AIA Philadelphia
A Chapter of The American Institute of Architects

Underpinning 101

A Down & Dirty Overview

John Davis, PE
Denise Richards, PE

April 25, 2016

CONTINUING EDUCATION AIA

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

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

KEAST & HOOD
STRUCTURAL ENGINEERS

CONTINUING EDUCATION
AIA

Learning Objectives

- Learn the basic principles of underpinning.
- Understand the proper techniques of “approach pit” underpinning for wall foundations.
- Understand how not to do approach pit underpinning.
- Review techniques for individual spread footing underpinning.
- Review alternative underpinning/foundation modification techniques.

KEAST & HOOD
STRUCTURAL ENGINEERS

CONTINUING EDUCATION AIA

Without a solid foundation…

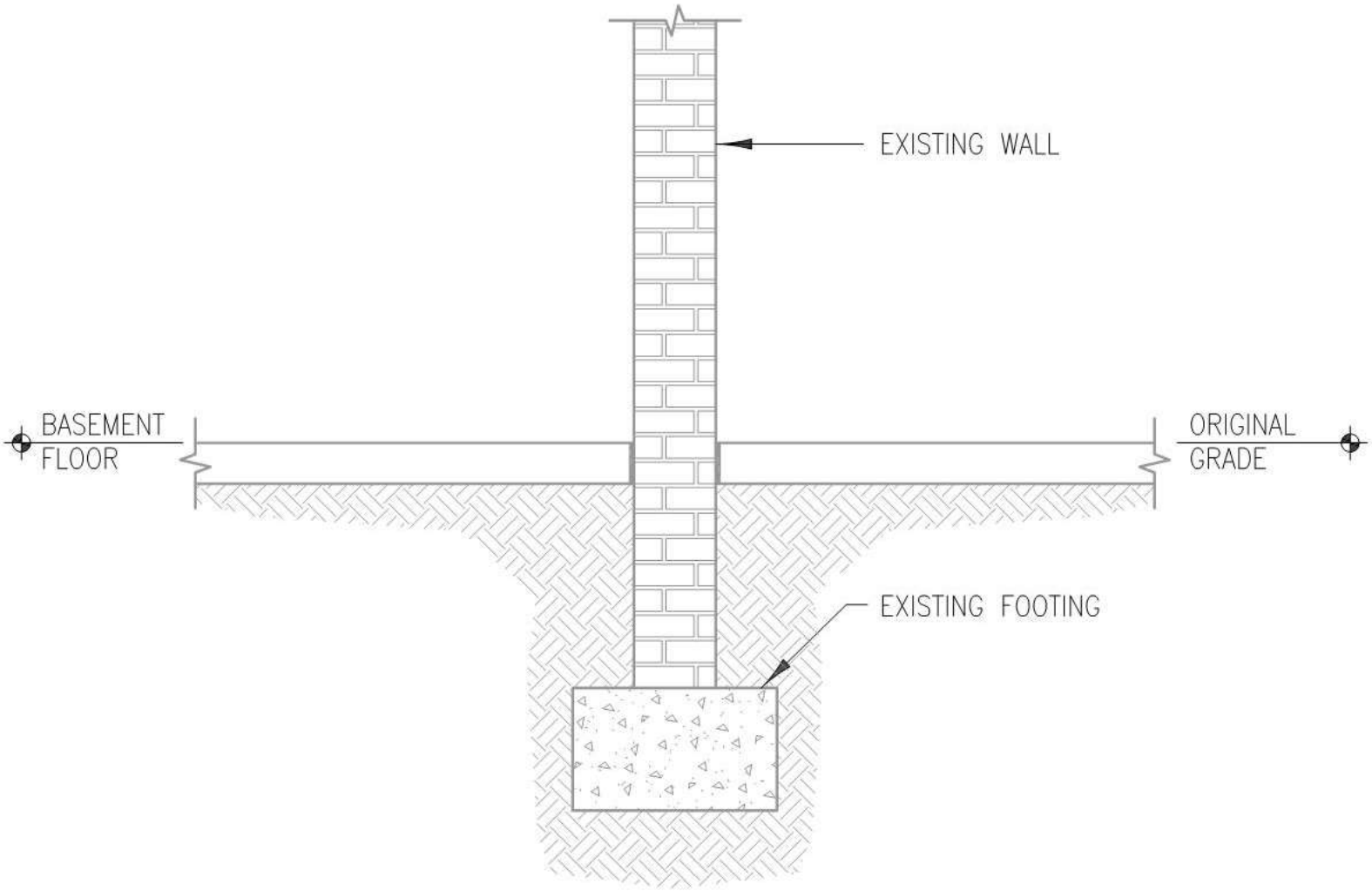
London, 2014

Toronto, 2014

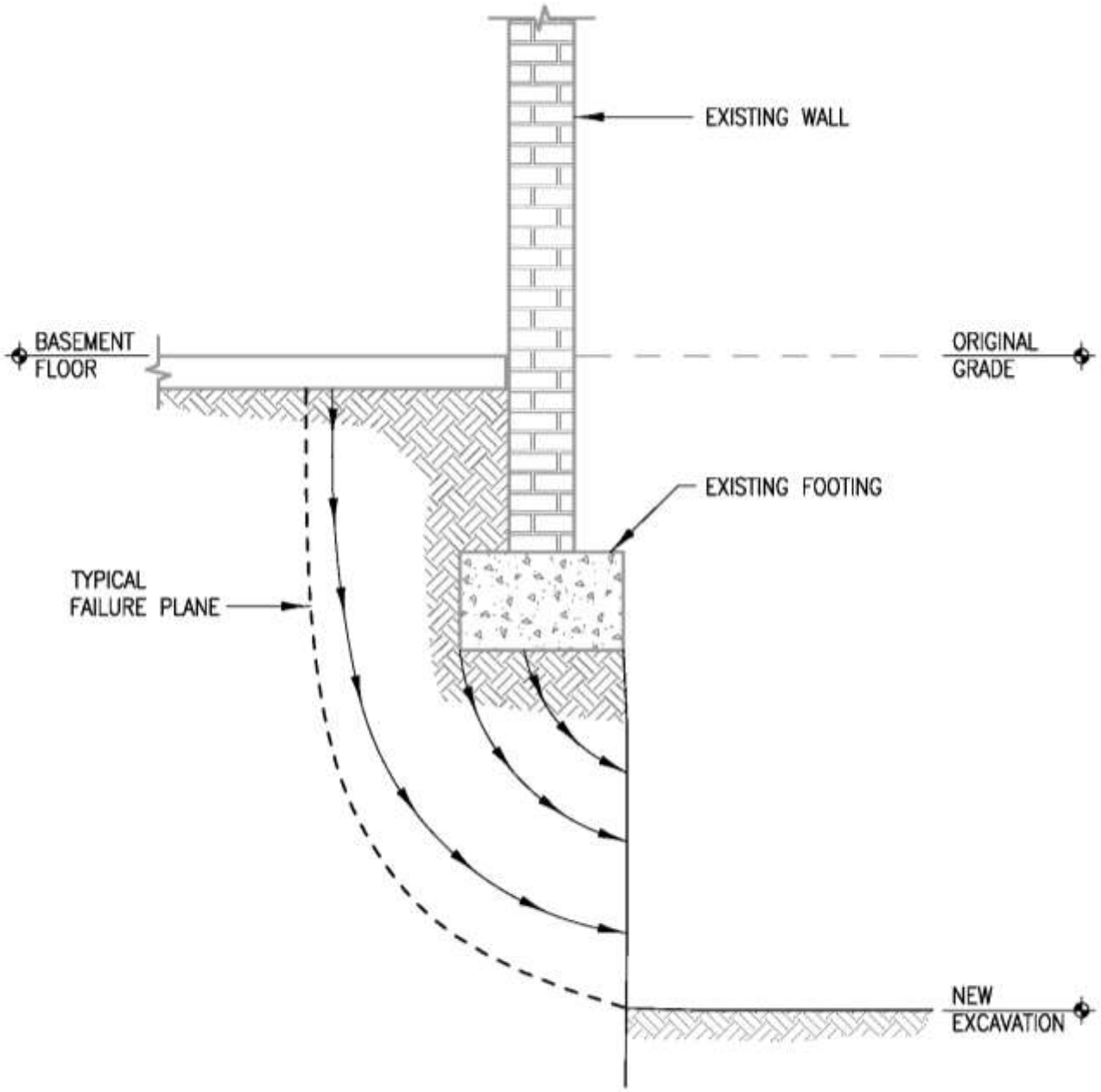
Toronto, 2014

On a Larger Scale…

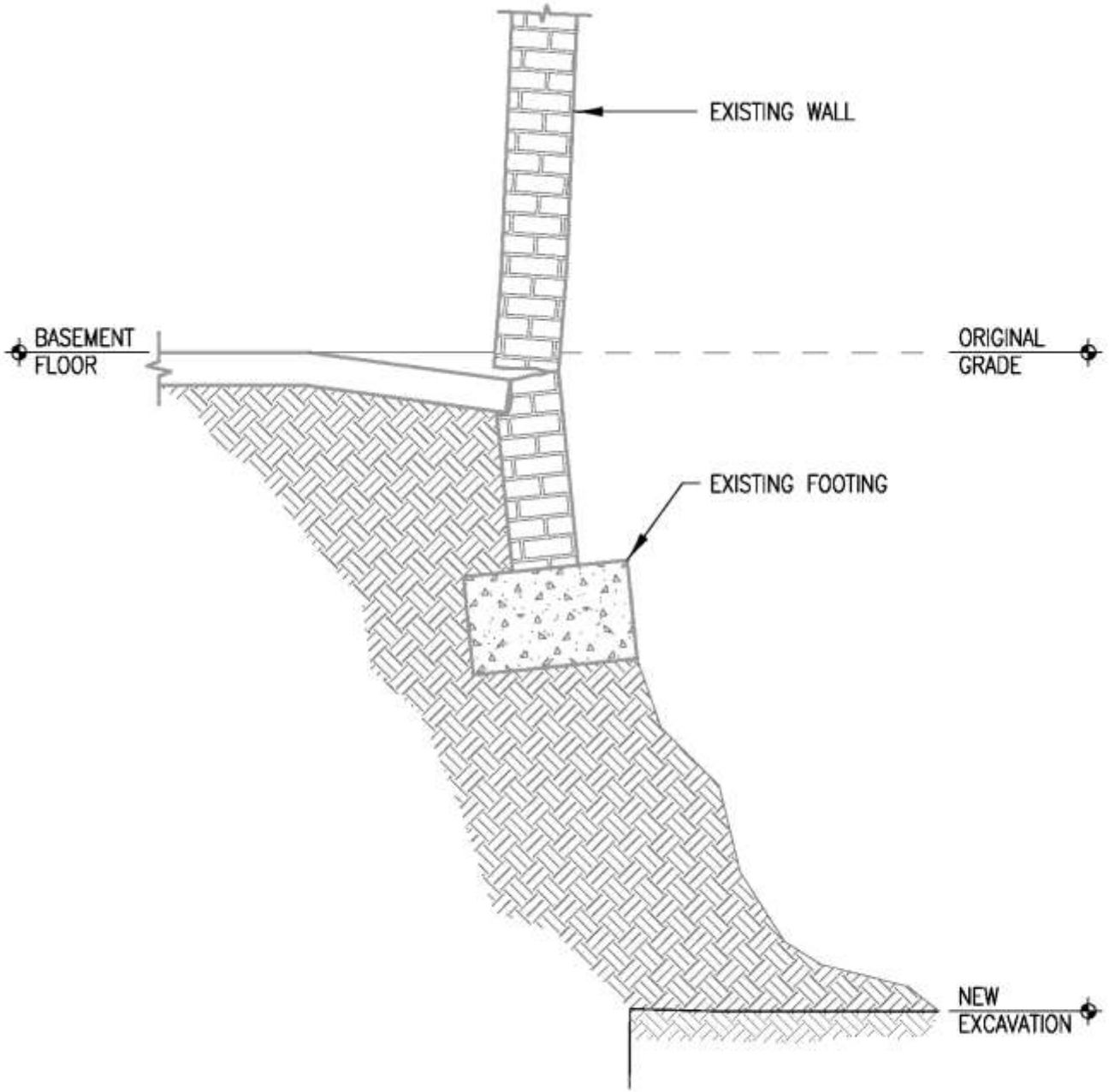
Minard Hall,
North Dakota State, 2009



INITIAL CONFIGURATION



IMMEDIATELY AFTER EXCAVATION



SUBSEQUENT COLLAPSED CONDITION

un·der·pin·ning [uhn-der-pin-ing] –
verb (used with object)

1. the introduction of additional support to the foundation of a structure to deepen or increase its bearing value.
   a. if done because the foundation is inadequate, it is called remedial underpinning.
   b. if done to deepen a foundation to enable adjacent, lower construction, it is called precautionary underpinning.[1]

1. Edward E. White (1913-1988), Spencer White and Prentis, Inc.

In the Code

2012 IBC Section 1804.1 - Excavations for any purpose shall not remove lateral support from any footing or foundation without first underpinning or protecting the footing or foundation against settlement or lateral translation.

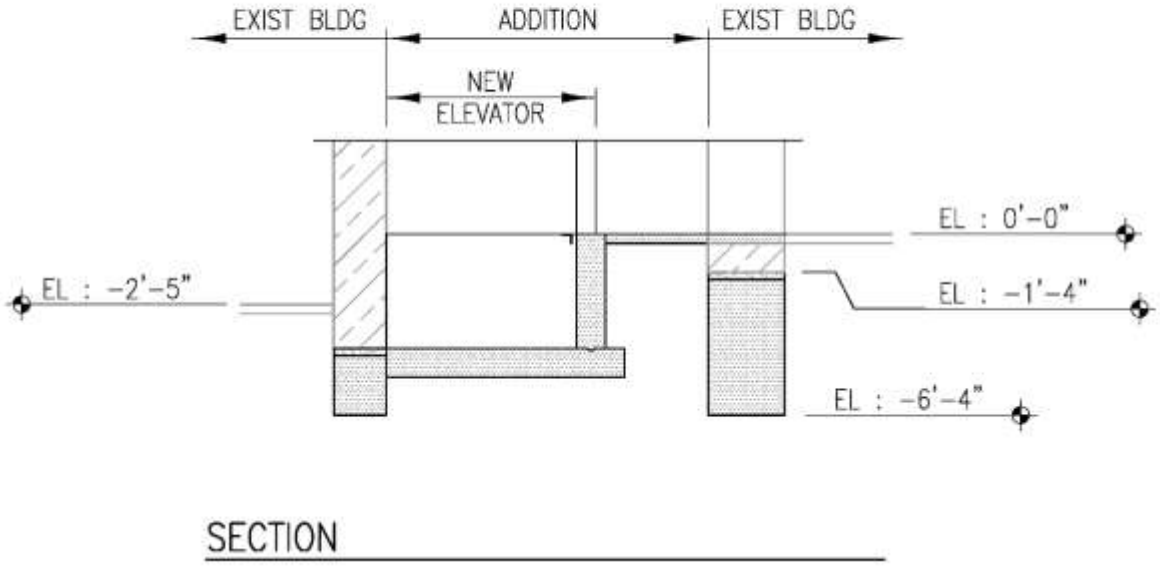
Historic Building Foundations

- Prevalent in Philadelphia housing
- Rubble stone foundations without footings
- If exposed or undermined, more susceptible to instability or sudden failure

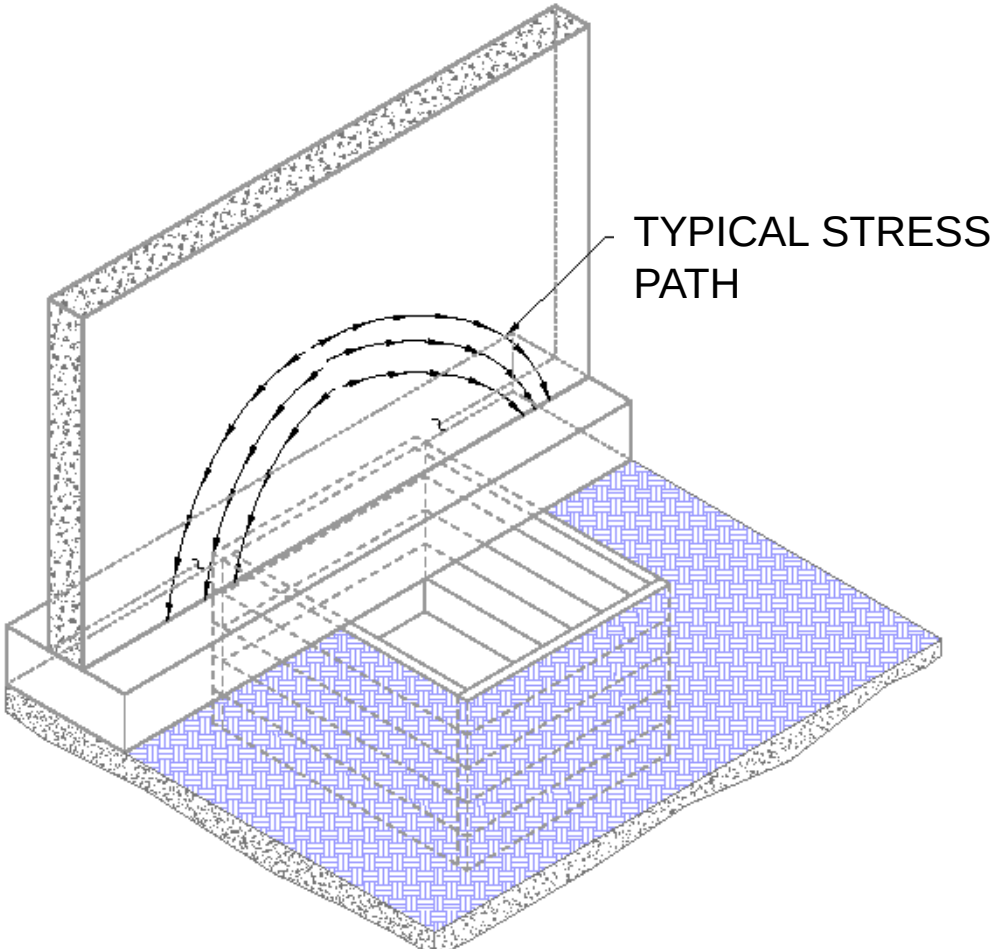
Most Common Type of Precautionary Underpinning

"Approach Pit":

underpinning in order to lower the foundation bearing level to enable adjacent lower construction.

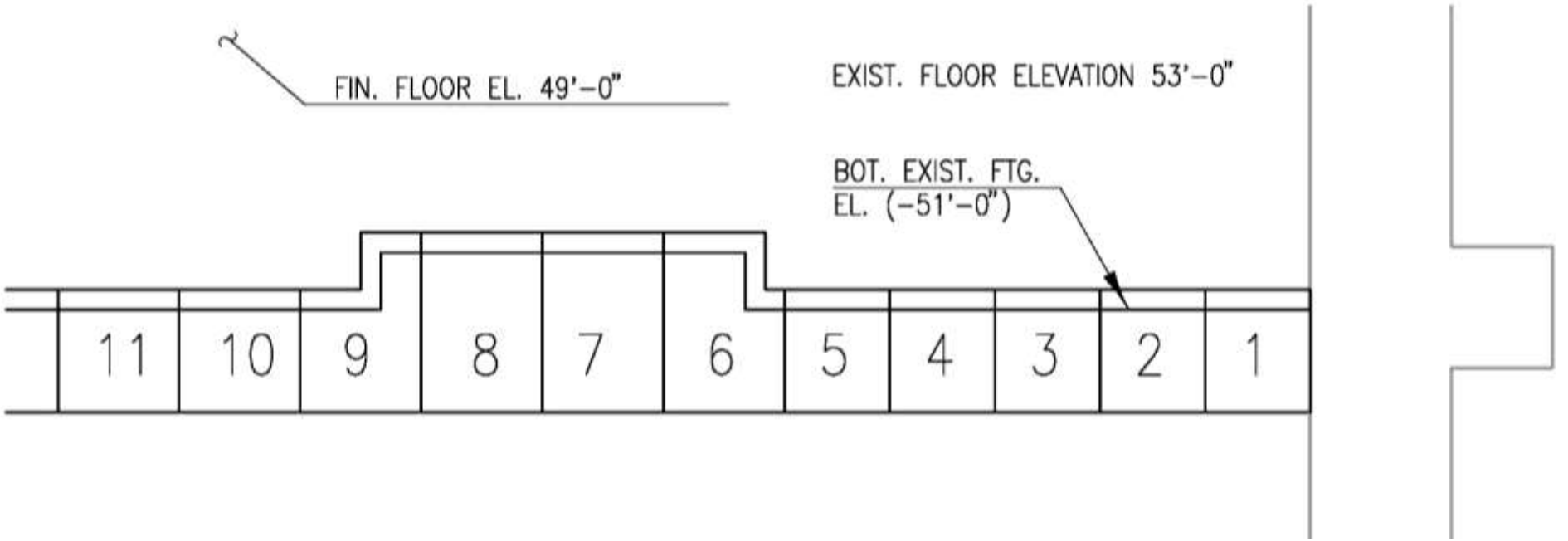


Theory of Approach Pit Underpinning

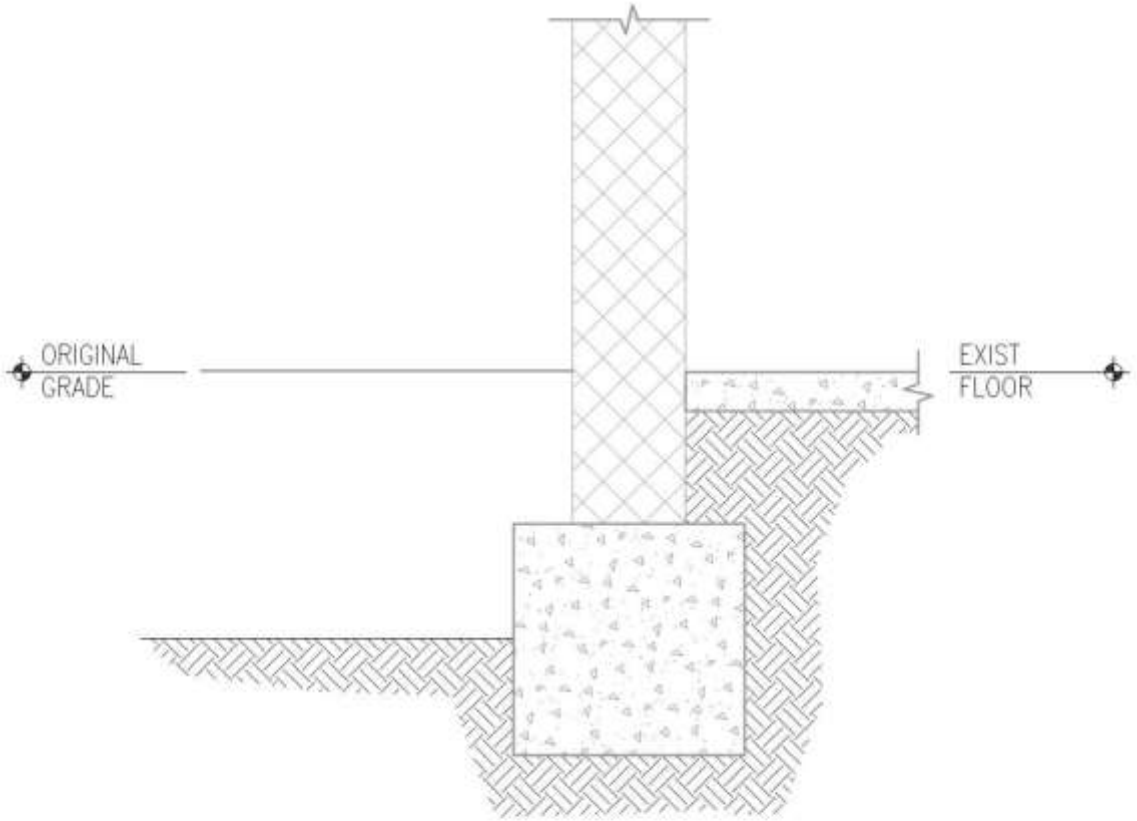


ARCHING OF WALL OVER APPROACH PIT

1. Plan the sequence

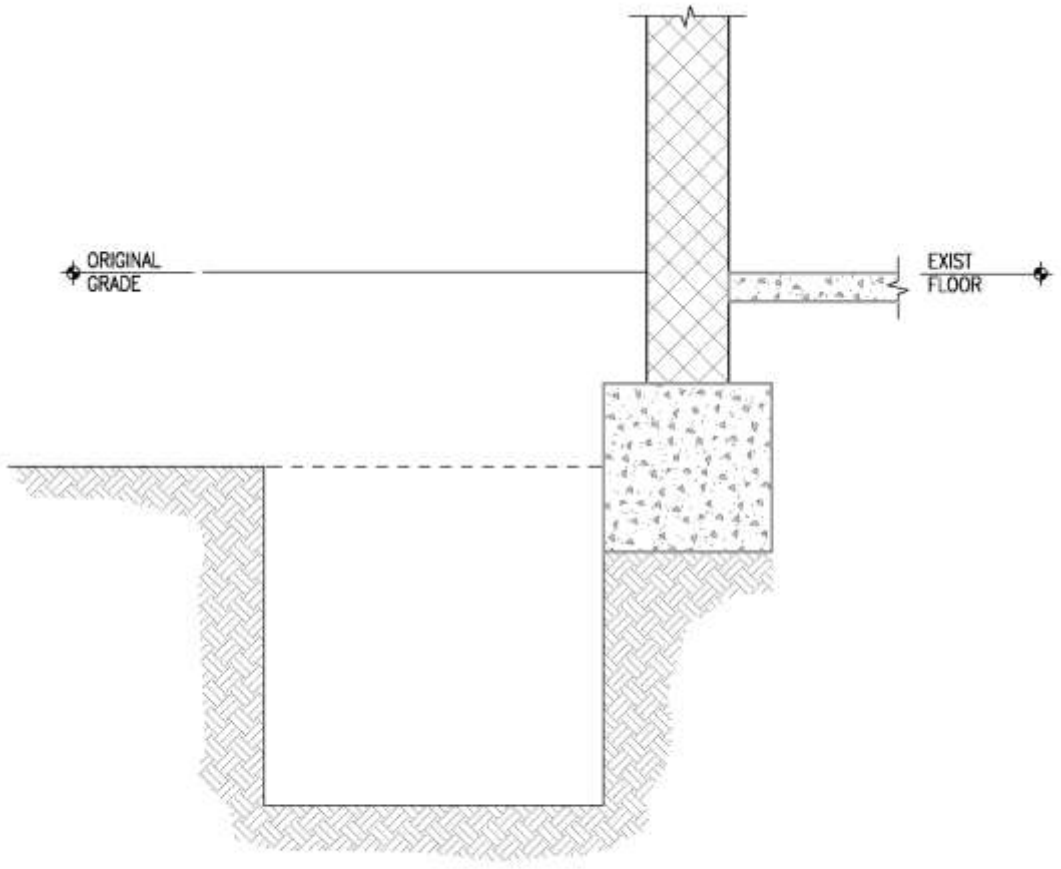


2. Initial Excavation



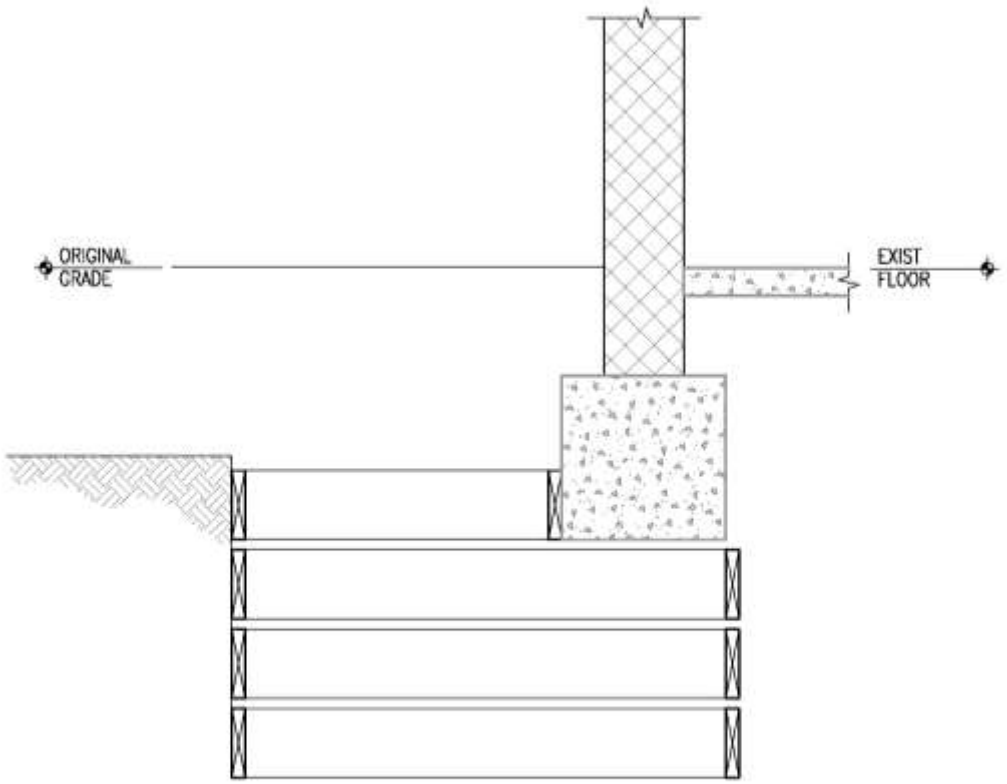
STEP 1: LOCALLY EXCAVATE FOR
APPROACH PIT

3. Start “Approach Pit”



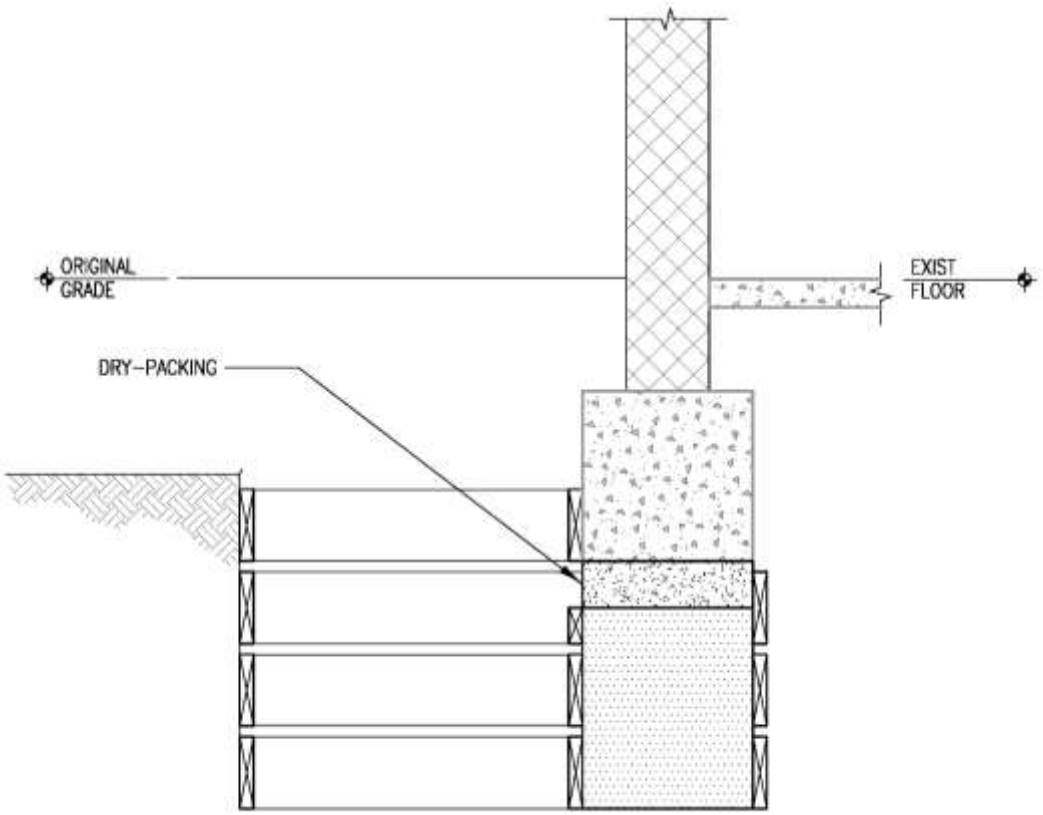
STEP 2: LOCALLY EXCAVATE
APPROACH PIT w/o LAGGING

4. Install Lagging and Extend Shaft Under Footing

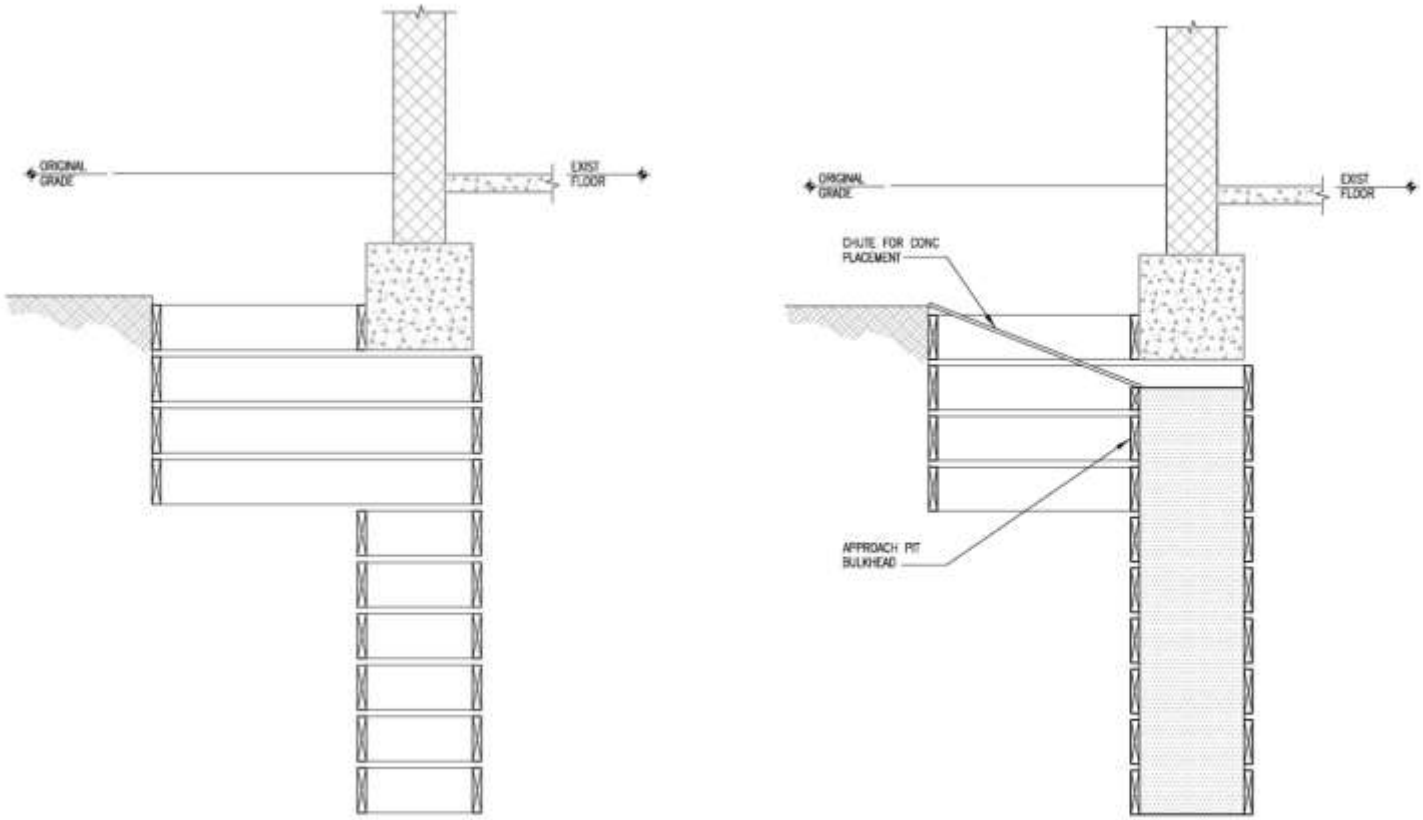


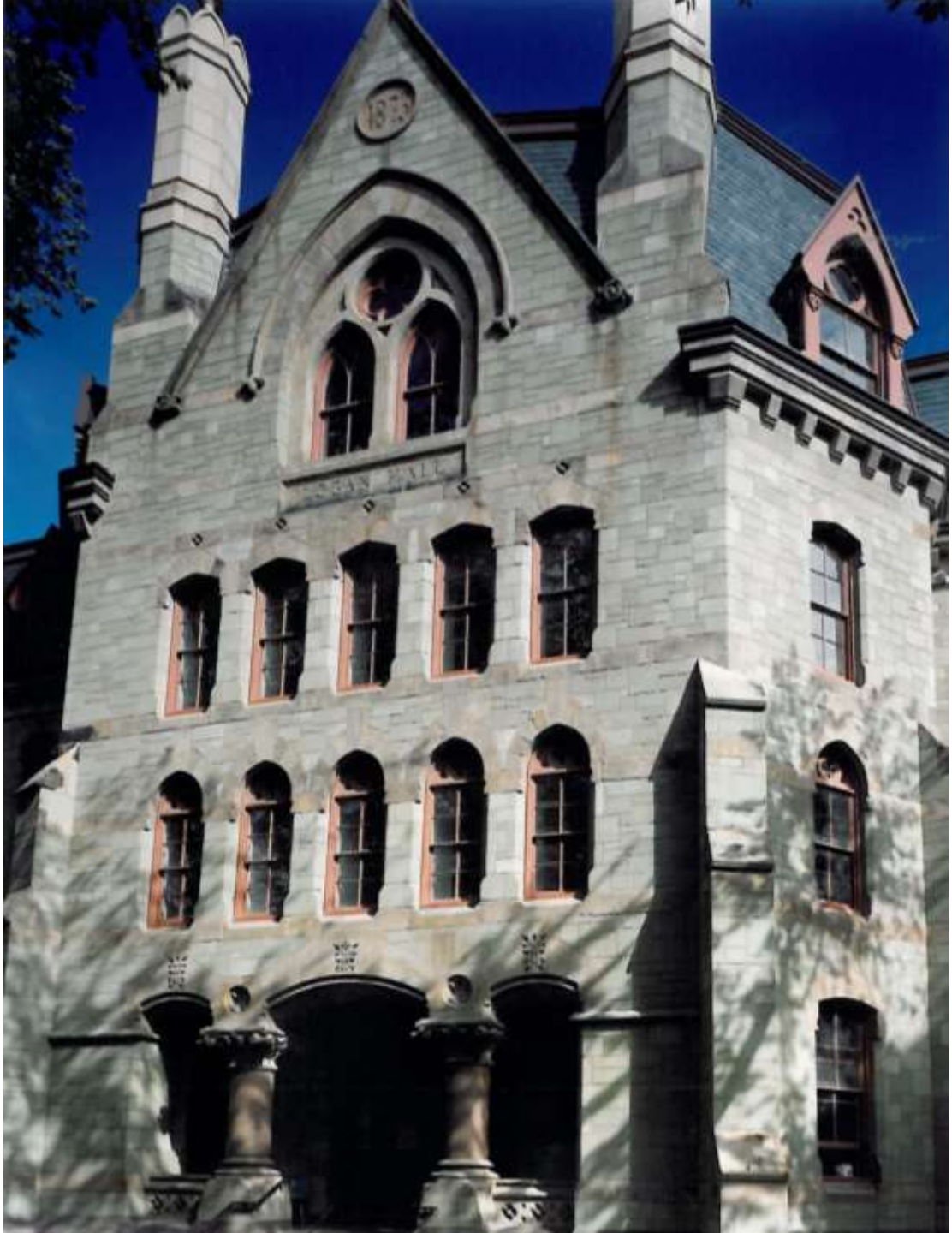
STEP 2: LOCALLY EXCAVATE
APPROACH PIT WITH LAGGING

5. Place Concrete and Drypack

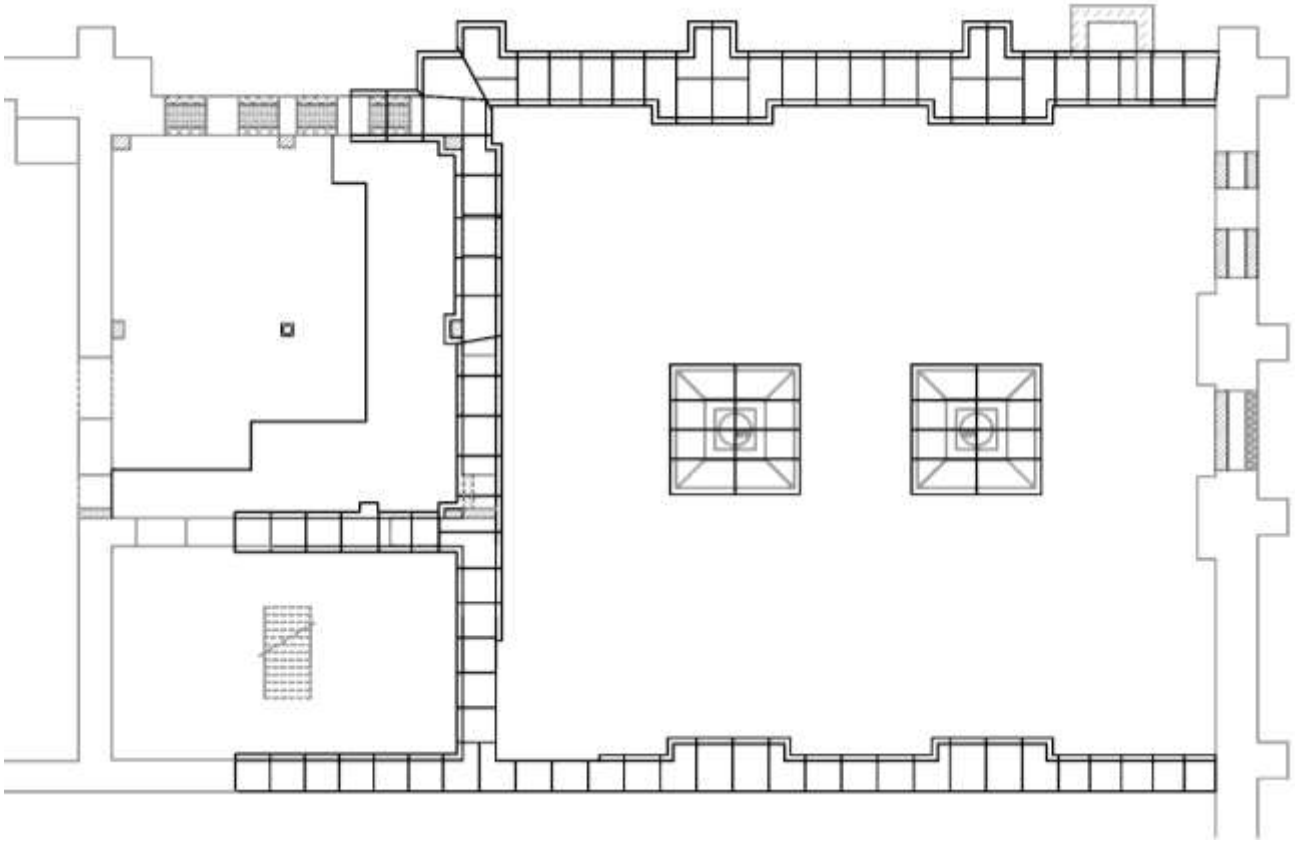


5a. Or Extend Shaft to Depth Needed Then Place and Drypack

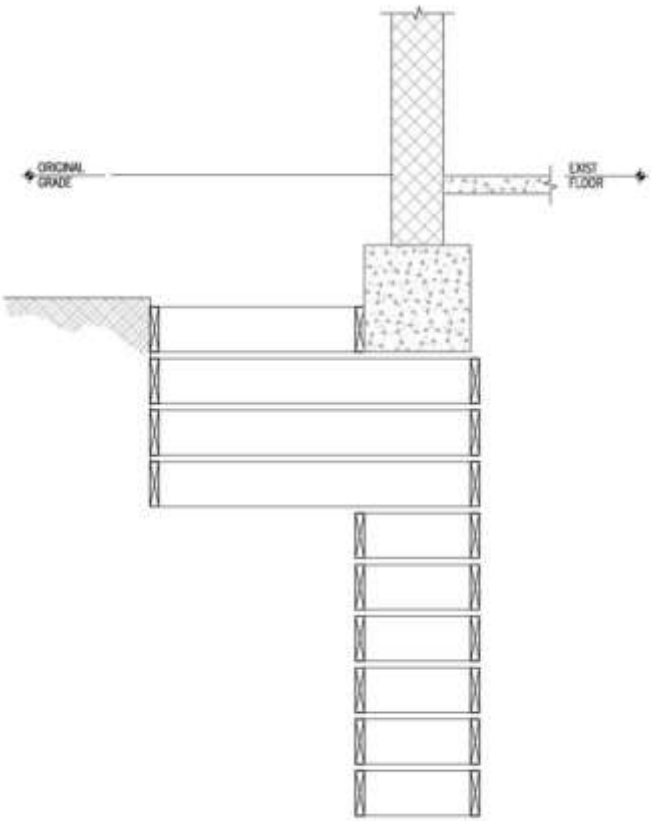


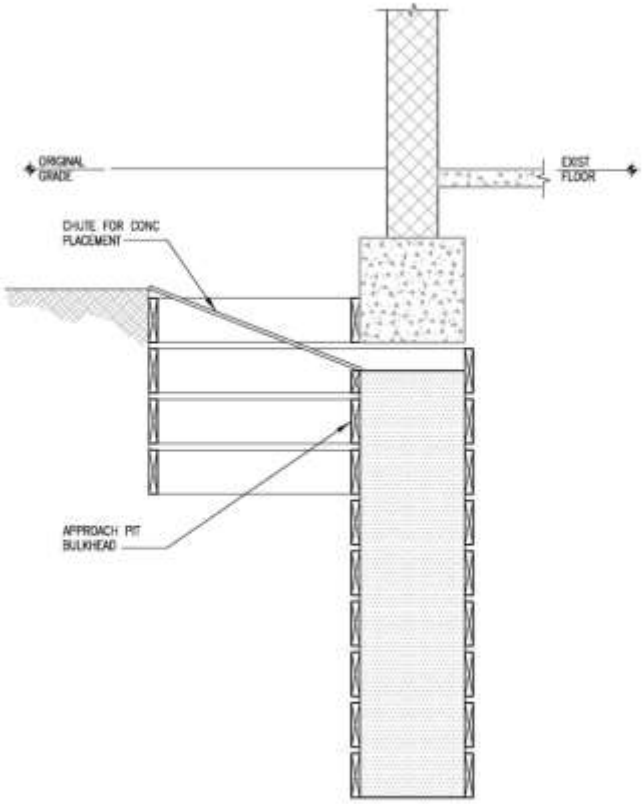


Underpinning Plan




6171

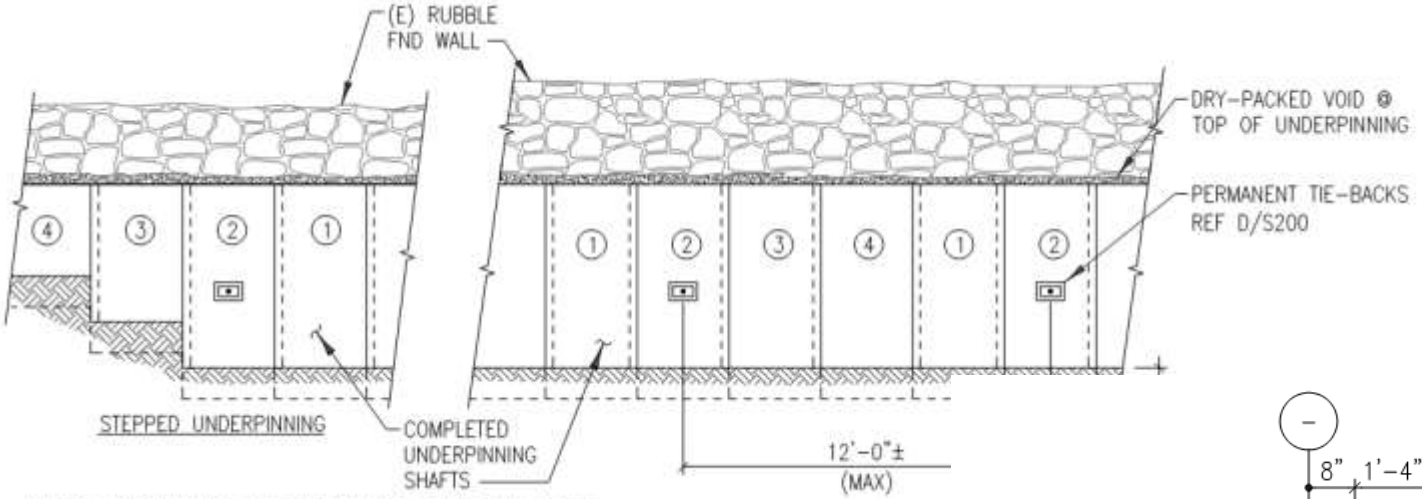

ORIGINAL GRADE
EXIST FLOOR


ORIGINAL GRADE
EXIST FLOOR
CHUTE FOR CONC PLACEMENT
APPROACH PIT BULKHEAD


12 8'95


United Rentals
15TH STREET
MORRIS


CASE

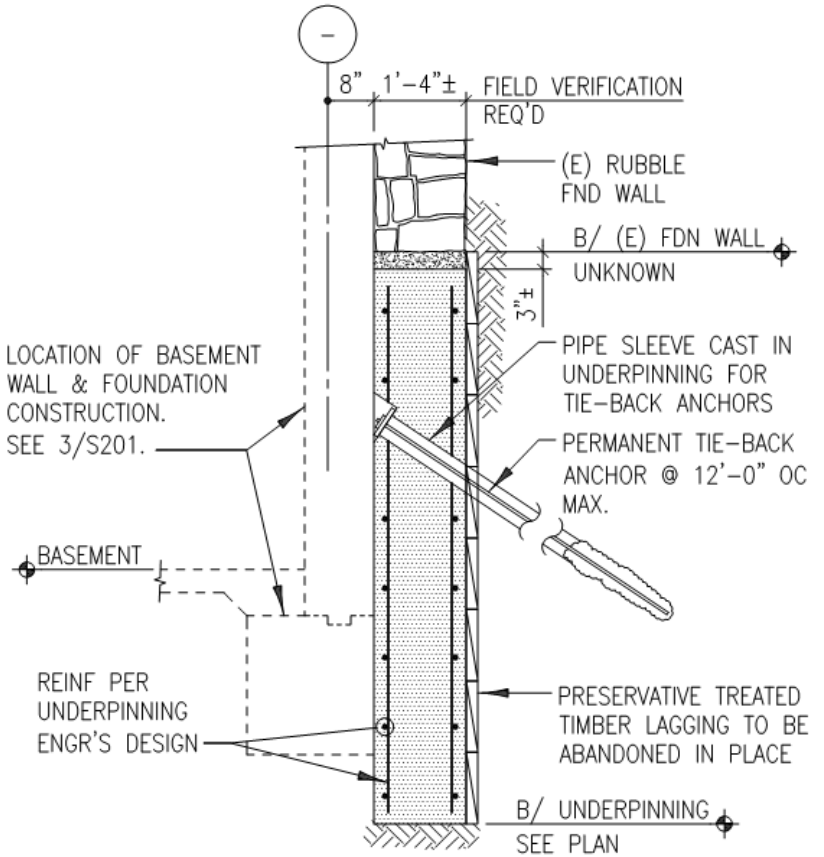


WHERE UNDERPINNING SHAFT ELEVATIONS STEP THE SHAFT @ THE LOWEST ELEVATION SHALL BE CONSTRUCTED FIRST. SUBSEQUENT SHAFTS SHALL BE CONSTRUCTED IN THE SEQUENTIAL ORDER OF UPWARD STEPPING BEARING ELEVATIONS WITHOUT SKIPPING SHAFTS TO AVOID UNDERMINING PREVIOUSLY CONSTRUCTED SHAFT.

TYPICAL ELEVATION – COMPLETED UNDERPINNING

4' 0 4' 8'

SCALE AT FULL SIZE ¼"=1'-0"



SECTION – EXISTING FOOTING UNDERPINNING

D / S200

2' 0 2' 4'

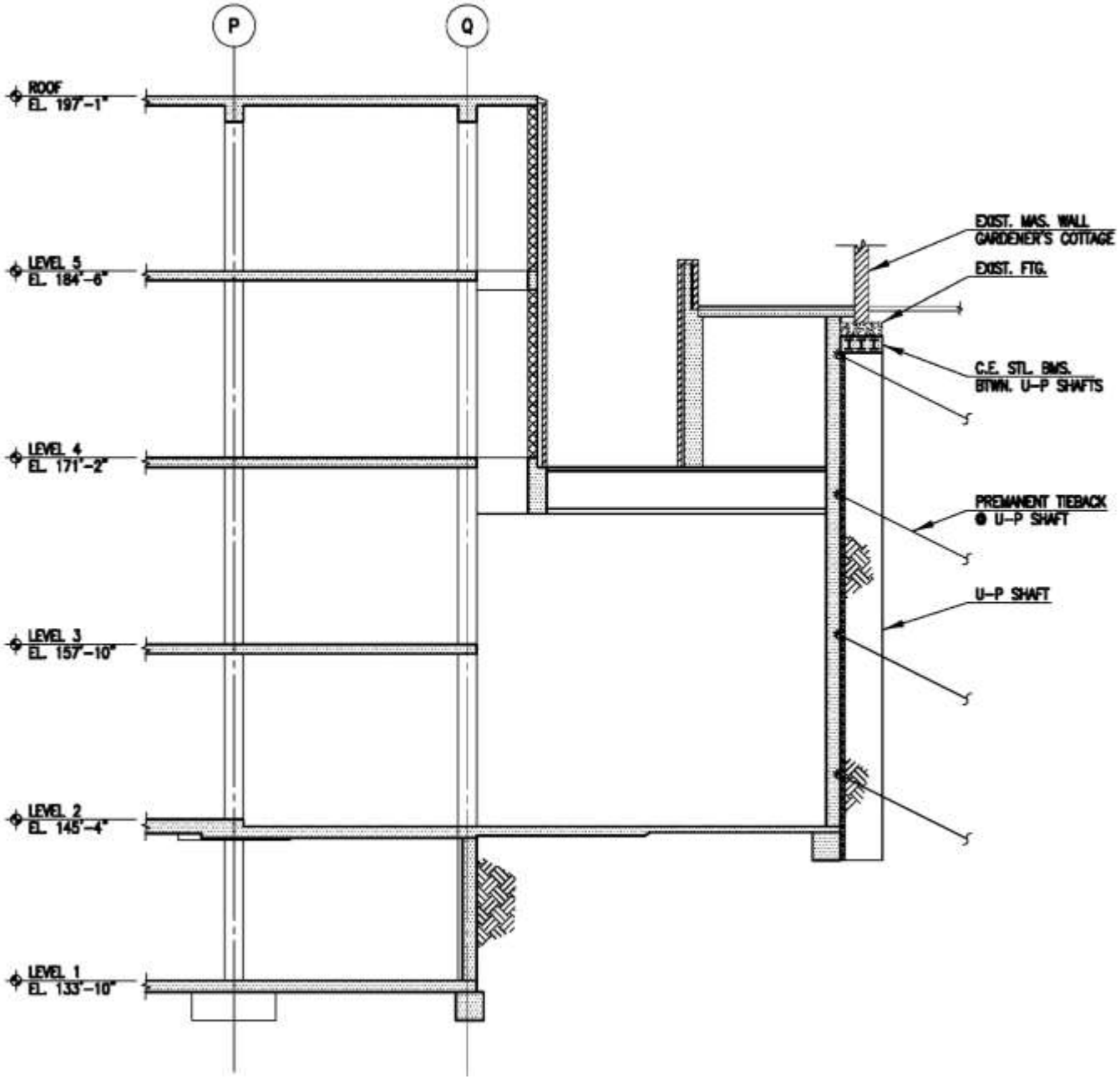
SCALE AT FULL SIZE ½"=1'-0"

Exceptions to the Rule


310SE


DANGER

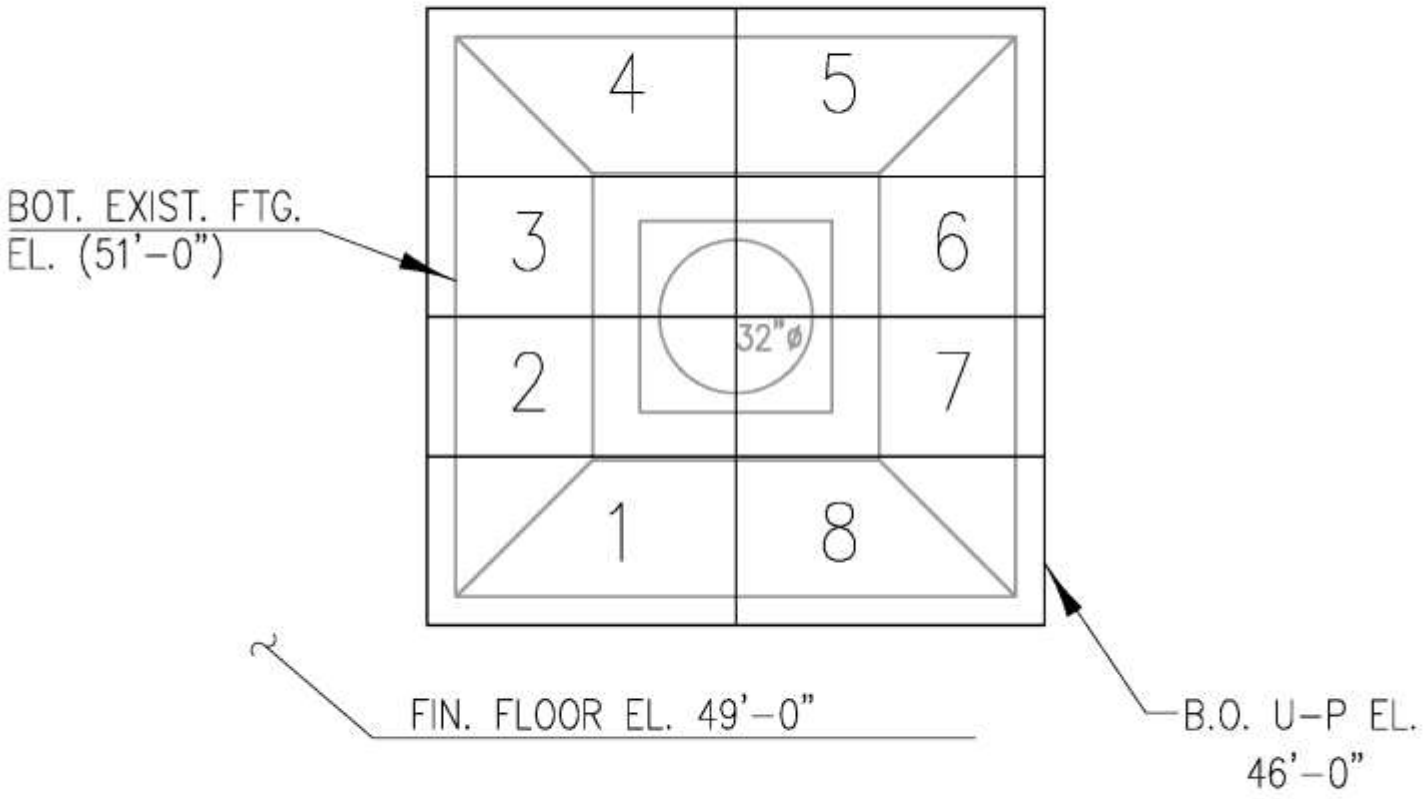
Non Continuous Approach Pit Underpinning

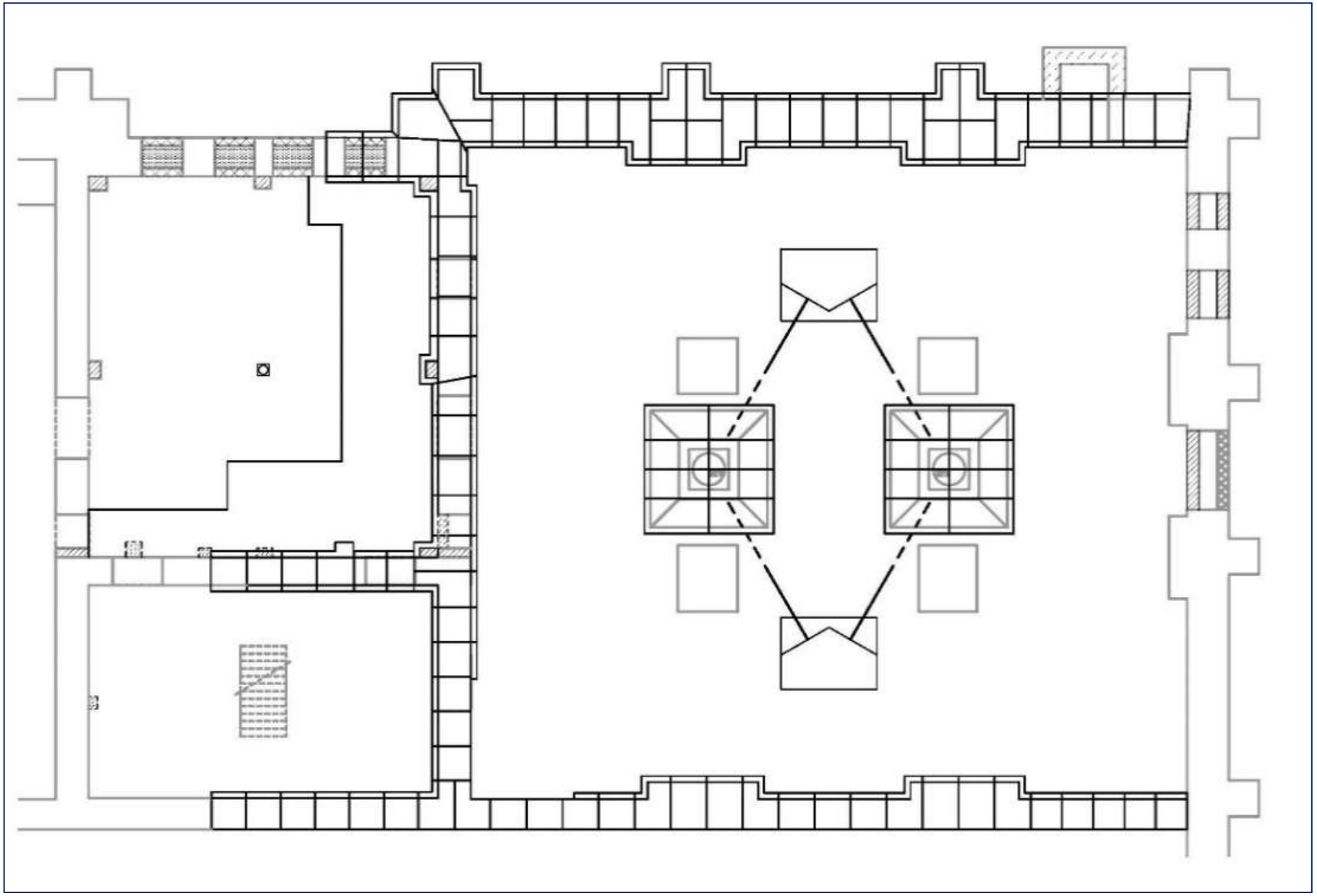

P
Q
ROOF
EL. 197'-1"
LEVEL 5
EL. 184'-6"
LEVEL 4
EL. 171'-2"
LEVEL 3
EL. 157'-10"
LEVEL 2
EL. 145'-4"
LEVEL 1
EL. 133'-10"
EXIST. MAS. WALL
GARDENER'S COTTAGE
EXIST. FTG.
C.F. STL. BMS.
BTWN. U-P SHAFTS
PREMANENT TIEBACK
@ U-P SHAFT
U-P SHAFT

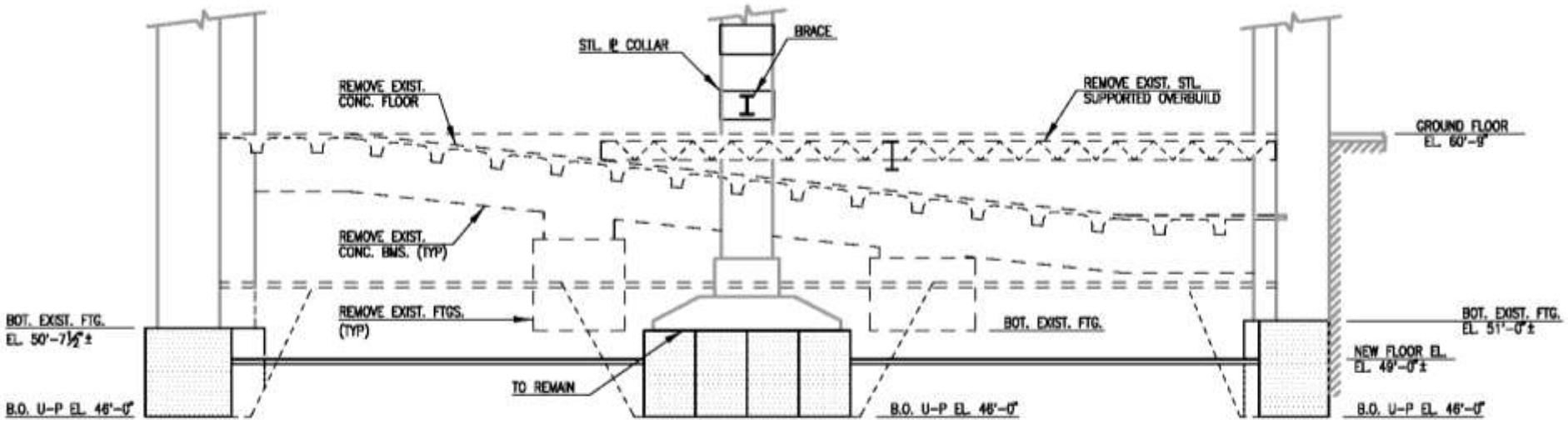

HITACHI
HITACHI
CAUTION


CAUTION

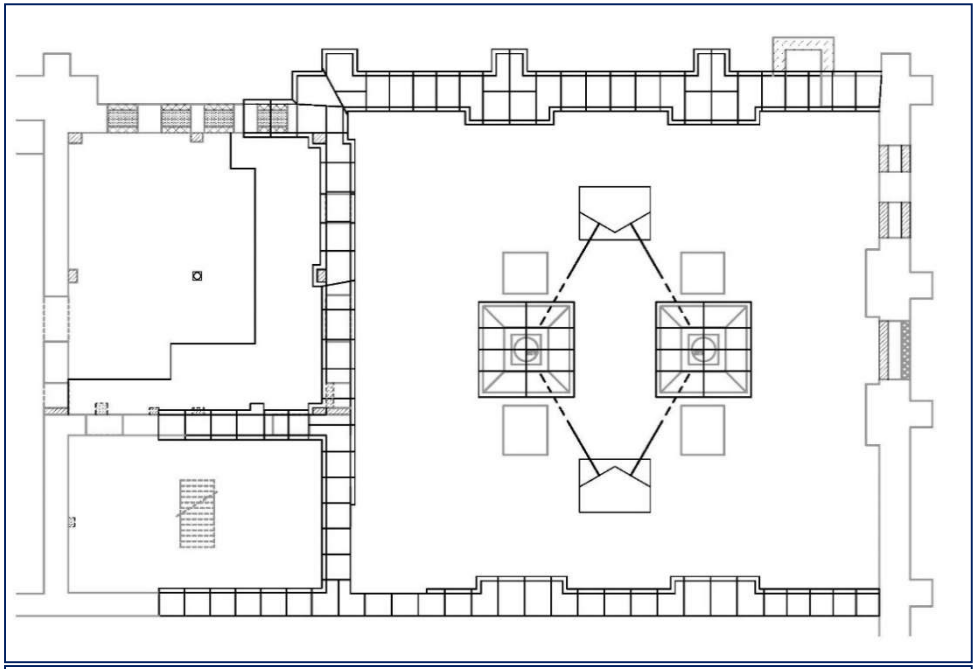
Individual Spread Footing Underpinning

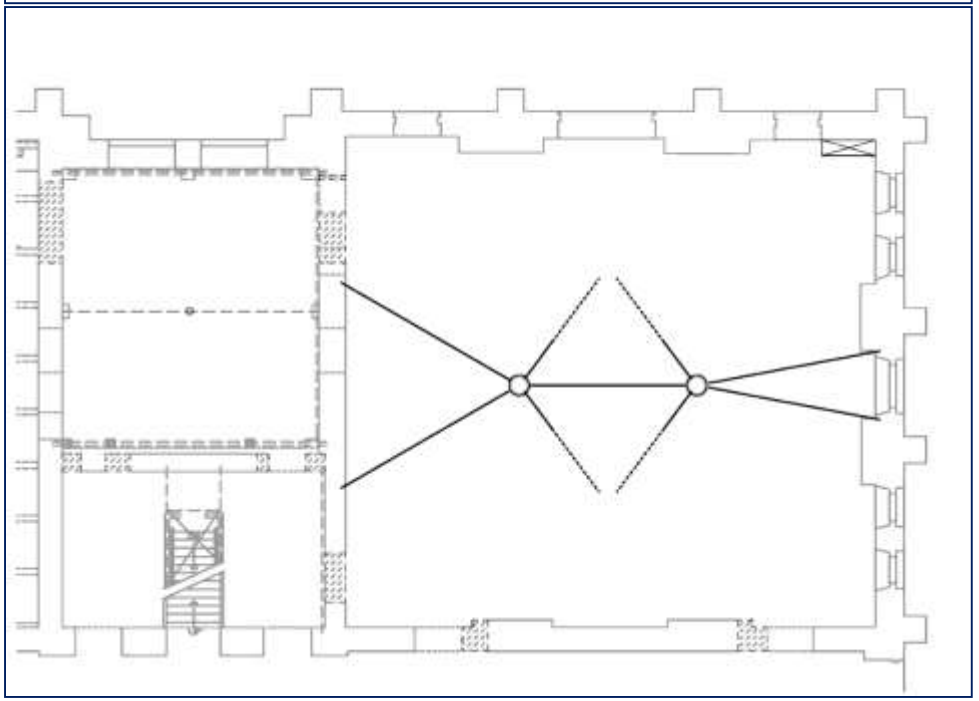

BOT. EXIST. FTG.
EL. (51'-0")
4
5
3
6
32"ø
2
7
1
8
FIN. FLOOR EL. 49'-0"
B.O. U-P EL.
46'-0"

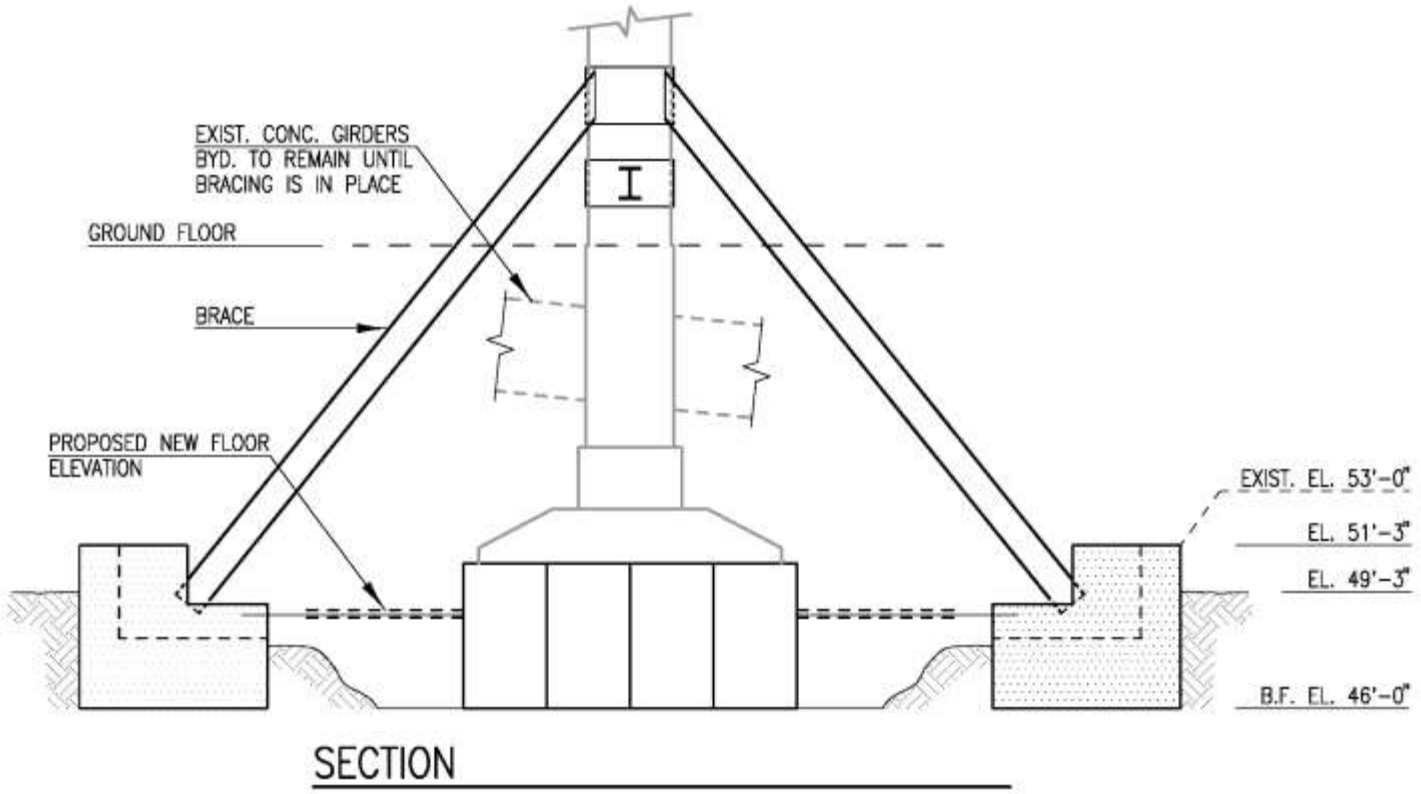



STL. ℄ COLLAR
BRACE
REMOVE EXIST.
CONC. FLOOR
REMOVE EXIST. STL.
SUPPORTED OVERBUILD
GROUND FLOOR
EL. 60'-9"
REMOVE EXIST.
CONC. BMS. (TYP)
BOT. EXIST. FTG.
EL. 50'-7½" ±
REMOVE EXIST. FTGS.
(TYP)
BOT. EXIST. FTG.
BOT. EXIST. FTG.
EL. 51'-0" ±
NEW FLOOR EL.
EL. 49'-0" ±
TO REMAIN
B.O. U-P EL. 46'-0"
B.O. U-P EL. 46'-0"
B.O. U-P EL. 46'-0"

SECTION





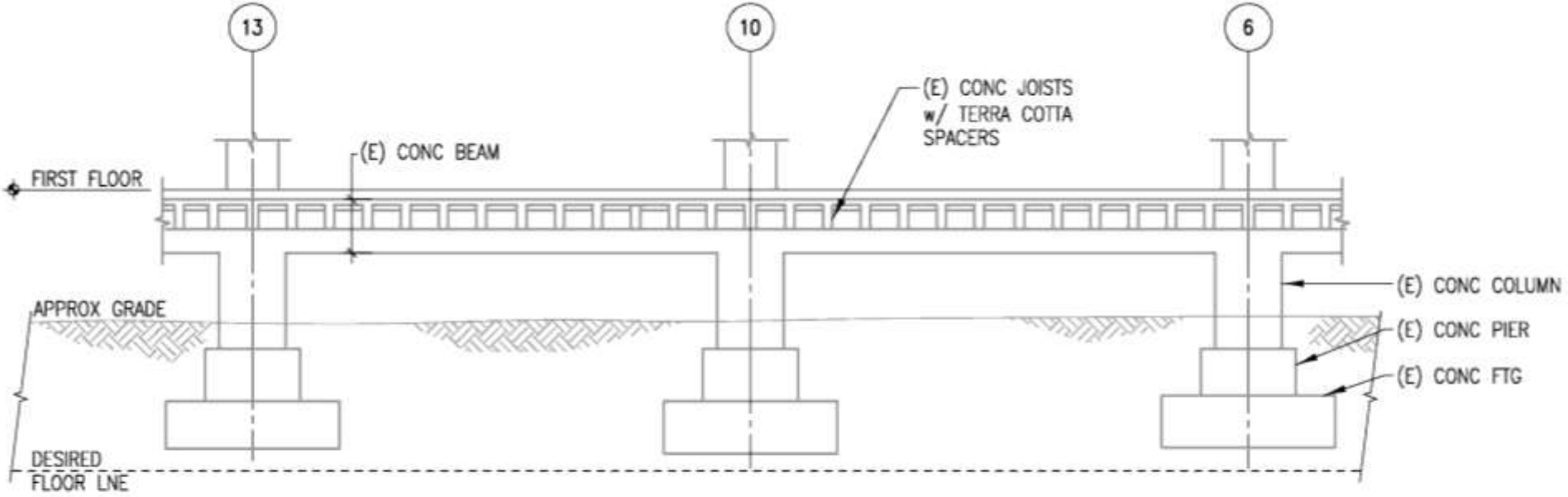

EXIST. CONC. GIRDERS
BYD. TO REMAIN UNTIL
BRACING IS IN PLACE
GROUND FLOOR
BRACE
PROPOSED NEW FLOOR
ELEVATION
EXIST. EL. 53'-0"
EL. 51'-3"
EL. 49'-3"
B.F. EL. 46'-0"

SECTION


10 '96


'87

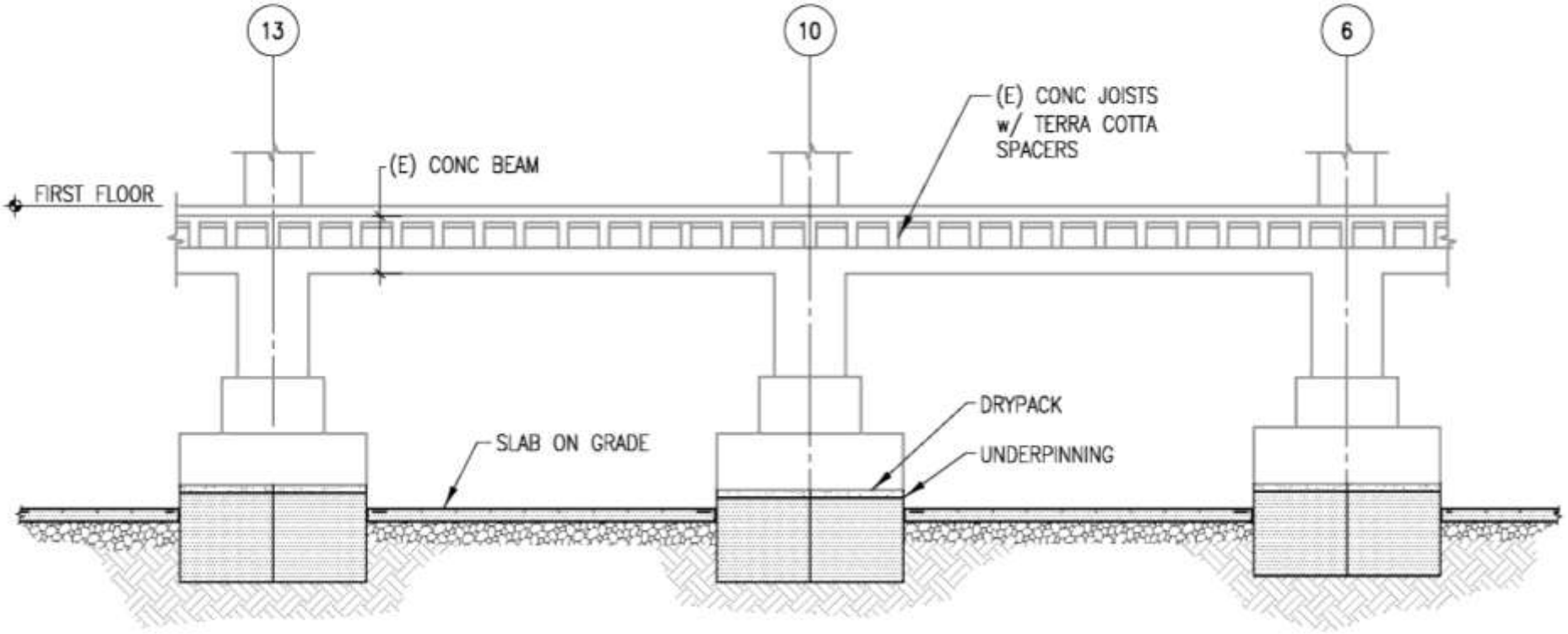
Temporary Footings & Support Beams



SECTION

4' 0 4' 8'

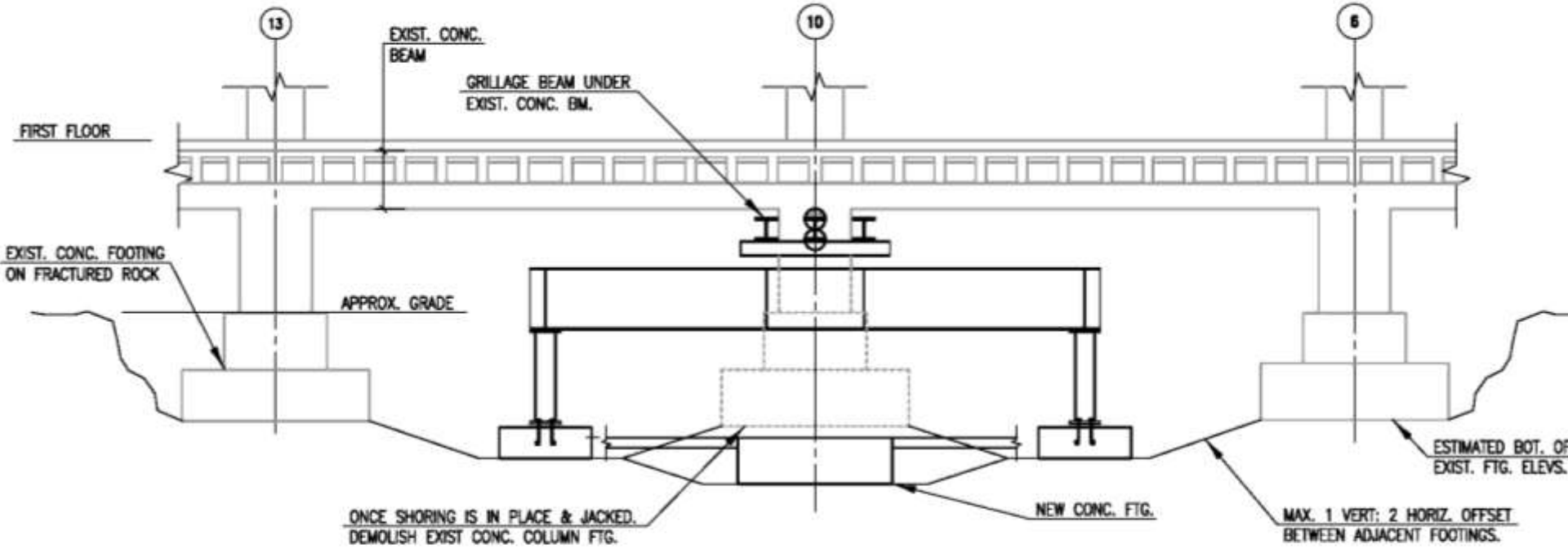
SCALE AT FULL SIZE ¼"=1'-0"



SECTION

4' 0 4' 8'

SCALE AT FULL SIZE ¼"=1'-0"



SECTION – NEW FOUNDATIONS AT INTERIOR COLUMNS
1/4" = 1'-0"

NOTE:
1. REPLACE ONE COLUMN/FOOTING AT A TIME.
2. REPEAT DETAIL FOR OTHER FOOTINGS.


NEW HOLLAND
EC 25


66
1456


BACK
14


66
1456


66
1456

How Not to Underpin


INTECH

Second/Third
Floor Window

Third/Fourth
Floor Window

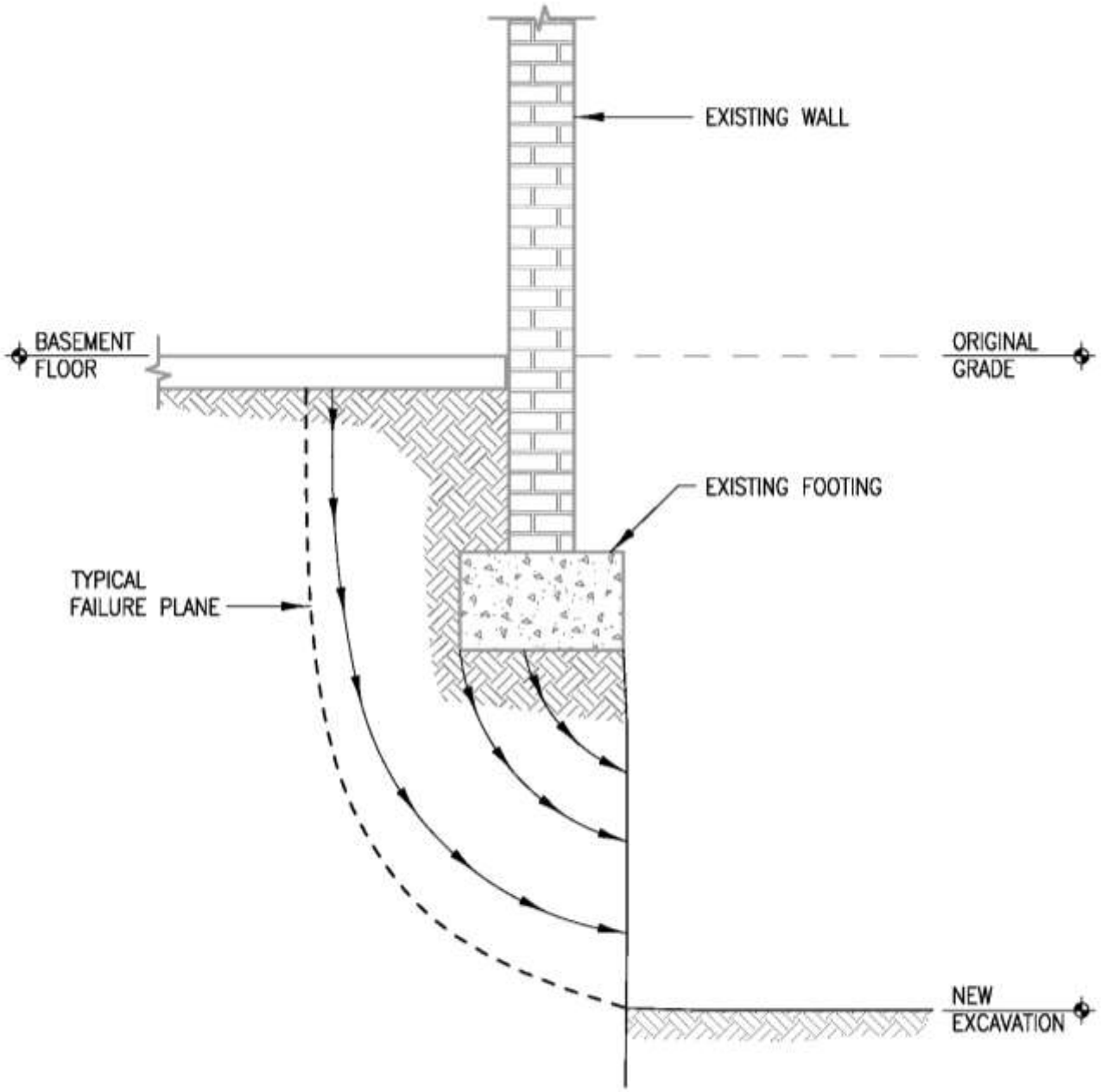
Fourth/Fifth Floor Window

Fifth Floor Window/Parapet

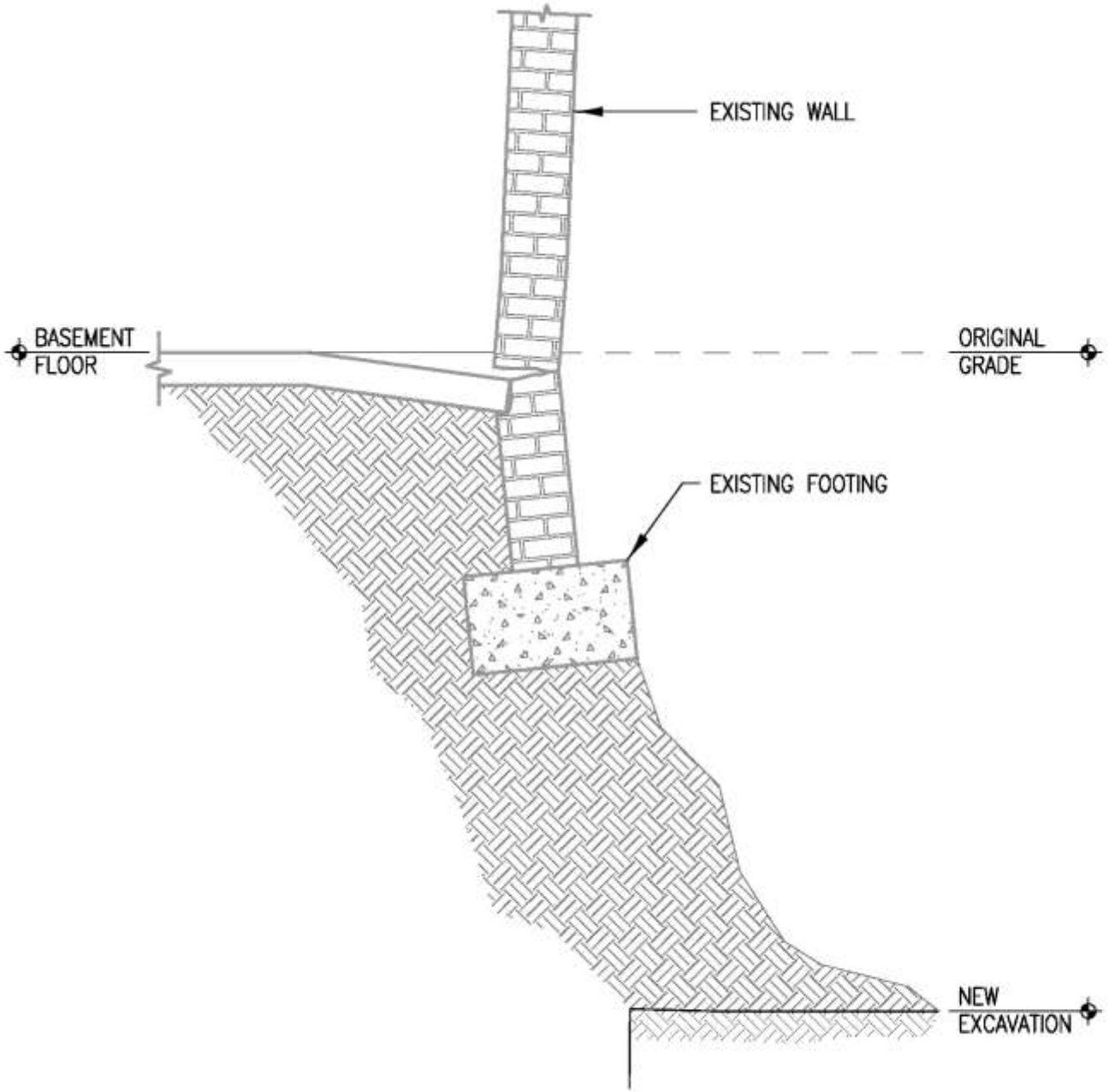
Cracking also appeared on the interior and through the wall finishes.

Repairs completed tied the wall back to the interior framing or the perpendicular walls.


BRYN MAWR
BRYN MAWR FILM INSTITUTE
BURN AFTER READING ELEGY
TRANSSIBBERIAN
DAYLIN LEACH
DAYLIN LEACH



IMMEDIATELY AFTER EXCAVATION



SUBSEQUENT COLLAPSED CONDITION

Thank You!