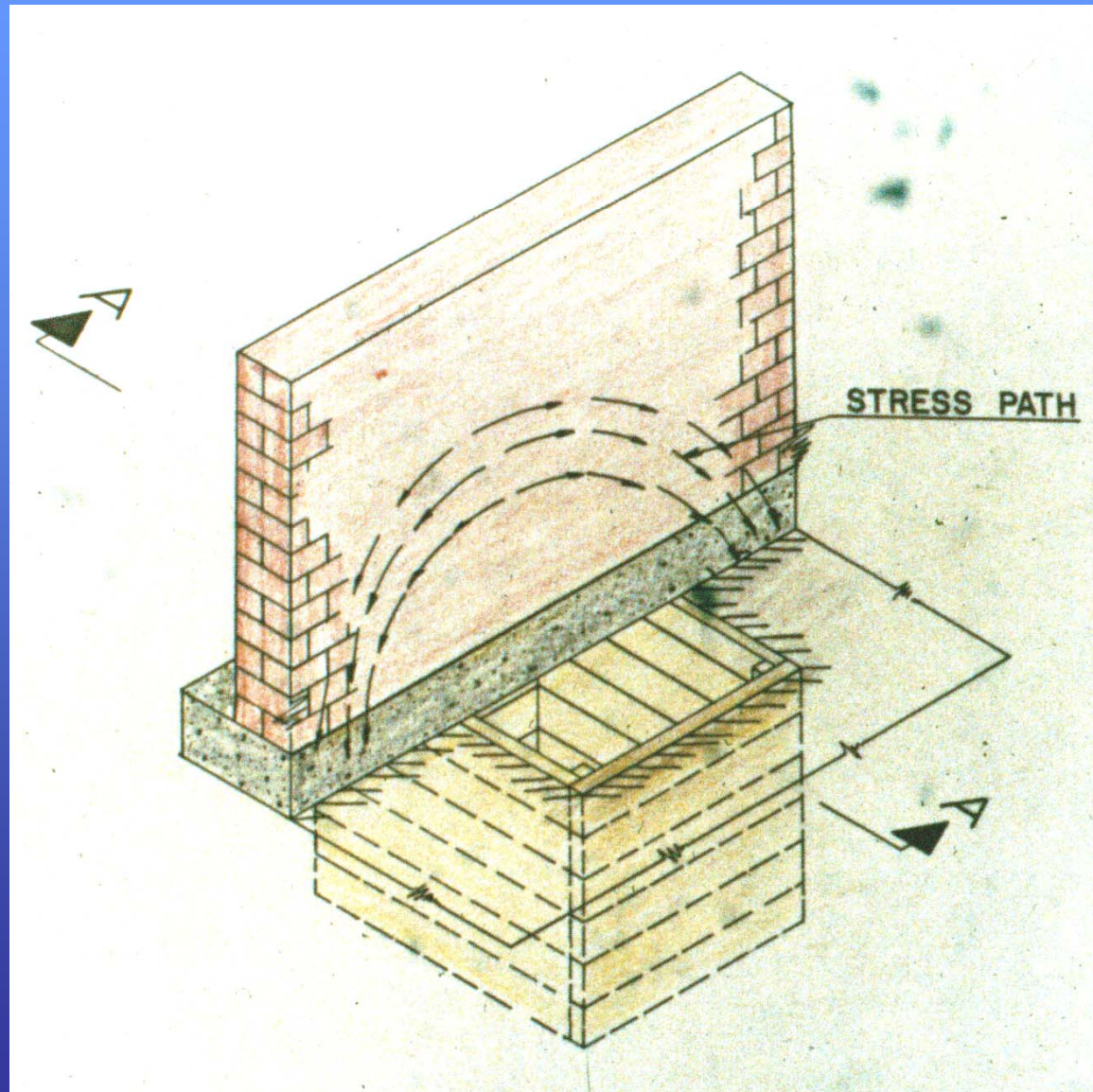
- Pit underpinning
- Jack piles
- Bracket piles
- Micro piles
- Ground improvement
- Rigid excavation support walls



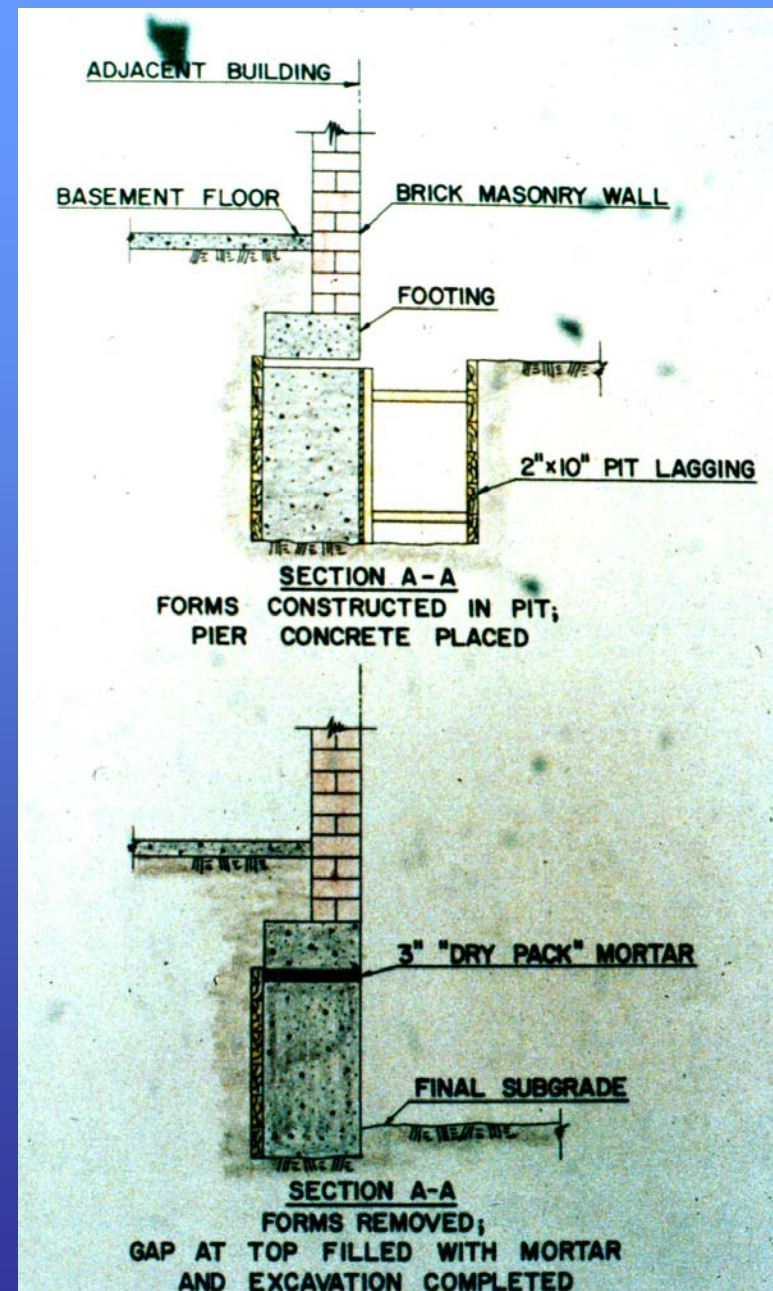
Typical approach pit for pit underpinning



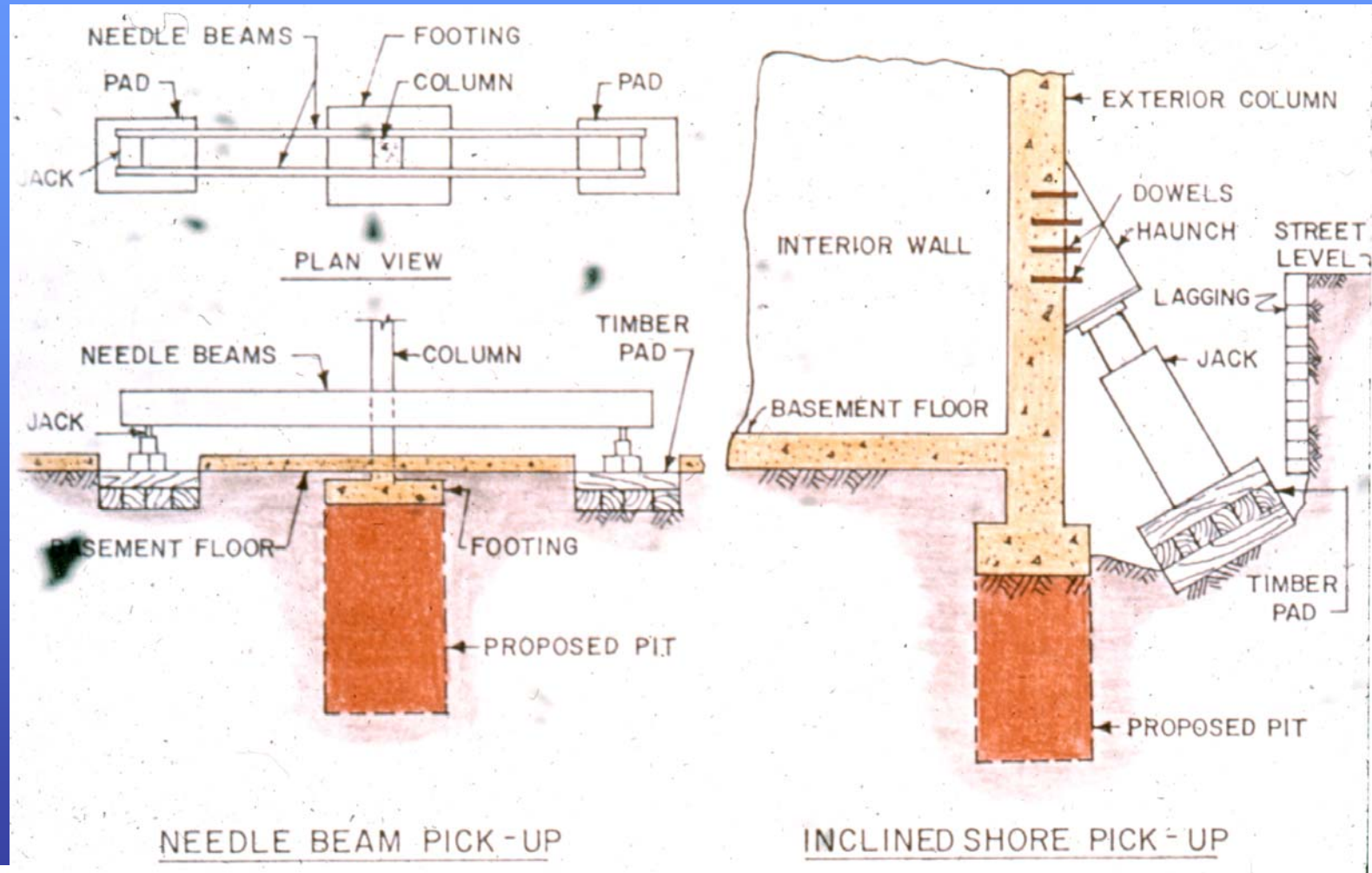
Arching of wall over approach pit

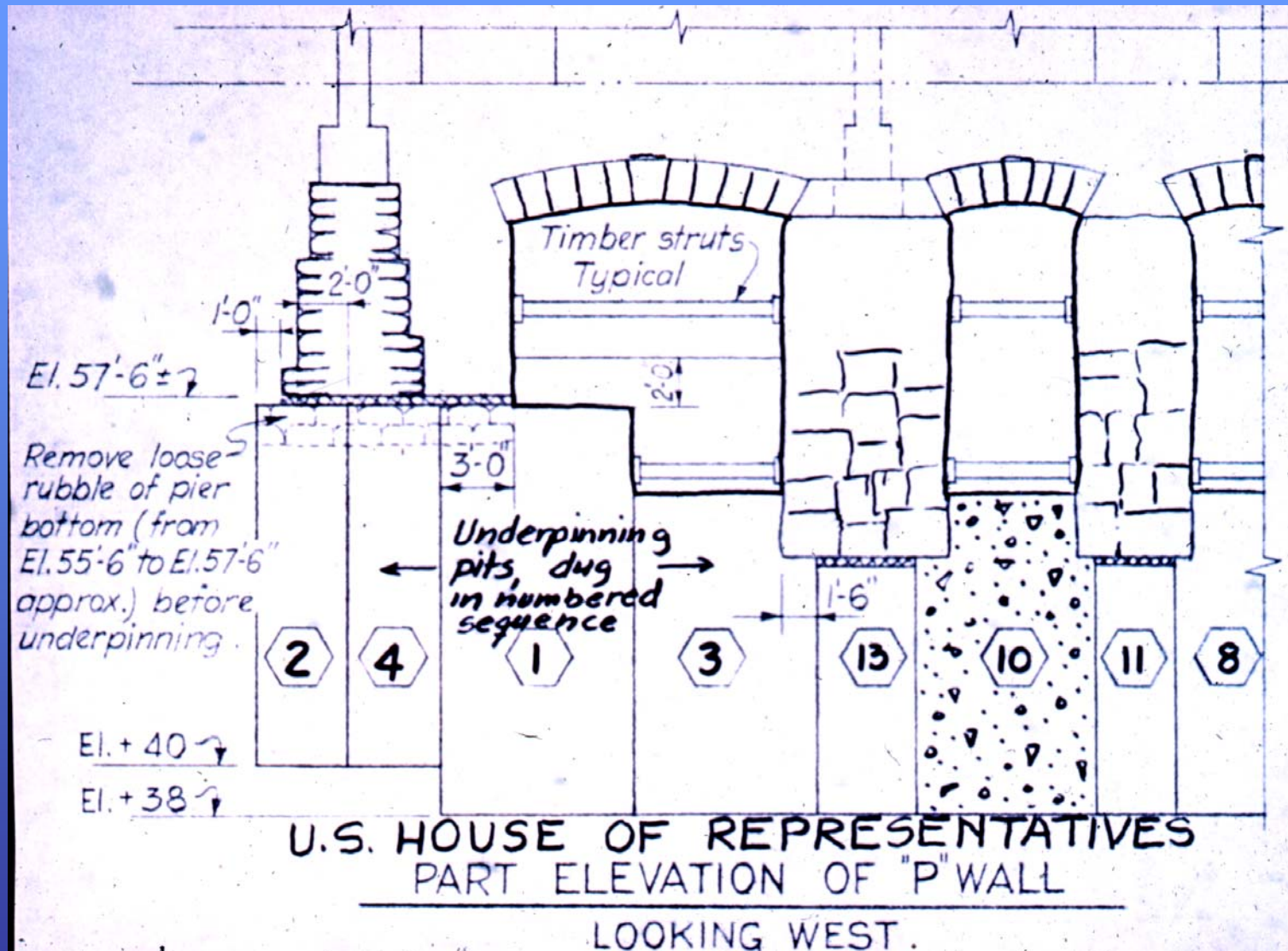


Concreting and preloading of the underpinning pier



Temporary support of concentrated load (column)





Staging is important



PILE GROUP READY FOR CONCRETING



MEASURING MOVEMENT OF
INDIVIDUAL PILE



Jack pile installation



Bracket pile
installation



Preloading with
steel wedges



Micro pile installation





Ground improvement
Jet grout underpinning



Rigid excavation support walls (slurry walls) can eliminate direct underpinning of structure

Support of rock face in lieu of underpinning



II. During Design:

What is the structural engineers role?

What level of information should be shown on the structural engineers drawings?

“Means and Methods of Construction”

What is the Geotechnical engineers role?



What is the structural engineers role?

Due Diligence

Provide an underpinning detail that is applicable to the specific project

Make sure contractor understands the site and complications of underpinning

Stay involved when construction starts



Due Diligence

Understand the site conditions

Understand the adjoining buildings

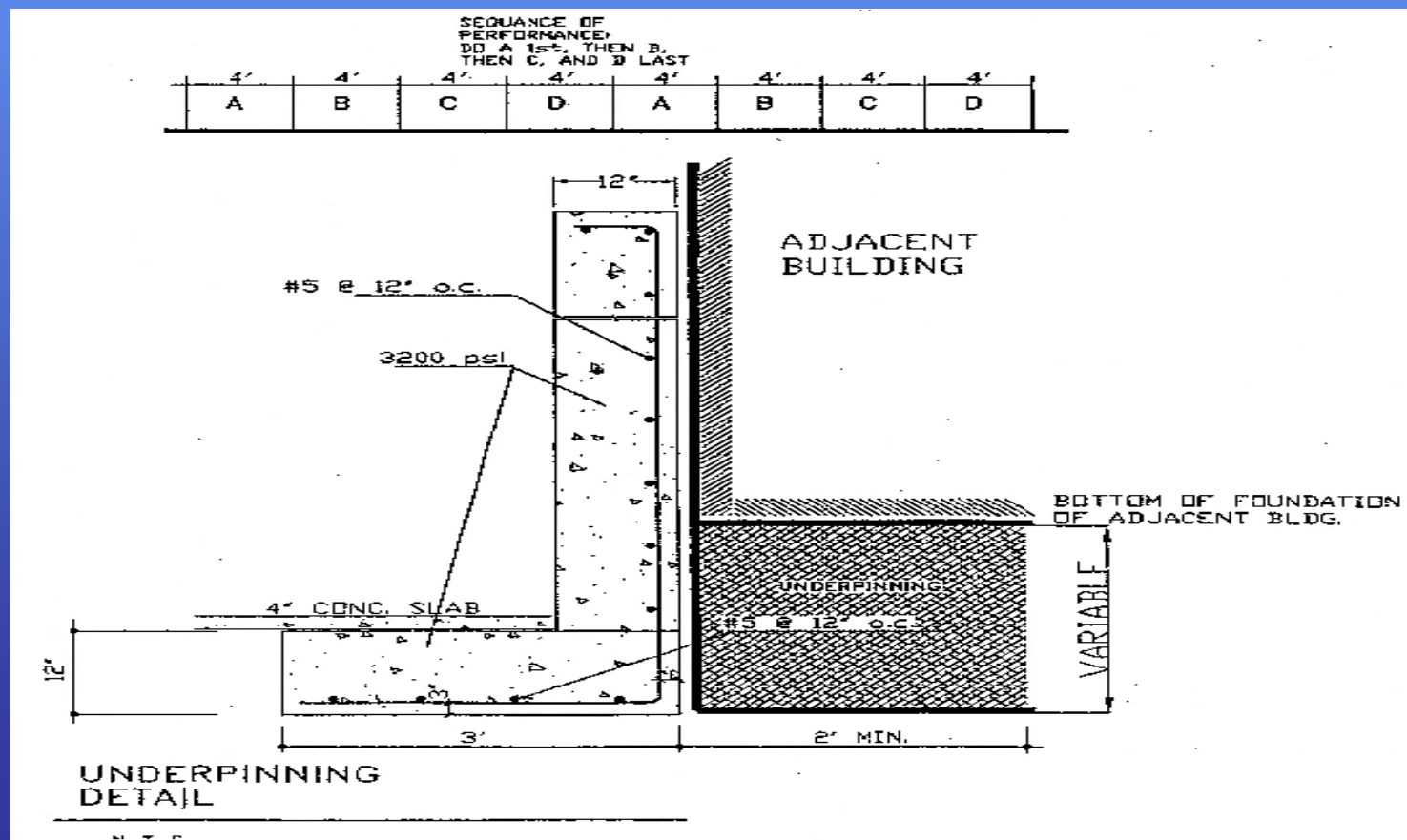
Inform the contractor and his engineer of all
issues uncovered prior to design

Educate the owner

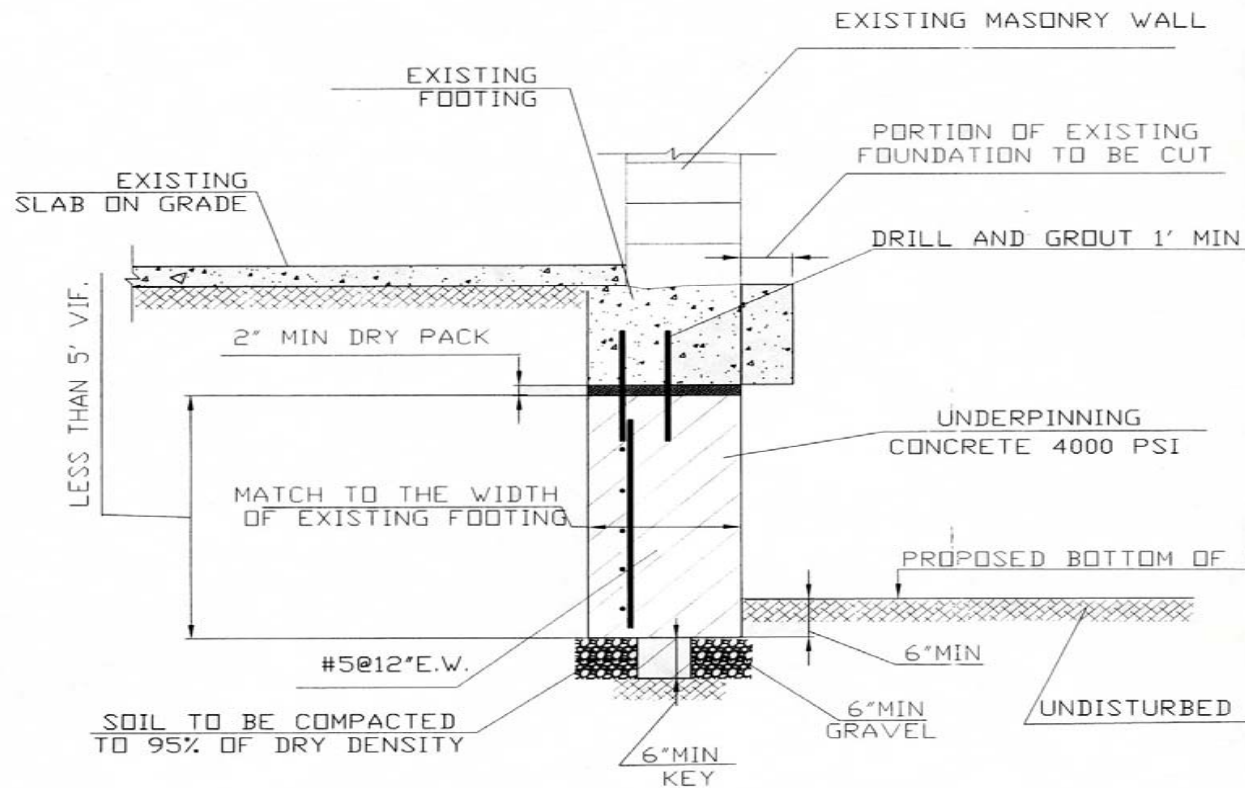


Provide an adequate level of information on the design documents

The engineer of record (EOR) should provide detailed information on his/her drawings that relates specifically to the site under consideration. Is this enough information???

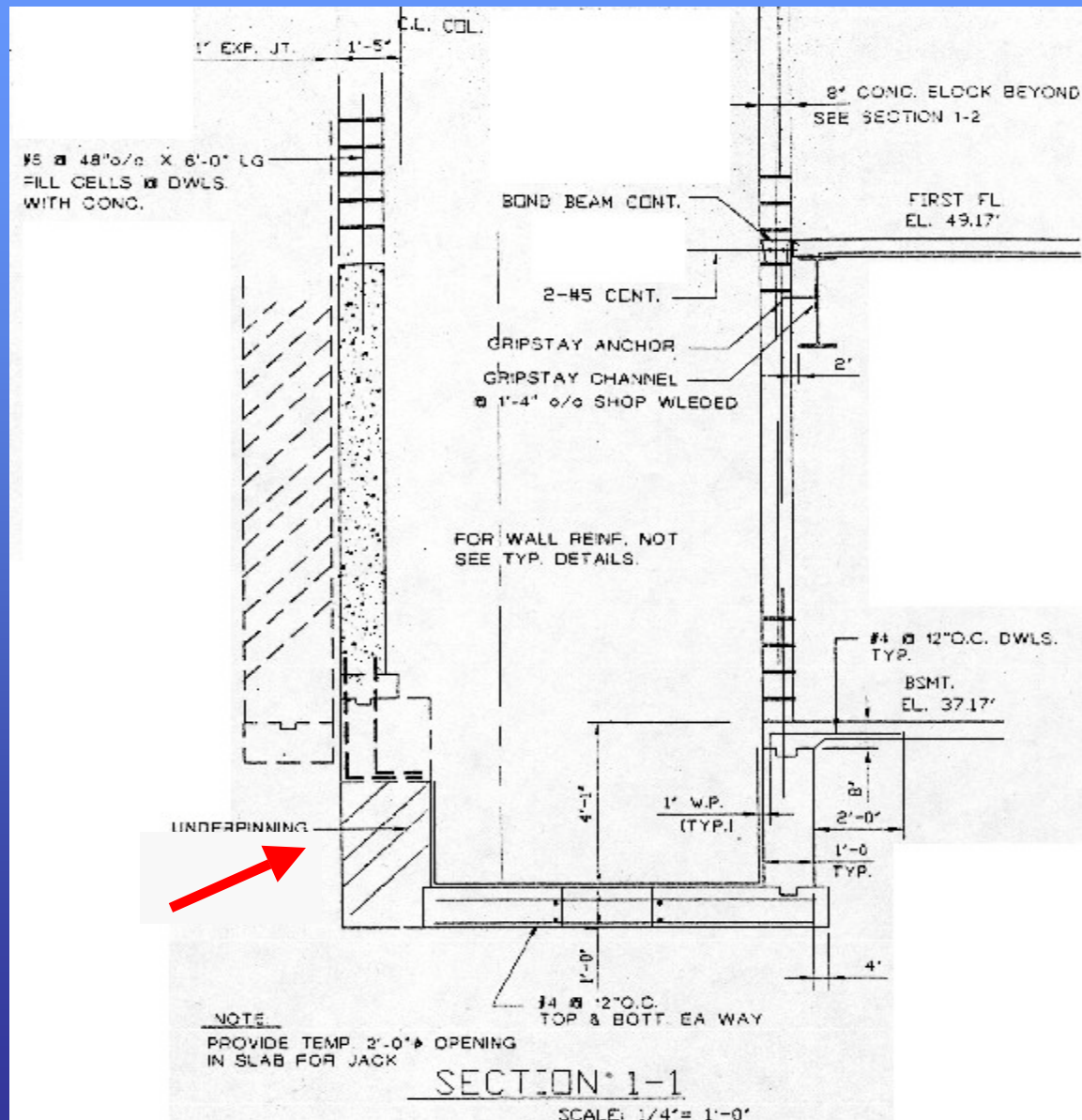


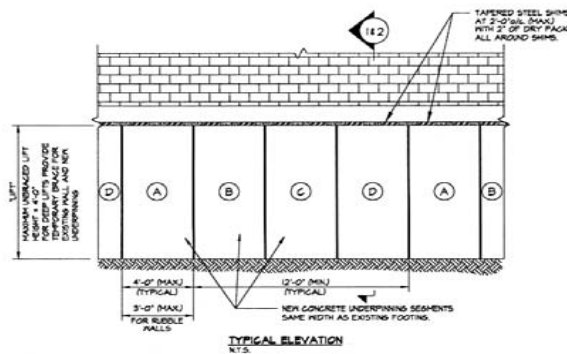
**"God is in the details."
Ludwig Mies van der
Rohe (not in this case!!)**



**SECTION A-A
SCALE 1/2"=1'**

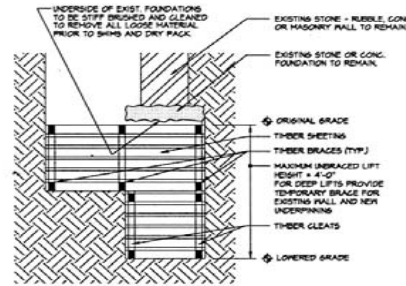
What's wrong with this picture???





EXISTING WALL UNDERPINNING SEQUENCE

1. STARTING WITH SEGMENTS (A) ONLY, DIG PITS 4'-0" WIDE, MAXIMUM, SIMULTANEOUSLY PLACING REQUIRED SHEETING AND BRACING. ALL PITS TO BE SHEETED ON ALL FOUR SIDES. FILL Voids BETWEEN SHEETING AND SOIL WITH SOIL. COVERT. LEAVE A MINIMUM OF 12'-0" OF EXISTING SOIL BETWEEN PITS.
2. CLEAN BOTTOM OF EXISTING FOOTING AND RECOMPACT DISTURBED SOIL AT BOTTOM OF PIT WITH MECHANICAL PAIN TAMPERS. COMPACT TO MIN OF THE MAXIMUM DENSITY OF THE SOIL. LOSS OF GROUND SHOULD BE KEPT TO A MINIMUM BY BACKFILLING BEHIND THE BOARDING WHERE AND WHEN POSSIBLE WITH GROUT PUMPED INTO THE VOIDS.
3. THE CONTRACTOR SHALL INSTALL ADEQUATE LATERAL BRACING SYSTEMS TO PREVENT MOVEMENT IN THE EXISTING STRUCTURE(S) AND IN THE NEW UNDERPINNING.
4. POUR NEW CONCRETE UNDERPINNING FOR SEGMENTS (A). AFTER CONCRETE ATTAINS 50% OF THE DESIGN STRENGTH OR 48 HOURS, PLACE 3'-4" TAPERED STEEL PEGS AT 2'-0" MAX. MIN. THEN PACK SOIL WITH DRYPACK INTO SPACE BETWEEN TOP OF UNDERPINNING AND BOTTOM OF EXISTING FOOTING, TO TRANSFER LOAD. ENSURE THE BACK OF VOID IS FORMED SO THAT DRYPACK IS NOT LOST WHEN RAMPED INTO THE SHAFT.
5. FOR SEGMENTS (B) DIG PITS 4'-0", MAXIMUM, WIDE WITH REQUIRED SHEETING & BRACING.
6. FOR SEGMENTS (C) REPEAT CONCRETING, CLEANING, COMPACTION, STEEL PEGS AND DRYPACKING AS DESCRIBED IN NOTES 2, 3 AND 4.
7. FOR SEGMENTS (D) DIG PITS 4'-0", MAXIMUM, WIDE WITH REQUIRED SHEETING & BRACING.
8. FOR SEGMENTS (A) REPEAT CONCRETING, CLEANING, COMPACTION, STEEL PEGS AND DRYPACKING AS DESCRIBED IN NOTES 2, 3 AND 4.
9. FOR SEGMENTS (B) DIG OUT SOIL BETWEEN COMPLETED SEGMENTS (C) AND (A) PROVIDE SHEETING AND BRACING AS REQUIRED.
10. FOR SEGMENTS (C) REPEAT CONCRETING, CLEANING, COMPACTION, STEEL PEGS AND DRYPACKING AS DESCRIBED IN NOTES 2, 3 AND 4.
11. WHERE BOTTOM OF ADJACENT UNDERPINNING PITS ARE AT DIFFERENT ELEVATIONS, THE DEEPER PIT SHALL BE INSTALLED FIRST.
12. UNDERPINNING PITS CLOSER THAN 12' APART SHALL NOT BE EXCAVATED AT THE SAME TIME.



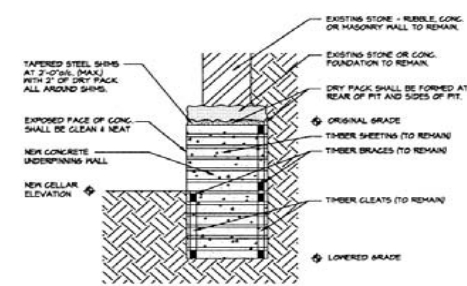
NOTE: ALL SHEETING, CLEATS AND BRACING SHALL BE PRESSURE TREATED LUMBER SIZED IN ACCORDANCE WITH TABLE 4-1 OF THE NEW YORK CITY BUILDING CODE.

SECTION OF WOOD SHEETING/BRACING

TYPICAL UNDERPINNING DETAILS

UNDERPINNING NOTES

1. REFER TO THE PROJECT SPECIFICATIONS FOR ADDITIONAL UNDERPINNING REQUIREMENTS IF APPLICABLE.
2. THE UNDERPINNING DETAILS SHOWN HEREIN ARE A GENERAL GUIDELINE FOR THE CONTRACTOR. THE CONTRACTOR SHALL RETAIN A LICENSED PROFESSIONAL ENGINEER TO DESIGN AND DETAIL THE REQUIRED UNDERPINNING SHEETING AND SHORING SPECIFIC TO THE EXISTING FIELD CONDITIONS. THE CONTRACTOR IS RESPONSIBLE TO SUBMIT SIGNED AND SEALED DRAWINGS AND CALCULATIONS TO THE ENGINEER OF RECORD FOR REVIEW. THE DRAWINGS SHALL INCORPORATE ALL FIELD DATA, DIMENSIONS, MATERIALS, CONSTRUCTION SEQUENCING AND MEANS AND METHODS TO BE USED SPECIFIC TO THE EXISTING CONDITIONS.
3. THE CONTRACTOR SHALL COMPLY WITH THE ALL RELEVANT PROVISIONS OF THE NYC BUILDING CODE.
4. ALL FOUNDATIONS AND EARTHWORK OPERATIONS SHALL BE PERFORMED IN ACCORDANCE WITH THE REQUIREMENTS OF THE NYC BUILDING CODE AND ALL CITY, BUILDING AND SERVICE FACILITIES ADJOINING THE FOUNDATION AND EARTHWORK AREAS SHALL BE PROTECTED AND SUPPORTED.
5. ALL TEST PITS, BORINGS AND UNDERPINNING OPERATIONS ARE SUBJECT TO CONTROLLED INSPECTION.
6. THE OWNER SHALL RETAIN A LICENSED SURVEYOR TO SURVEY ALL LOAD BEARING WALLS, PIERES AND GULLINGS TO BE UNDERPINNED. THE SURVEYOR SHALL CHECK THE DATUM OF SUCH STRUCTURAL ELEMENTS EVERY TWO WEEKS FOR THE DURATION OF THE WORK. LANDMARKED BUILDINGS SHALL BE CHECKED EVERY FIVE WORKING DAYS.
7. THE CONTRACTOR AND/OR SUB-CONTRACTOR(S) SHALL HAVE COMPLETED NO LESS THAN FIVE (5) UNDERPINNING PROJECTS OF A COMPARABLE SIZE AND TYPE TO THIS PROJECT, AND MUST HAVE AT LEAST FIVE (5) YEARS EXPERIENCE IN THE WORK AND/OR APPLICABLE TRADE. SUBMIT EVIDENCE OF SUCH EXPERIENCE FOR REVIEW.
8. THERE SHALL BE A PRE-CONSTRUCTION MEETING WITH THE OWNER, ARCHITECT, ENGINEER OF RECORD, GENERAL CONTRACTOR AND SUB-CONTRACTOR(S) PRIOR TO WORK COMMENCEMENT.
9. ALL ADJACENT PROPERTIES, INCLUDING BUT NOT LIMITED TO EXISTING WALLS AND FOOTINGS ARE TO BE OBSERVED BY THE ENGINEER OF RECORD PRIOR TO WORK COMMENCEMENT.
10. THE CONTRACTOR SHALL REQUEST PERMISSION TO ENTER BUILDINGS DIRECTLY ADJACENT TO THE AREAS OF PROPOSED UNDERPINNING.
11. NO FOUNDATION OR EARTHWORK PERMIT SHALL BE ISSUED UNTIL AT LEAST FIVE DAYS AFTER A WRITTEN NOTICE OF THE PERMIT APPLICATION HAS BEEN PROVIDED BY THE APPLICANT TO THE OWNERS OF ALL ADJOINING LOTS, BUILDINGS AND SERVICE FACILITIES WHICH MAY BE AFFECTED BY THE PROPOSED FOUNDATION WORK OR EARTHWORK OPERATIONS.
12. THE UNDERPINNING FOUNDATIONS SHALL BEAR ON SUBGRADE HAVING A BEARING CAPACITY EQUAL TO OR GREATER THAN THE SUBGRADE OF THE EXISTING FOUNDATION. THE SUBGRADE AT THE LEVEL OF THE EXISTING FOUNDATION SHALL BE INSPECTED BY A LICENSED PROFESSIONAL ENGINEER RETAINED BY THE OWNER TO VERIFY THE BEARING CAPACITY, AND DEFICIENCIES BROUGHT TO THE ATTENTION OF THE ENGINEER OF RECORD.



SECTION OF CONCRETE UNDERPINNING

TYPICAL UNDERPINNING DETAILS

13. DO NOT TRANSFER THE BUILDING LOAD ONTO NEW UNDERPINNING WALLS UNTIL ALL WALLS HAVE ATTAINED 50% OF THE CONCRETE DESIGN STRENGTH, AS CONFIRMED BY THE CYLINDER TESTS, OR 48 HOURS.
14. DO NOT PLACE BACKFILL AGAINST NEW UNDERPINNING WALLS UNTIL WALLS HAVE ATTAINED 50% OF THE CONCRETE DESIGN STRENGTH, AS CONFIRMED BY THE CYLINDER TESTS, OR 48 HOURS.
15. ALL CONCRETE SHALL BE NORMAL WEIGHT CONCRETE WITH A MINIMUM ULTIMATE COMPRESSIVE STRENGTH OF 4000 PSI AT 28 DAYS.
16. ALL GROUT SHALL BE NONSHRINKING WITH A MINIMUM COMPRESSIVE STRENGTH OF 5000 PSI.
17. ALL DRYPACK SHALL BE A MIXTURE OF 1 PART CEMENT AND 2 PARTS SAND, WITH 0.5" BELLS.
18. ALL UNDERPINNING SHEETING AND BRACING TO REMAIN SHALL BE PRESSURE TREATED LUMBER AND/OR OTHER APPROVED MATERIAL.
19. THE EXTENT OF THE UNDERPINNING SHALL BE DETERMINED UPON REVIEW OF THE SOILS REPORT, TEST PIT DATA AND EXISTING CONDITIONS BY A LICENSED PROFESSIONAL ENGINEER RETAINED AS REVIEWED AND REPORTED UPON TO THE ARCHITECT.
20. EXCAVATION BELOW THE WATER TABLE SHOULD BE AVOIDED. IF POSSIBLE, DEWATER THE SITE PRIOR TO EXCAVATION. EXCAVATION MAY ONLY PROCEED AFTER REVIEW BY THE ENGINEER OF RECORD.
21. IF WATER IS ENCOUNTERED IN THE PIT, PROVIDE A WELL POINT NEAR THE PIT. THE CONTRACTOR'S LICENSED PROFESSIONAL ENGINEER SHALL DETERMINE THE LOCATIONS OF THE WELL POINTS AND THE METHOD(S) OF REMOVING WATER FROM THE PIT.
22. ALL SIDES OR FACES OF EXCAVATIONS OR EMBANKMENTS SHALL BE INSPECTED AGAINST EARTHWORK.
23. EXCAVATED MATERIAL AND SUPERIMPOSED LOADS SUCH AS EQUIPMENT AND TRUCKS SHALL NOT BE PLACED CLOSER TO THE EDGE OF THE EXCAVATION THAN A DISTANCE EQUAL TO ONE AND ONE-HALF TIMES THE DEPTH OF SUCH EXCAVATION.
24. THE UNDERPINNING SHALL BE INSTALLED IN A MANNER SUCH THAT THE EXPOSED FACE OF THE CONCRETE IS VERTICAL, (OR AS OTHERWISE SPECIFIED), CLEAN AND NEAT.
25. EXISTING STRUCTURE(S) WALLS TO BE UNDERPINNED SHALL BE TREATED BY PRESSURE INJECTED GROUT AT THE DISCRETION OF THE ENGINEER OF RECORD.
26. THE DEPTH OF THE UNDERPINNING PITS SHALL BE A MAXIMUM OF ONE LIFT. THE LIFT SHALL BE WITHOUT INTERMEDIATE HORIZONTAL CONSTRUCTION JOINTS (E.G. JOINTS). MULTIPLE VERTICAL LEVELS OF UNDERPINNING SHALL NOT BE PERMITTED.



Provide enough information to the contractor

What is “Means and Methods of Construction”?

This is a term used by the AIA to describe construction procedures that are the responsibility of the contractor. That does not mean that the design professional should avoid the underpinning process.



What is the Geotechnical Engineers Role?

- Incorporate requirements of specific site so that contractors engineer can be better educated!
- Indicate how load should be transferred; how pits should be sheeted and or braced; the soil conditions (refer to the geotechnical report!)
- Specify the appropriate type of underpinning to the site conditions.



III. During Construction

What are the key breakdowns that often lead to failures?



Excavation begins on site without proper supervision or notification. Before long, undermining occurs or too much overburden is removed.



Over excavation with disregard for adjoining properties



Complete excavation with
inadequate underpinning and
bracing in place



What can be done to avoid these problems?

Contractors must be more aware of the ramifications of sending an excavator on site to do a general excavation.

Submit “mass excavation plan”

The contractor **MUST** hire his own engineer to design and detail the required underpinning.

The controlled inspector must be retained **BEFORE** construction starts and actively involved in the planning process.



Preconstruction surveys

A thorough preconstruction survey of all adjacent properties is imperative. Cracks which were pre-existing will become the contractors and owners responsibility if they are not documented. Every tenant will claim damages that were pre-existing!! Access can be difficult but that should not mean we should not try. SEAoNY's recommendation to the DOB is to make this mandatory and if not allowed, the adjacent owner waives the right to sue.



An active and positive relationship with neighboring property owners can alleviate many of the inherent adversarial problems associated with underpinning.

Monitoring of site should be done using surveyors, crack monitors, vibration monitors.

The design team should be consulted for knowledge about the site. A working relationship is beneficial.

Proper and complete shop drawings and calculations should be submitted for review prior to any work commencing.



How can the project's structural engineer play a role during construction?

- Review the contractor's engineers submission for how it applies to the specific site and site conditions.
- Make sure the contractor has the proper experience in underpinning buildings of similar construction and site conditions.
- Remain an active participant. Encourage a dialogue with neighbors.

Take advantage of the early Due Diligence!



How can the project's geotechnical engineer play a role during construction?

Have the Geotechnical engineer review the contractor's underpinning design and construction sequence and then verify that the design is being followed in the field

- Consult the Geotechnical engineer during the course of construction, especially if conditions found in the field do not conform with those expected
- Have the Geotechnical engineer review monitoring data



What steps can be included in the design of the underpinning to improve the results?



Steel shims for load transfer



Sheeting and Bracing

All pits, unless otherwise dictated by geotechnical engineer, should be sheeted excavations.

Deep pits must be laterally braced and reinforced as required.

Corner excavations should return under the adjacent building on a slope and be sheeted.



Monitoring

Vibration monitors should be used where historic structures are present (required by code)

Surveyor should be retained to monitor settlement. Settlement predictions can be made by geotechnical engineer. This can help prevent problems getting out of control.

Crack monitors can be installed to measure all existing cracks.



Controlled Inspections

N.Y. City requires controlled inspections for underpinning.

§ 27-724(C26-1112.6) Construction required for or affecting the support of adjacent properties or buildings. Except in cases where a proposed excavation will extend less than ten feet below the legally established grade, all underpinning operations and the construction and excavation of temporary or permanent cofferdams, caissons, braced excavated surfaces, or other constructions or excavations required for or affecting the support of adjacent properties or buildings shall be subject to controlled inspection. The details of underpinning, cofferdams, caissons, bracing, or other constructions required for the support of adjacent properties or buildings shall be shown on the plans or prepared in the form of shop or detail drawings and shall be approved by the architect or engineer who prepared the plans.



Communication is key!!

Involve the inspector early on in the projects construction to insure that they are on board with what is proposed and are aware of sequencing, start dates and all details of underpinning.

Inform them of site conditions

Provide the geotechnical report for reference

Make sure the design team knows that construction has commenced



What can a homeowner who wants to underpin his neighbors house do if he cannot afford experts and all of the recommendations we make?

Assuming that cost prohibits this extensive evaluation, a series of standards for certain site types could be developed.

If underpinning is necessary, an engineer and/or suitable contractor must be retained.

Underpinning contractors could be licensed, further protecting the public.

Inspectors for the DOB could be educated on what to look for.

Can he afford “not” do this??



Thank you!

Questions and answers/panel discussion

Panelists include:

John S. Deerkoski, P.E. FASCE, President,
John S. Deerkoski, P.E. and Associates

Robert LiMandri, Deputy Commissioner,
Operations, NYC DOB

Dan Eschenasy, P.E., Deputy Asst.
Commissioner, Safety and Emergency
Operations, NYC DOB

