

2018 IRC/IBC

# Foundation Inspections

Chris Kimball, PE, SE, FPE, MCP

✉ ckimball916@gmail.com

☎ (801) 682-5031



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## Learning Objectives

1. Understand the key items to look for when performing foundation inspections
2. Discuss key items for specialty foundations
3. Understand when and what special inspections are required

## Seminar Format

1. Introduction
2. Code Provisions
3. Shallow Foundations
4. Specialty Foundations
5. Special Inspections

## Part 1: Introduction



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## What is the purpose of the code?

- Minimum requirements → only “safeguard” they do not ensure
- Our job is to enforce a reasonable level of safety
- There will always be “what-ifs”

**R101.3 Intent.** The purpose of this code is to establish minimum requirements to **safeguard** the public safety, health and general welfare through affordability, structural strength, means of egress facilities, stability, sanitation, light and ventilation, energy conservation and safety to life and property from fire and other hazards attributed to the built environment and to provide safety to fire fighters and emergency responders during emergency operations.

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## What if we Miss Something?

- “Reviewed For Code Compliance” certifies that the plans were reviewed, not that they are in complete compliance with the code.

**R106.3.1 Approval of construction documents.** Where the *building official* issues a *permit*, the *construction documents* shall be *approved* in writing or by a stamp that states **“REVIEWED FOR CODE COMPLIANCE.”** One set of *construction documents* so reviewed shall be retained by the *building official*. The other set shall be returned to the applicant, shall be kept at the site of work and shall be open to inspection by the *building official* or a duly authorized representative.

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## What if we Miss Something?

- Our authority to enforce the code is never weakened due to plan review approval
- Pick up the “crumbs” in the field, the code allows us to do that

**R105.6 Suspension or revocation.** The *building official* is authorized to suspend or revoke a *permit* issued under the provisions of this code wherever the *permit* is issued in error or on the basis of incorrect, inaccurate or incomplete information, or in violation of any ordinance or regulation or any of the provisions of this code.

**R113.1 Unlawful acts.** It shall be unlawful for any person, firm or corporation to erect, construct, alter, extend, repair, move, remove, demolish or occupy any building, structure or *equipment* regulated by this code, or cause same to be done, in conflict with or in violation of any of the provisions of this code.

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## Inspection Considerations

- What are contractors consistently missing?
- What's new in the code that contractors aren't used to?
- Is the permit for an owner-builder, production builder, or small-time builder? Adjust accordingly!
- What is unique about this house or building?
- If you don't know, call someone or take time to look it up.
- Keep a mental list of questions every day

# Checklists

- o Is it okay to use checklists?

RESIDENTIAL FOOTING AND FOUNDATION 2018 IRC  
 This is a general list and is not intended to address all possible conditions.

Permits & Plans	
R119	Job address is posted in a visible location.
R105.7	Permit and approved plans and specifications for any engineered systems are on site and accessible to the inspector. Approved plans may be copied for use on job site.
R106.3.1	Permit information is correct (address, permit number, description of work, etc.)
	Portable toilet or access to toilet available on lot. OSHA standard 1926.51(c)
Footings	
R106.2	Setbacks per approved site plan?
R403.7	Proximity to slope? Within 15' of slope more than 3:1 require BO approval. (Site plan)
R403.1.4.1	Footings do not bear on frozen soil. (see Cold Weather below)
R401.2	Footings on undisturbed soil or engineered fill. Compaction test required for fill over 1 ft
R403.1	All loose soil, mud or water is removed from the bottom of the footing. (ACI 318.5.7)
R403.4	Footings rest on solid ground. No questionable soils.
ACT 318.7.4.1	Steel is clean of ice, mud, oil, or other deleterious substances.
R404.1.3.3.7.5	Steel is properly lapped per approved plans.
R404.1.3.3.7.4	Horizontal steel supported in place. Debris OK, rocks not OK.
R404.1.3.3.7.4	Minimum 3" when cast against and permanently exposed to ground.
R404.1.3.3.7.4	Minimum 2" for No. 6 - No. 18 bar when exposed to earth or weather.
R404.1.3.3.7.4	Minimum 1.5" for No. 5 or smaller bar when exposed to earth or weather.
R403.1.5	Footings are level or stepped if the ground slopes more than 1 foot in 10 feet.
R403.1.1	Footings extend beyond the foundation at least 2 inches, but not more than the thickness of the footing.
R403.1.4	Below frost line for jurisdiction and at least 1.2" below grade.
R403.1.2	Continuous, or with a designed (engineered) lintel at step-downs.
R2604.4	No parallel excavation or pipe under footing within 45 degrees of bottom
Foundation Walls	
R404.1.6	Top of wall minimum of 6" above finished grade. 4" for masonry veneer
R403.1.7.3	Top of wall minimum 12" above low point of curb or other approved point of discharge.
	plan Foundation thickness per plan.
	plan Reinforcement steel grade, size, cover, spacing, and splicing are per plan.
R404.1	Utah State Amendment for empirical foundations. Refers to IRC 1807.1.6.4
R403.1.6	Anchor bolts minimum 2" embedment, within steel.
R408.1, plans	Crawl space vents properly sized, spaced and installed. Not required when...R408.3
R406.1	Foundation is dampproofed or waterproofed. (Check at a later inspection)
R405	Footing drain road for basements. Exception for well-drained ground - BO decision
E1608.1.2	Hold-down and bolts on site.
E1608.1.2	Ufer size, location.
	Cold weather requirements. (ACI 318.5.12) IRC 1808.8.4
	Equipment provided for heating concrete materials and protecting concrete during freezing or near-freezing weather. (ACI 318.5.11.1) - keep above 50°F
	Concrete materials, reinforcement, forms, fillers and ground with which concrete is to come in contact are free from frost or ice.

ACI = American Concrete Institute. ACT 318 adopted as part of IBC. See IBC 1901.2.

# Key Indicators of a Good Inspection

- o Minimal phone calls and emails asking for clarification
- o Issues are resolved at re-inspection. If not, did the original comment make sense and give proper direction?
- o Over time construction from regular contractors is getting cleaner. Consistency pays off.
- o Can a different inspector perform the re-inspection easily and quickly?



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## Inspection Process- Tips

- Call the contractor prior to arriving.
- Ensure approved plans are on-site.
- Walk with contractor if possible.
- Consistency Improves Quality- Do it the same way every time



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## Inspection Report Writing

- Be legible (#1 most important thing)
- Number your comments
- Write Clearly
- Be Specific
- Reference plan sheets/details
- Include code references as needed

### Bad

Anchor bolts, garage. (In poor handwriting)

### Good!

1. Please add (2) additional anchor bolts at the cut end of plates in the garage. (North Wall) See shear wall schedule on Sheet S2.

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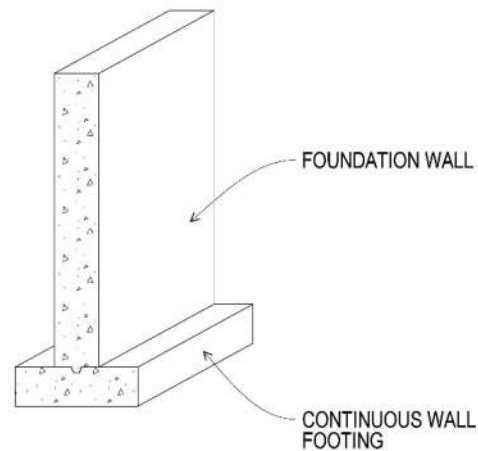
## Introduction

### ○ Foundation

- Cambridge Dictionary: The structures below the ground that support a building.

### ○ Footing

- Google Dictionary: The bottommost part of a foundation wall, with a course of concrete wider than the base of the wall.



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## Introduction

### ○ Shallow Foundation

- An individual or strip footing, a mat foundation, a slab-on-grade foundation or similar foundation element.

### ○ Deep Foundation

- A foundation element that does not satisfy the definition of a shallow foundation.



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## Introduction

- Is it easy to build your house upon the rock?



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## Introduction

- How much settlement is acceptable?
- If near-surface soils are not adequate for shallow foundations, are deep foundations the only option?





# Introduction

*Some work better than others...*



# Part 2: Code Provisions



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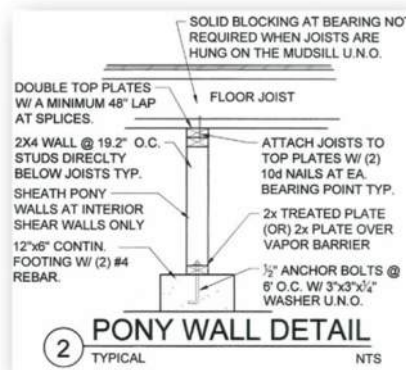
## Required Inspections (R109.1)

- Foundation Inspection
- Rough Plumbing, Mechanical, Gas and Electrical Inspection
- Floodplain Inspection
- Framing and Masonry
- Fire-Resistance-Rated Construction
- Final Inspection



## Depth (R403.1.4)

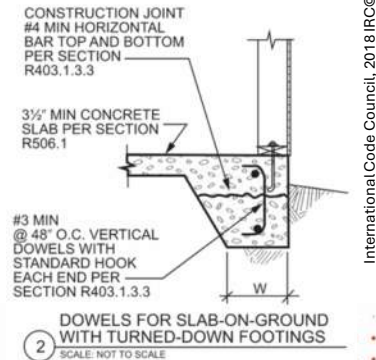
- Exterior Footings  $\geq$  12 inches
- Frost Protection:
  - Extend below frost line
  - Frost-protected (R403.3 of ASCE 32)
  - Erected on solid rock



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## Frost Depth (R403.1.4)

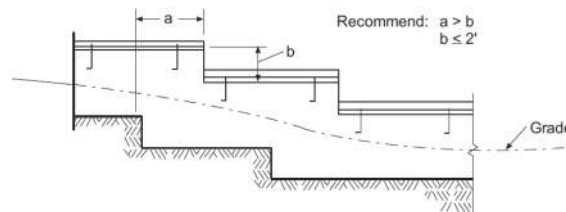
- Exceptions: (not required to be below frost depth)
  - Accessory structures  $\leq 600\text{ft}^2$  and  $\leq 10$ -feet to eave (wood)
  - Accessory structures  $\leq 400\text{ft}^2$  and  $\leq 10$ -feet to eave (other)
  - Freestanding Decks



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## Slope (R403.1.5)

- Top Surface:
  - Shall be level
- Bottom Surface:
  - Slope  $\leq 1:10$  (10% slope), otherwise...
  - Footings shall be stepped



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## Anchorage (R403.1.6)

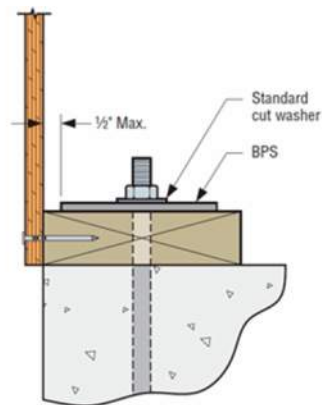
- Anchor Bolts:
  - 1/2" diameter
  - 7" embedment
- Placement:
  - Max. spacing = 6-feet
  - Two bolts per plate
  - $\leq 12"$  from end of plate
  - $\geq 7_{bd}$  from end of plate
  - Middle third of plate



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## Anchorage (R403.1.6.1)

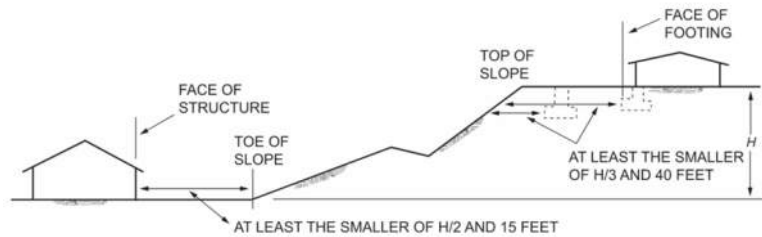
- SDC D0, D1 and D2:
  - 3"x3"x0.229" plate washers are required
  - Max. spacing = 4-feet if two-stories or more



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## Slopes (R403.1.7)

- o Footings on or Adjacent to Slopes:



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## Retaining Walls (R404.4)

- o Design required if...
  - > 48" of unbalanced backfill
  - > 24" and not laterally supported at top
- o Design must include...
  - Safety factor of 1.5 against sliding and overturning
  - Excessive foundation pressure
  - Water uplift



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## Drainage (R405.1)

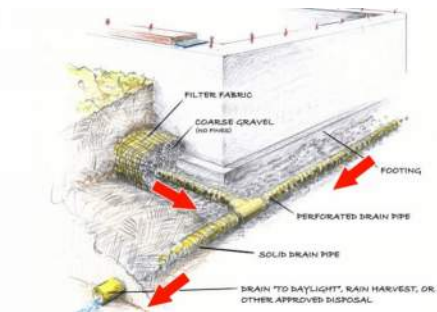
- Foundation drains are required around all concrete or masonry foundations that retain earth and enclose habitable or usable spaces
- Exception:
  - Not required when foundation is installed on well-drained ground or sand-gravel mixture



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## Drainage (R405.1)

- Drain Requirements:
  - Shall discharge by gravity or mechanical means
  - Gravel or crushed stone drain
  - Extends  $\geq$  1-foot beyond outside edge of footing
  - Extends  $\geq$  6-inches above top of footing
  - Covered in filter material



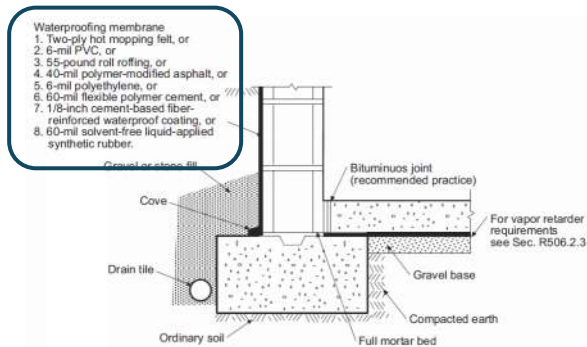
## Dampproofing (R406.1)

- Foundations shall be dampproofed unless they are required to be waterproofed
- This shall consist of...
  - Bituminous coating
  - 3pounds/ft2 of acrylic modified cement
  - 1/8" surface-bonding cement
  - Any waterproofing material
  - Other approved methods



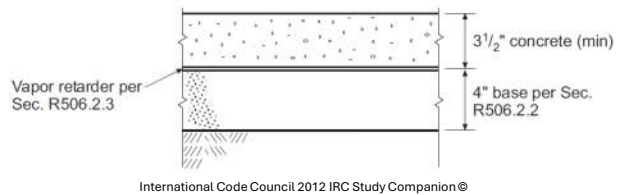
## Waterproofing (R406)

- Foundations shall be water-proofed, if...
  - High water table
  - Severe soil-water conditions



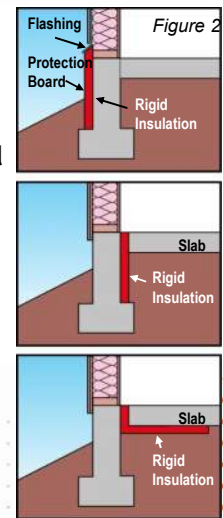
## Slab-on-Grade (R506)

- 3.5" min. thickness
- Vapor Retarder (R506.2.3)
  - 6-mil polyethylene
  - Joints lapped 6-inches
  - Exception: Garages, accessory structures, flatwork and where approved by B.O.



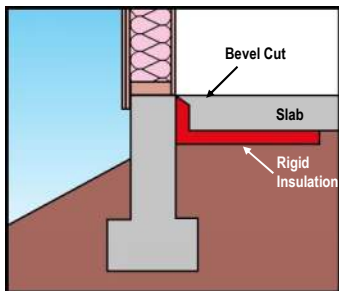
## Slab Edge Insulation (R402.2.10)

- Applies to slabs with a floor surface < 12 inches below grade
  - R-10 (typically 2 inches) insulation in Zones 4 and above
  - Must extend downward from top of slab a minimum of 24" (Zones 4 and 5) or 48" (Zones 6, 7, and 8)
  - Insulation can be vertical or extend horizontally under the slab or out from the building
  - Insulation extending outward must be under 10 inches of soil or pavement
    - An additional R-5 is required for heated slabs
    - Insulation to depth of the footing or 2 feet, whichever is less in Zones 1-3 for heated slabs





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## IBC 110: Inspections

- ***Shall*** remain visible and able to be accessed until ***approved***.
- Approval shall not be construed as approval of a violation.



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## IBC 110: Inspections

### ○ 110.2: Preliminary Inspections

- The B.O. is authorized to examine buildings, structures or sites for which an application has been filed.
- Why would you do this?

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## IBC 110: Inspections

### ○ 110.3: Required Inspections

- The B.O., upon notification, *shall*...
  - Footing & foundation ← **Our focus today**
  - Concrete slab & underfloor
  - Lowest floor elevation
  - Frame inspection
  - Lath, gypsum board, gypsum panel
  - Weather-exposed balconies
  - Fire- and smoke-resistant penetrations
  - Energy efficiency

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City of Henderson - Building Inspection Codes

Code	Description
1002	Miscellaneous
1007	Temp C/O
1251	Basement 4 Pre-Grout
1252	Basement 8 Pre-Grout
1253	Basement 12 Pre-Grout
1255	Basement Damp-Proof/Drainage
1261	Basement Wall Reinforcing
1262	Basement Wall Forms
1310	Footings
1311	Fence/Wall Footing - Concrete or Masonry
1312	Post-Hole
1315	Setbacks
1317	Pre-Slab
1318	Stem Walls
1319	Post Tension
1320	Underground Electrical
1325	Ufer Ground
1326	Ufer Ground
1330	Underground Plumbing
1332	Sewer Connection
1333	Water Connection
1335	Underground Gas
1340	Underground Mechanical
1360	Temp Power (Freestanding)
1361	Temp Power (Red Iron)
1400	CMU 4 Pre-Grout
1401	CMU 8 Pre-Grout
1402	CMU 12 Pre-Grout
1403	CMU 16 Pre-Grout
1404	CMU 20 Pre-Grout
1405	CMU 24 Pre-Grout
1406	CMU 28 Pre-Grout
1408	CMU Pre-Grout/Final
1410	Concrete Wall Reinforcing
1411	Concrete Wall Forms
1430	Concrete Floor Reinforcement
1431	Concrete Floor Forms
1435	Concrete Roof Reinforcing
1436	Concrete Roof Forms
1450	Concrete Reinforcing
1451	Concrete Forms
1459	Dry Pack Bolts
1460	Struct Metal Frame
1461	Struct Metal Floor Frame

City of Henderson, NV, Building Inspection Codes, Page 1 of 4

## IBC 110: Inspections

- **110.3: Required Inspections**
  - *110.3.9: Other Inspections*
  - B.O. may require other inspections of any construction work to ascertain compliance.

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## IBC 110: Inspections

- **110.3: Required Inspections**
  - *110.3.10: Special Inspections*
  - Notice this is still a “required inspection”!
  - Not performed by the B.O.
  - Will discuss in detail in Part 5 of this seminar

## IBC 110: Inspections

### ○ 110.3: Required Inspections

- *110.3.11: Final Inspections*
- Why is this listed after special inspections?
- *"...shall be made after all work required by the building permit is completed."*

## IBC 110: Inspections

### ○ 110.6: Approval Required

- "Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the B.O."
- "The B.O... shall either indicate the portion of construction that is satisfactory as completed, or notify the permit holder... the same fails to comply with this code."
- "Any portions that do not comply shall be corrected and such portion shall not be covered or concealed until authorized by the B.O."

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## IBC Chapter 18

### ○ Key items related to footings & foundations:

- 1803: Geotechnical Investigations
- 1804: Excavations, Grading & Fill
- 1806: Presumptive Load-Bearing Values
- 1807: Foundations, Retaining Walls & Posts
- 1808: Foundations
- 1809: Shallow Foundations
- 1810: Deep Foundations

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## IBC 1803: Geotechnical Investigation

### ○ When is one required?

- Questionable soil
- Expansive soil
- Ground-water table
- Rock strata
- Excavations near foundations
- Compacted fill
- CLSM
- Alternate setbacks/clearances
- SDC 'C-F'
- Deep foundations

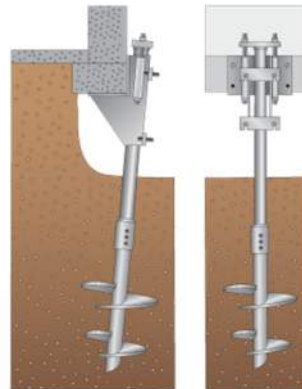


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## IBC 1803: Geotechnical Investigation

### ○ Will deep foundations be used?

- This includes specialty piles such as pin piles, rammed aggregate piers, helical piers, drilled piers and micropiles.
- This is often decided after the geotechnical report has been completed.



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## IBC 1803: Geotechnical Investigation

### ○ IBC 1803.5.5: Deep Foundations

- Recommended deep foundation types
- Recommended center-to-center spacing
- Driving criteria
- Installation procedures
- Field inspection & reporting procedures
- Load test requirements
- Reductions for group action

# IBC 1804: Excavations & Grading

- Shoring?
- Underpinning?
- Slopes?



# IBC 1806: Presumptive Values

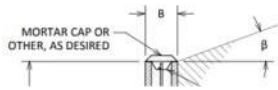
- Can presumptive values be used?

TABLE 1806.2  
PRESUMPTIVE LOAD-BEARING VALUES

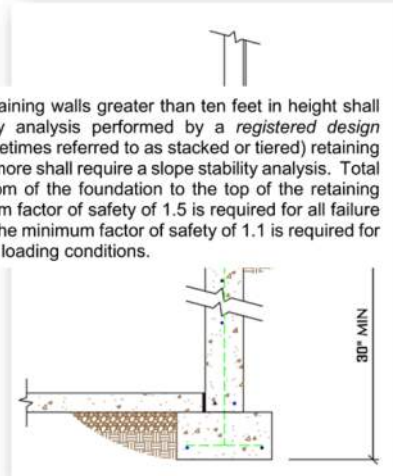
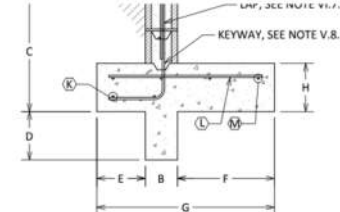
CLASS OF MATERIALS	VERTICAL FOUNDATION PRESSURE (psf)	LATERAL BEARING PRESSURE (psf/ft below natural grade)	LATERAL SLIDING RESISTANCE	
			Coefficient of friction <sup>a</sup>	Cohesion (psf) <sup>b</sup>
1. Crystalline bedrock	12,000	1,200	0.70	—
2. Sedimentary and foliated rock	4,000	400	0.35	—
3. Sandy gravel and gravel (GW and GP)	3,000	200	0.35	—
4. Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000	150	0.25	—
5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500	100	—	130

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# IBC 1807: Foundations & Retaining



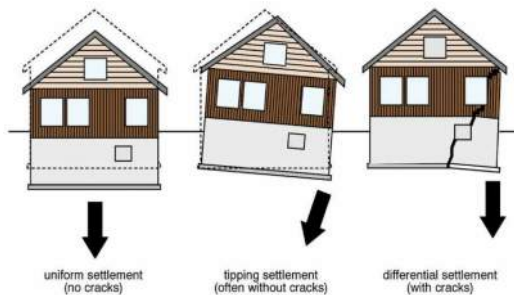
**1807.2.4 Slope Stability Analysis.** Retaining walls greater than ten feet in height shall be required to submit a slope stability analysis performed by a *registered design professional*. Multiple terraced (also sometimes referred to as stacked or tiered) retaining walls with a total height of sixteen feet or more shall require a slope stability analysis. Total height shall be measured from the bottom of the foundation to the top of the retaining wall(s) or total slope height. The minimum factor of safety of 1.5 is required for all failure modes under static loading conditions. The minimum factor of safety of 1.1 is required for all failure modes under seismic and wind loading conditions.



# IBC 1808: Foundations

## IBC 1808.2: Capacity & Settlement

- Allowable bearing capacity shall not be exceeded
- Differential settlement is minimized



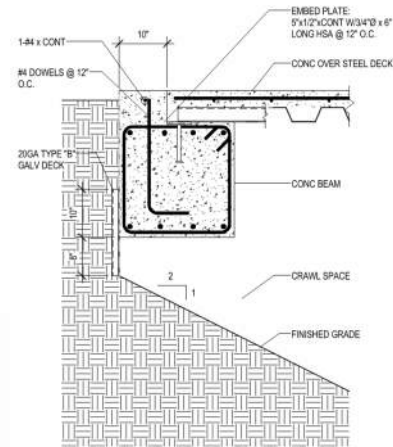


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## IBC 1808: Foundations

### ○ IBC 1808.6: Expansive Soils

- Foundations shall be designed to prevent uplift, and...
- To resist forces exerted on foundation due to volume changes, or...
- Be isolated from the expansive soil.



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## IBC 1808: Foundations

### ○ IBC 1808.6: Expansive Soils

- Exceptions:
  - Removal of expansive soil
  - Stabilization of soil provided and approved by B.O.



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## IBC 1808: Foundations

### ○ IBC 1808.7: Near Slopes

- IBC Figure 1808.7.1 (< 1:1)

*or...*

- Ascending Slopes – IBC 1808.7.1 (> 1:1)
- Descending Slopes – IBC 1808.7.2 (> 1:1)

*or...*

- Alternate setbacks & clearances allowed by the Building Official (1808.7.5)

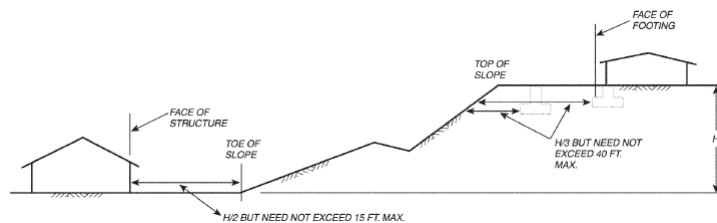
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## IBC 1808: Foundations

### ○ IBC 1808.7: Near Slopes

- **Option #1:** < 1:1

- Descending:  $H/3$ , but not greater than 40-feet
- Ascending:  $H/2$ , but not greater than 15-feet



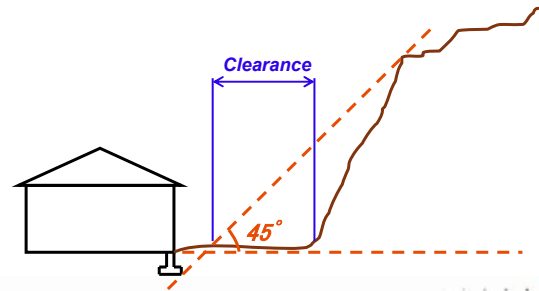
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## IBC 1808: Foundations

### ○ IBC 1808.7: Near Slopes

- **Option #2:** > 1:1, Ascending
- Clearance = "...sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures."

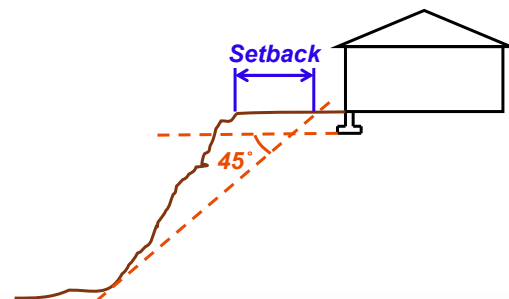


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## IBC 1808: Foundations

### ○ IBC 1808.7: Near Slopes

- **Option #2:** > 1:1, Descending
- Setback = "...set back from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement."



# IBC 1808: Foundations

## o IBC 1808.7: Near Slopes

- Option #3: Alternate setbacks or clearances



# IBC 1808: Foundations

## o IBC 1808.8: Concrete Foundations

- Minimum concrete & grout strength

TABLE 1808.8.1  
MINIMUM SPECIFIED COMPRESSIVE STRENGTH  $f'_c$  OF CONCRETE OR GROUT

FOUNDATION ELEMENT OR CONDITION	SPECIFIED COMPRESSIVE STRENGTH, $f'_c$
1. Foundations for structures assigned to <i>Seismic Design Category A, B or C</i>	2,500 psi
2a. Foundations for Group R or U occupancies of light-frame construction, two stories or less in height, assigned to <i>Seismic Design Category D, E or F</i>	2,500 psi
2b. Foundations for other structures assigned to <i>Seismic Design Category D, E or F</i>	3,000 psi
3. Precast nonprestressed driven piles	4,000 psi
4. Socketed drilled shafts	4,000 psi
5. Micropiles	4,000 psi
6. Precast prestressed driven piles	5,000 psi

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# IBC 1808: Foundations

## o IBC 1808.8: Concrete Foundations

- Minimum cover

TABLE 1808.8.2  
MINIMUM CONCRETE COVER

FOUNDATION ELEMENT OR CONDITION	MINIMUM COVER
1. Shallow foundations	In accordance with Section 20.6 of ACI 318
2. Precast nonprestressed deep foundation elements	3 inches
Exposed to seawater Not manufactured under plant conditions	2 inches
Manufactured under plant control conditions	In accordance with Section 20.6.1.3.3 of ACI 318
3. Precast prestressed deep foundation elements	2.5 inches
Exposed to seawater	In accordance with Section 20.6.1.3.3 of ACI 318
Other	2.5 inches
4. Cast-in-place deep foundation elements not enclosed by a steel pipe, tube or permanent casing	2.5 inches
5. Cast-in-place deep foundation elements enclosed by a steel pipe, tube or permanent casing	1 inch
6. Structural steel core within a steel pipe, tube or permanent casing	2 inches
7. Cast-in-place drilled shafts enclosed by a stable rock socket	1.5 inches

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# ACI 318: Nonprestressed CIP

Exposure	Member	Reinforcement	Cover (in.)
Cast against and permanently in contact with ground	All	All	3
Exposed to weather or in contact with ground	All	No. 6 thru 18	2
		WWF or ≤ No. 5	1.5
Not exposed to weather or in contact with ground	Slabs, joists, and walls Beams, columns, pedestals, and tension ties	No. 14 & No. 18	1.5
	Beams, columns, pedestals, and tension ties	≤ No. 11	0.75
		Primary reinforcement, stirrups, ties, spirals, and hoops	1.5

## ACI 318: Prestressed CIP

Exposure	Member	Reinforcement	Cover (in.)
Cast against and permanently in contact with ground	All	All	3
Exposed to weather or in contact with ground	Slabs, joists, and walls	All	1
	All other	All	1.5
Not exposed to weather or in contact with ground	Slabs, joists, and walls	All	0.75
	Beams, columns, and tension ties	Primary reinforcement	1.5
		Stirrups, ties, spirals, and hoops	1

## ACI 318: Deep Foundations

Exposure	Member	Reinforcement	Cover (in.)
Not enclosed by steel pipe, tube permanent casing, or stable rock socket	Cast-in-place	All	3
Enclosed by steel pipe, tube, permanent casing, or stable rock socket	Cast-in-place	All	1.5
Permanently in contact with ground	Precast-nonprestressed	All	1.5
	Precast-prestressed		
Exposed to seawater	Precast-nonprestressed	All	2.5
	Precast-prestressed	All	2

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## IBC 1808: Foundations

### ○ IBC 1808.8: Concrete Foundations

- Placement shall ensure...
  - Exclusion of foreign matter
  - Deep foundations:
    - Chuted in directly into smooth pipe, or...
    - Placed in rapid, continuous operation through funnel hopper



Tin cans were found in the structural concrete beams of a collapsed high-rise building in Taiwan after a 6.4 magnitude earthquake in 2016. The cans were used as a filler to make the beams appear larger without adding much weight.

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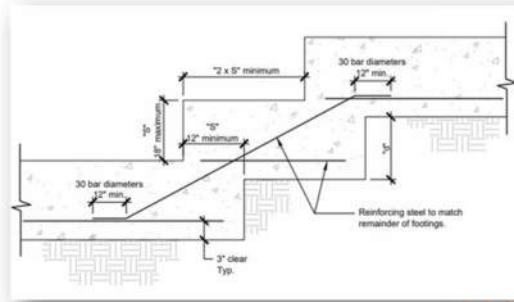
## IBC 1808: Foundations

### ○ IBC 1808.8: Concrete Foundations

- Shall be protected from freezing during depositing and for a period of not less than 5 days thereafter.
- IBC Table 1705.3 requires special inspection of curing temperature and techniques.
- ACI 306R-16 defines "cold weather" as the air temperature is expected to fall below **40°F**.

## IBC 1809: Shallow Foundations

- Depth: 12 inches min. (or to frost depth)
- Width: 12 inches min.
- Stepped Footings: If  $> 1V:1H$

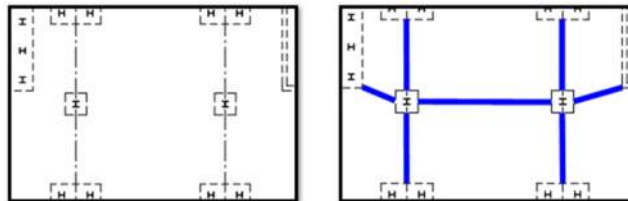
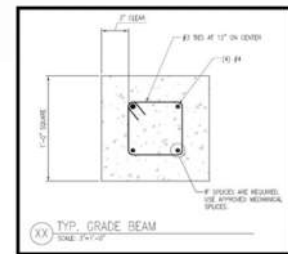


City of Santa Clarita, Typical Stepped Footing Detail

## IBC 1809: Shallow Foundations

### ○ IBC 1809.13: Footing Seismic Ties

- Located in SDC 'D-F', and...
- Site Class E & F soils
- Individual spread footings shall be interconnected by ties.
- These can be reinforced concrete beams or reinforced SOG





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## IBC 1810: Deep Foundations

### o IBC 1810.1: General

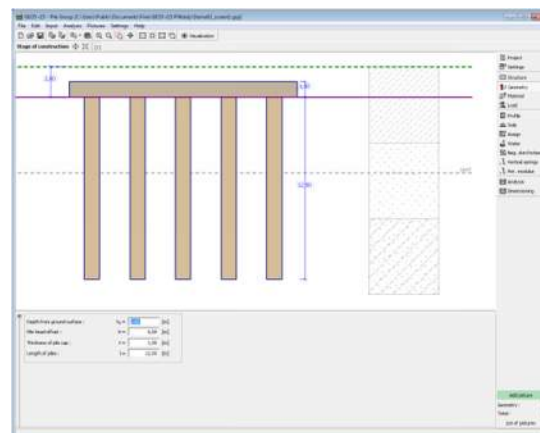
- Installed on basis of a geotechnical report
- Unbraced in air, water or fluid shall be designed as columns
- Special Types:
  - Approved by B.O.
  - Acceptable test data
  - Calculations
  - Other information
  - Stresses cannot exceed IBC 1810

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## IBC 1810: Deep Foundations

### o IBC 1810.2: Analysis

- Lateral support
- Stability\*
- Settlement
- Lateral loads
- Group effects



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## IBC 1810: Deep Foundations

### o IBC 1810.2.2: Stability

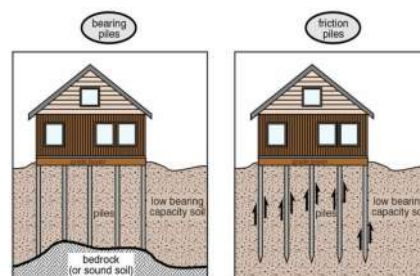
- Elements must be braced to provide lateral stability in all directions
- $\geq 3$  elements connected to a pile cap are braced
- 2 elements are braced along the axis in which they are connected
- Elements supporting walls shall be placed symmetrically under the C.G. for the wall.
- Methods of bracing shall be approved by B.O.

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## IBC 1810: Deep Foundations

### o IBC 1810.3.3: Allowable Loads

- Allowable vs. Ultimate
- Allowable axial and lateral loads shall be determined by...
  - An approved formula
  - Load tests
  - Method of analysis



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## IBC 1810: Deep Foundations

### ○ IBC 1810.3.3.1.2: Load Tests

- One element or more in each area of uniform soil conditions
- If required by B.O., more shall be tested
- $P_{all} \leq 0.5 * P_{ult}$  (Safety Factor = 2.0)
- $P_{ult}$  shall consider both total and differential settlement
- Methods:
  - Davisson Offset Limit
  - Brinch-Hansen 90-percent Criterion
  - Butler-Hoy Criterion
  - Other "approved" methods

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## IBC 1810: Deep Foundations

### ○ IBC 1810.3.3.2: Allowable Lateral Loads

- Allowable lateral loads shall be determined by...
  - An approved method of analysis, or...
  - Load tests
- $P_{ult} =$  Maximum 1-inch of lateral movement
- $P_{all} \leq 0.5 * P_{ult}$

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## IBC 1810: Deep Foundations

### ○ IBC 1810.3.11: Pile Caps

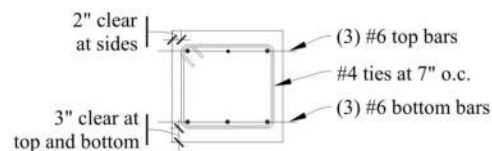
- Shall consist of reinforced concrete
- Do not consider bearing of soil below
- Foundation elements embedded  $\geq 3''$  into cap
- Caps shall extend  $\geq 4''$  past foundation element
- Tops of elements shall be cut or chipped back to sound material before capping
- Special requirements for SDC 'C-F'

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## IBC 1810: Deep Foundations

### ○ IBC 1810.3.12: Grade Beams

- Considered part of pile cap
- SDC 'D-F'  $\rightarrow$  shall comply with ACI 318, Chapter 18
- Smallest dimension  $\geq$  spacing of columns  $\div 20$ , or 18", whichever is less
- Seismic tie spacing  $\leq 0.5 \times$  smallest dimension, or 12", whichever is less



# IBC 1810: Deep Foundations

## o IBC 1810.4.3: Location Plan

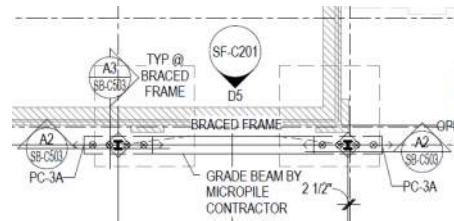
- Shall be filed with B.O.
- Location and designation of deep foundation elements



# IBC 1810: Deep Foundations

## o Submittal Summary:

- Location Plan
- Analysis
- Load Testing
- Special Inspections



MICRO PILE SCHEDULE							REMARKS
TYPE MARK	VERTICAL LOADS (k)				HORIZONTAL LOADS (k)		
	DL	LL	SL	E	E		
PC-1A	7.4	3.0	3.0	0.0	0.0		
PC-1B	20.0	13.0	13.0	0.0	0.0		
PC-1C	30.0	20.0	0.0	0.0	0.0		
PC-1D	30.0	20.0	22.0	0.0	0.0		
PC-1E	30.0	22.0	15.0	0.0	0.0		
PC-1F	35.0	20.0	40.0	0.0	0.0		
PC-1G	30.0	15.0	24.0	0.0	0.0		
PC-1H	15.0	13.0	0.0	0.0	0.0		
PC-2A	31.0	15.0	22.0	±4.0	±1.5		

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## IBC Chapter 19

### ○ Key items related to concrete:

- 1901.3: Anchoring to concrete
- 1901.5: Construction documents
- 1904: Durability requirements



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## IBC Chapter 19

### ○ IBC 1901.3: Anchoring to Concrete

- In accordance with ACI 318 (as amended by IBC 1905)
- Applies to cast-in; post-installed expansion, undercut and adhesive anchors

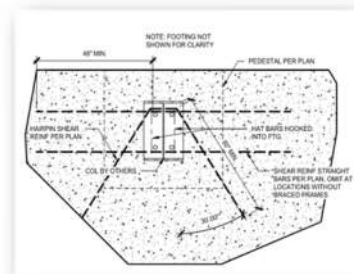


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## IBC Chapter 19

### o IBC 1901.5: Construction Documents

- Concrete compressive strengths
- Strength & grade of reinforcement
- Size & location of structural elements, reinforcing & anchors
- Magnitude & location of prestressing forces
- Lap splice lengths & anchorage lengths
- Type & location of mechanical and welded splices
- Contraction & isolation joint details
- Strength & stressing sequence for posttensioning
- SDC "D-F" → Statement if slab on grade is a structural diaphragm



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## IBC Chapter 19

### o IBC 1904: Durability

- Shall conform to ACI 318-14 (Exception: R-2 & R-3 ≤ 3-stories)
- Section 19.3 of ACI 318-14:
  - Freezing (F0, F1, F2, & F3)
  - Sulfate (S0, S1, S2, & S3)
  - Permeability (P0, P1, P2, & P3)
  - Corrosive (C0, C1, & C2)
  - 0 = Not applicable
  - 1 = Moderate
  - 2 = Severe
  - 3 = Very severe

# IBC Chapter 19

## o IBC 1904: Durability

- Section 19.3.1.1 of ACI 318-14: "Licensed design professional shall assign exposure classes in accordance with the severity of the anticipated exposures..."

CONCRETE ELEMENT:	STRENGTH:	EXPOSURE CLASS:
FOOTINGS & FOUNDATION WALLS:	4000 PSI	(F1, S0, W0, C1)
TILT-UP CONCRETE WALL PANELS	4500 PSI	(F2, S0, W1, C1)
INTERIOR SLABS ON GRADE:	3500 PSI	(F0, S0, W0, C0)
SITE CONCRETE:	4500 PSI	(F3, S0, W1, C2)

# Part 3: Shallow Foundations





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## Standard Inspection Protocol

- Verify Address/Location
- Approved plans must be on-site
- Call contractor if possible
- Introduce yourself
- Explain why you are on-site
- Be safe: Excavations, Reinforcement Steel

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## Necessary Equipment

- AHJ/Jobsite PPE
- Measuring Tape
- Flashlight
- Gloves
- Clipboard/Tablet
- Pen/Note Pad



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## Key Elements – Footings

- Check Site Plan / Setbacks
- Consult Geotechnical Report
- Site Prep / Soil Conditions
- Footing Depth, Sizes & Layout
- Footing Reinforcement
- Holdowns
- Grounding Electrode (UFER)
- Cold Weather Provisions



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## Site Plan / Setbacks

- Are approved plans (including the site plan) onsite?
  - Often concrete contractors have a limited set of plans or partial set that include just structural sheets.
- Building Orientation
- Distances from Property Lines
- Distances from Public Way

# Geotechnical Report

- Report matches the lot
- Soil on-site is consistent with report
- All recommendations have been followed
- Contractor is aware of requirements

DEPARTMENT OF BUILDING & SAFETY  
**PAD CERTIFICATION**  
 www.LasVegasNevada.gov/BuildingPermits  
 Phone: (702) 259-4251 Fax: (702) 380-1240

One Certification for Each Address

PERMIT # \_\_\_\_\_ PROJECT NAME \_\_\_\_\_  
 ADDRESS: \_\_\_\_\_ DATE: \_\_\_\_\_

Equal Pad Certification and Items A-F to cert@lvsos.com or pads prior to Footing or Foundation Installation

I hereby certify that the grading and earthwork is complete and substantially complies with the requirements of the geo-technical report including any approved supplements or addenda identified below.

Geotechnical Report Title: \_\_\_\_\_  
 Project No: \_\_\_\_\_ Dated: \_\_\_\_\_

Engineering Firm Name: \_\_\_\_\_

This Certification / Report is used as an interim document until a Final Grading Report is completed (i.e. Final Grading report for the entire project or a particular phase(s) of a project). This report shall include the following information for each pad or structure:

- A. Quality assurance inspection and / or testing agency contract (copy).
- B. Site plan and description of use.
- C. The first test date of the first test of the final fill.
- D. Classification of foundation soil for expansive properties (i.e. non-expansive or result from standard 60 pounds per square foot swell test).
- E. The name(s) of the approved special inspector(s) and any technicians that observed grading or foundation improvements.
- F. The firm name that prepared the geotechnical report, the report number, and the date of the geotechnical report.

Affix Seal, Sign, and Date

EMAIL COMPLETED CERTIFICATE TO [cert@lvsos.com](mailto:cert@lvsos.com)

# Site Prep / Soil Conditions

- Native Soil or Fill
- Slope 1:10 maximum
- Organics (roots, debris, trash)
- Soggy, Muddy, Standing Water
- Frozen Soil, Snow and Ice
- Undermining of adjacent foundations?



## Footing Sizes / Layout

- Location
- Depth
- Width
- Steps



FOOTING SCHEDULE					
MARK	WIDTH	LENGTH	THICKNESS	REINFORCEMENT	
				TRANSVERSE	LENGTHWISE
FT12D	12"	CONT.	15"	-	(2) #5 T & B
FT15D	15"	CONT.	15"	-	(2) #5 T & B
SF24D	24"	24"	15"	(4) #4	(4) #4
1. CONTINUOUS FOOTINGS SHALL BE CENTERED UNDER WALLS AND SPOT FOOTINGS SHALL BE CENTERED UNDER COLUMNS UNLESS NOTED OTHERWISE.					
2. FOOTINGS AND FOUNDATIONS, EXCAVATIONS, GRADING, AND FILL SHALL COMPLY WITH THE PROVISIONS OF THE GEOTECHNICAL REPORT (SEE GSN)					

## Footing Reinforcement

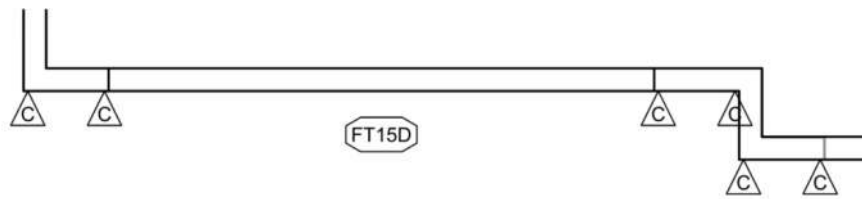
- Location
- Bar sizes
- Lap Splices
- Ties
- Support & Clearances
- Free from mud, oil, excessive rust



# Holdowns

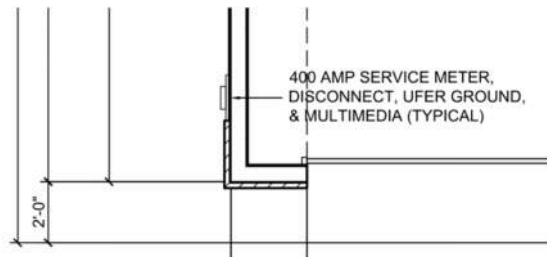
- Type & size match
- Locations
- Tied in place

HOLD-DOWN SCHEDULE				
MARK	HOLD-DOWN	MINIMUM FASTENERS	ANCHOR	POST
A	LSTHD8 (SEE NOTE 3)	10d X 2-1/2" (.148 X 2-1/2")	STRAP 8" EMBED.	(2) 2X POST
C	STHD14 (SEE NOTE 3)	10d X 2-1/2" (.148 X 2-1/2")	STRAP 14" EMBED.	(2) 2X POST
1. HOLD-DOWNS SHALL BE SIMPSON STRONG-TIE OR EQUIVALENT.				
2. SHEAR WALL EDGE NAILING SHALL BE TO HOLD-DOWN POST.				
3. STHD STRAPS SHALL BE "RJ" TYPE AT RIM JOIST LOCATIONS.				



# Grounding Electrode

- Check for UFER ground: #4 rebar- 20' of total steel in footing
- Can be #6 bare copper, 20' long or shorter length attached to steel
- One required at each building (garages, etc.)



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## Cold Weather

- Frozen Ground
- Curing Blankets
- Additional Heat
- Special Inspection



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## Miscellaneous

- Do they have the required embeds and anchor bolts for things like structural steel?
- Will there be other footings/foundations to come later that I should mention in a report?



## Common Errors

- Incorrect Footing Sizes
- Missing Footings
- Incorrect Reinforcement Quantity/Size
- Incorrect Reinforcement Clearances/Laps
- Footings at Wrong Elevations
- Footings too Close to Property Lines
- Work Not Ready for Inspection



## Key Elements – Foundation Walls

- Re-check Site Plan / Setbacks
- Wall Layout and Thicknesses
- Wall Heights
- Reinforcement
- Ufer Ground
- Hold-downs, Straps, Anchor Bolts
- Cold Weather Provisions

3,000 PSI CONCRETE		FOUNDATION SCHEDULE						60,000 PSI STEEL	
MAXIMUM WALL HEIGHT FROM TOP OF FOOTING	TOP EDGE SUPPORT	VERTICAL WALL REINF.		HORIZONTAL WALL REINF.		MIN. WALL FOOTING SIZE AND REINF.	REINFORCING	NOTES	SILL PLATE J-BOLTS, U.N.G. - SEE PLAN* (MIN. 7' EMBEDMENT)
		MIN. WALL WIDTH	SIZE	SPACING	SIZE				
2'-0" TO 4'-0"	NONE	#4	#4	32" O.C.	#4	14" O.C.	SEE PLAN		3" x 10" @ 32" O.C.
4'-0" TO 6'-0"	NONE	#4	#4	14" O.C.	#4	12" O.C.	(1) #4 X CONT.	SEE NOTE #4 BELOW	3" x 10" @ 32" O.C.
6'-0" TO 8'-0"	NONE	#4	#4	14" O.C.	#4	12" O.C.	(2) #4 X CONT.	SEE NOTE #4 BELOW	3" x 10" @ 32" O.C.
6'-0" TO 7'-0"	NONE	#4	#4	12" O.C.	#4	12" O.C.	(1) #4 X CONT. #4 @ 11" O.C. TRANSVERSE	SEE NOTE #4 BELOW	3" x 10" @ 32" O.C.
7'-0" TO 8'-0"	FLOOR	#4	#4	24" O.C.	#4	18" O.C.	SEE PLAN		3" x 10" @ 32" O.C.
8'-0" TO 9'-0"	FLOOR	#4	#4	18" O.C.	#4	18" O.C.	SEE PLAN		3" x 10" @ 32" O.C.
9'-0" TO 10'-0"	FLOOR	#4	#4	12" O.C.	#4	12" O.C.	(3) #4 X CONT.	USE MIN. F-24 FOOTING	3" x 10" @ 24" O.C.
10'-0" TO 11'-0"	FLOOR	#4	#4	8" O.C.	#4	12" O.C.	(3) #4 X CONT.	USE MIN. F-30 FOOTING	3" x 10" @ 24" O.C.
11'-0" TO 12'-0"	FLOOR	#4	#4	8" O.C.	#4	12" O.C.	(4) #4 X CONT.	USE MIN. F-36 FOOTING	3" x 10" @ 24" O.C.
> 12'-0"	REQ. ENG.	-	-	-	-	-	-	-	REQUIRES ENG.

NOTES:  
 1. REBAR TO BE PLACED IN THE CENTER OF THE WALL U.N.G. SEE PLAN.  
 2. FOOTING CORNERS SHALL BE SETTING #4 BAR DIAMETERS INTO THE FOUNDATION WALL AND MATCH WALL VERTICAL STEEL SIZE AND SPACING. CORNERS SHALL HAVE A 90° STANDARD HOOK AT BOTTOM AND SHALL BE PLACED PER DETAILS.  
 3. USE 3" x 6" x 3" WADERS ON J-BOLTS. #8 SLOTTED WADERS IN USED. ADD SPLIT WADERS.  
 4. LARGER FOOTINGS SPECIFIED ON 4" TO 7'-0" WALLS WITH NO TOP EDGE SUPPORT MAY BE REDUCED TO SIZE SPECIFIED ON PLANS, AND VERTICAL REBAR SPACING OF 24" O.C. FOR FOUNDATION WALLS MAY BE USED PROVIDED ONE OF THE FOLLOWING CONDITIONS EXIST:  
 A. 4" TO 7'-0" WALL LENGTH DOES NOT EXCEED 10'-0" AND HAS PERPENDICULAR CONCRETE RETURN WALL AT EACH END.  
 B. UNBALANCED BACKFILL DOES NOT EXCEED 4'-0".  
 5. TITENS NO. BOLTS OR EPOXY THREADED HOODS MAY BE SUBSTITUTED FOR J-BOLTS OF SAME SIZE AND SPACING. USE 6" TITENS FOR SINGLE SILL PL.  
 6. USE #4 FOR DRILL SILL PL.  
 7. PERIODIC SPECIAL INSPECTIONS REQUIRED ON 11'-0" TO 12'-0" FOUNDATION WALLS.

## Common Errors

- Incorrect Wall Heights
- Incorrect Wall Widths
- Inadequate Reinforcement
- Inadequate Bar Clearances
- Holdowns/Embeds/Anchor Bolts
- Work Not Ready for Inspection



## Part 4: Specialty Foundations





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## Specialty Foundations

- PT Slabs-On-Grade
- Deep Foundations
  - Auger Cast-in-Place Piles (ACIP)
  - Steel Piles
  - Helical Piles
  - Micropiles
- Ground Improvement



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## PT Slabs-On-Grade

- ACI 318 does not apply
- **2024 IRC – Added Section R506.2: “Post-Tensioned Slab-on-Ground Floors”**
  - References PTI DC10.5-19
- Two options → Ribbed or Flat slabs

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## PT Slabs-On-Grade

### ○ Ribbed PT Slab:

- Pros
  - Structurally efficient with less materials.
  - Does not rely on under slab fill for support (less earthwork).
- Cons
  - Labor intensive.
  - Requires trenching into grade or forming fill.



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## PT Slabs-On-Grade

### ○ Flat PT Slabs:

- Pros
  - Does not require trenching or forming fill
- Cons
  - Requires more concrete and post-tensioning cables.
  - Sloping sites present problems.



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## PT Slabs-On-Grade

### ○ Typical Residential PT Slabs:

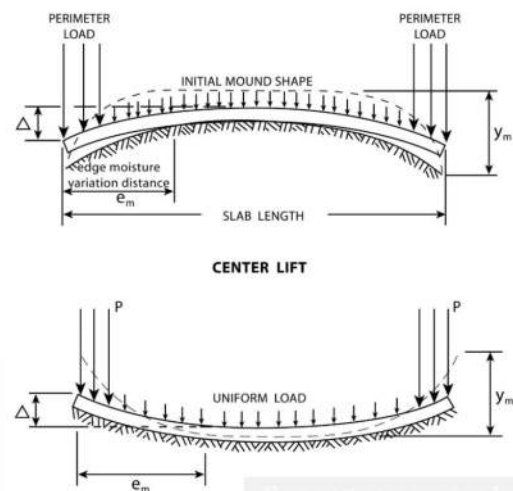
- 4-5" thick with tendons at 4-feet O.C.
- Tendons mid-slab and do not extend into footings.
- Locations of tendons is relatively arbitrary. It is the number that counts. Maximum spacing is typically 6-feet O.C.
- Can curve around obstructions but should be smooth and gradual.
- Length, color, and expected elongation should be listed on plans.
- Strands stressed to 33,000 pounds 3-10 days after casting concrete. (2,000psi minimum)
- 5.25" x 2" cast iron anchor is typical.

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## PT Slabs-On-Grade

### ○ Differential Movement:

- Center lift design:
  - Moment in both directions
  - Shear in long direction
- Edge lift design:
  - Moment in both directions
  - Shear in both directions
  - Differential deflection
- $Y_m = \text{Center Lift} + \text{Edge Lift}$



# PT Slabs-On-Grade

**1808.6.1.1 Minimum Foundation Depth in Expansive Soils.** The minimum foundation depth requirements when placing foundations in expansive soil shall be per Table 1808.6.1.1.

**Table 1808.6.1.1 Minimum Thickened Edge or Foundation Depth<sup>1</sup>**

Expansion	Percent Swell under 60 psf Surcharge	Minimum Thickened Edge or Foundation Depth (inches)
Low	> 0 to <4	12
Moderate	≥ 4 to < 8	15
High	≥8 to < 12	18
Critical 12	≥12 to < 16	24
Critical 16	≥16 to < 20	30
Critical 20+	20 or greater	36

Footnote:

<sup>1</sup>. Thickened edge embedment depth shall be measured from the top of the lowest adjacent final compacted subgrade to the bottom of the footing.

**Notes:**

1. This chart is intended to address expansive soil. The presence of collapsible soil or other geologic conditions may require different design criteria.
2. Foundations shall be designed to meet design criteria of PTI DC 10.5. Both edge lift and center lift conditions need to be evaluated.
3. Edge moisture variation distance (Em) shall be a minimum of 2.5 feet for edge lift and 4.75 feet for center lift.
4. CΔ for prefabricated roof truss clear spans shall be 360 for center lift and 800 for edge lift.
5. Typical systems using stiffener beams may be equated to a flat slab of equivalent stiffness. Stiffening beams in ribbed foundations shall be as required by PTI DC 10.5. Conventionally reinforced designs may also be used.
6. Modulus of elasticity of the soil (Es) shall be taken as 1000 psi unless tests indicate otherwise.
7. All concrete in the foundation system must be a minimum of 2500 psi and shall comply with ACI 318-14 Table 19.3.2.1. Lean concrete shall not be permitted in slabs or beams.
8. The calculated differential deflection of the foundation slab shall not exceed the limitations of PTI DC 10.5 nor 1/2 inch for edge lift.
9. Perimeter loading of slab (P) shall be limited to dead load.
10. Expansion (swell) test shall be performed in accordance with Section 1803.5.3.
11. Specific recommendations from geotechnical engineer required. Design shear value (Ym) shall be a minimum of 1 inch.
12. For soil conditions where a low swell potential is determined, a BRAB Type II may be used if specifically recommended by the geotechnical engineer.

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## ACIP

- Cased or uncased
- **IBC 1810.3.1.6: Casings**
  - Shall be of steel
  - Sufficiently strong to resist collapse
  - Sufficiently water-tight to exclude foreign materials
  - Horizontal joints shall be spliced



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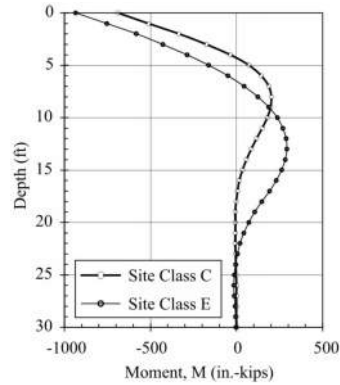
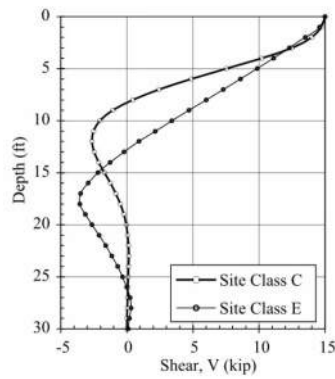
## ACIP

- **IBC 1810.3.5.2:**
  - Cased → 8"Ø
  - Uncased → 12"Ø
- **IBC 1810.3.9.3:**
  - Reinforcement shall be placed as a unit before filled with concrete



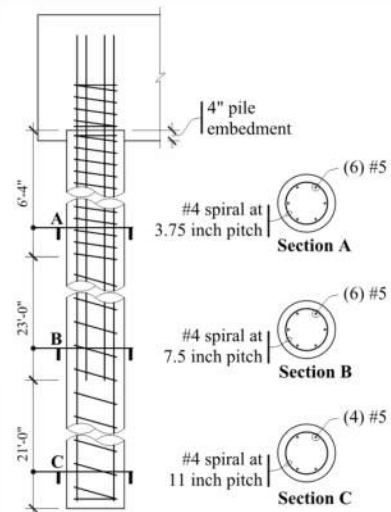
# ACIP

- o Shear and Moment decrease with depth



# ACIP

- o Larger amounts of reinforcement where moments and shear are high
- o Minimum amounts must extend beyond theoretical cutoff points



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## ACIP

### ○ IBC 1810.3.9.4.2: SDC 'D-F'

- 4 vertical bars minimum
- Min. Ratio of Steel ( $\rho$ )= 0.005
- Minimum Reinforced Length
  - 1/2 length of element
  - 10-feet
  - 3 \* the width or diameter
  - Where  $\phi M_n > M_{req}$

$$\rho = 0.005$$

$$\#4 \leq 14" \phi$$

$$\#5 \leq 17" \phi$$

$$\#6 \leq 21" \phi$$

$$\#7 \leq 24" \phi$$

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## ACIP

### ○ IBC 1810.3.9.4.2: SDC 'D-F'

- Transverse Reinforcement
  - If  $\leq 20" \phi$  use #3 bar min, otherwise #4 bar
  - Maximum spacing:
    - $12d_b$ , or...
    - 0.5 \* least dimension of element
    - 12-inches
  - Upper spacing...

$$12d_b$$

$$\#4 = 6"$$

$$\#5 = 7.5"$$

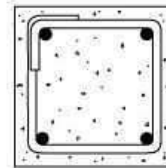
$$\#6 = 9"$$

$$\#7 = 10.5"$$

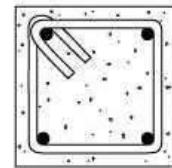
# ACIP

## o Seismic Hook: (ACI 318)

- Applies to stirrups, hoops or crossties
- A hook having a bend not less than 135°, except that circular hoops shall have a bend not less than 90°.
- Extensions shall be  $6d_b$ , but not less than 3".



90° hooks

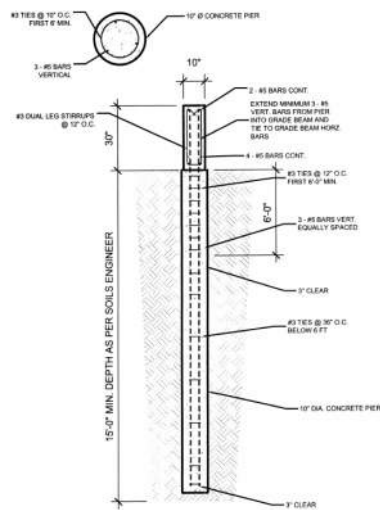


135° hooks

# ACIP

## o Do you see any problems with this detail?

- 10ø uncased
- (3) #5 vertical bars
- #3 ties @ 10" o.c. (upper 6')
- #3 ties @ 36" o.c. (lower 9')
- 15'-0" depth



12 CONCRETE PIER DETAIL  
S4 SCALE: NTS



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## ACIP

- Submittals:
  - Review stamp by design professional in responsible charge
  - Geotechnical recommendations
  - Location plan
  - Pile cap connection details
  - Embedment depth & detailing
  - Load test criteria (F.S.  $\geq 2.0$ )
  - Special inspections per IBC Table 1705.8

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## Steel Piles

- **IBC 1810.3.2.3: Materials**
  - H-piles  $\rightarrow$  ASTM A6
  - Steel pipe  $\rightarrow$  ASTM A252



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## Steel Piles

### ○ IBC 1810.3.2.5: Protection

- Corrosive conditions?
- Corrosion rate dependent upon soil resistivity, pH, chloride content, sulfate content, sulfide ion content, soil moisture, and oxygen content.
- Protective materials shall be applied.
- Cannot be reduced by installation.

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## Steel Piles

### ○ IBC 1810.3.2.5: Protection

- Caltrans:
  - Most corrosion occurs in fill soils rather than undisturbed soil.
  - Greatest concern for corrosion is the portion of the pile from the bottom of the pile cap down to 3 feet below the lowest ground water elevation.
- Protection Means:
  - Sacrificial metal (corrosion allowance)
  - Protective coatings
  - Cathodic protection

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## Steel Piles

### ○ IBC 1810.3.5.3: Dimensions

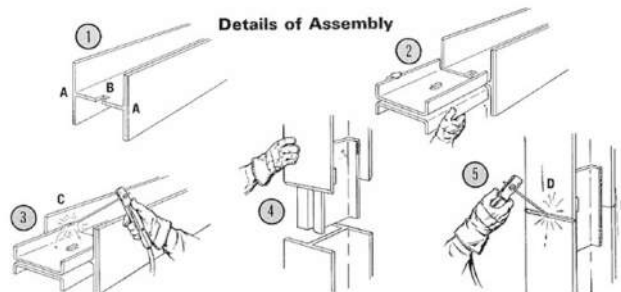
- H-piles:
  - Flange projections  $\leq 14 \times$  thickness of web or flange
  - Minimum flange or web thickness  $\geq 3/8$ -inch
  - Nominal depth  $\geq 8$ -inches
- Pipe piles:
  - Nominal diameter  $\geq 8$ -inches
  - Open-ended  $\rightarrow 0.34 \text{ in}^2$  steel per 1,000 ft-# hammer energy

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## Steel Piles

### ○ IBC 1810.3.6: Splices

- Shall maintain alignment
- Designed to resist axial, shear and moment
- Shall be designed to develop  $\geq 50\%$  of bending moment



# Steel Piles

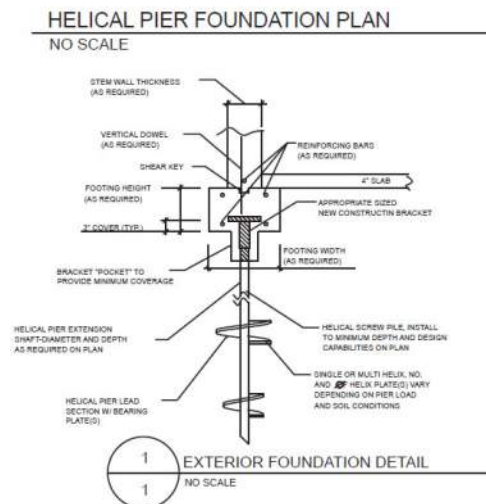
○ **Submittals:**

- Review stamp by design professional in responsible charge
- Geotechnical recommendations
- Location plan
- Pile cap connection details
- Embedment depth & detailing (including splices)
- Load test criteria (F.S.  $\geq 2.0$ )
- Special inspections per IBC Table 1705.7

# Helical Piles

○ **Common Terminology:**

- Helix Plate
- Lead Section
- Extension
- Torque Rating
- Installation Torque



# Helical Piles

o **IBC 1810.3.3.1.9: Allowable Axial Load**

- o  $P_{all} = 0.5 * P_{ult}$  → Where  $P_{ult}$  is the least of...
  - Sum of bearing plate areas \* the ultimate bearing capacity of the soil
  - Ultimate capacity determined from well-documented correlations with installation torque
  - Ultimate capacity determined from load tests
  - Ultimate axial capacity of pile shaft
  - Ultimate capacity of couplings
  - Sum of ultimate capacity of helical bearing plates affixed to pile

**TABLE A-2. RAM JACK HELICAL PLATE LOAD DIAMETERS AND LOAD RATINGS**

Helical Plate (in)	Central Pile Shaft (in)	Effective Area (ft <sup>2</sup> )	Plate Thickness (in)	Maximum Allowable Load Rating (lbs)
8	2 3/8	0.318	3/8	47,500
10		0.515		43,500
12		0.755		37,500
8	2 7/8	0.304	3/8	73,000
10		0.500		64,000
12		0.740		47,400
12		0.740	70,500	
14		1/2	1.02	58,500
16			1.35	50,000
8	3 1/2	0.283	3/8	65,000
10		0.479		51,000
12		0.719		44,500
12		0.719	80,500	
14		1/2	1.00	67,000
16			1.33	64,500
10			4 1/2	0.435
12		0.675		94,500
14	0.959	83,000		
16	1.290	76,000		

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## Helical Piles

### ○ IBC 1810.3.5.3.5: Materials

- Dimensions of central shaft, and...
- Number, size and thickness of bearing plates...
- Shall be sufficient to support design loads

### ○ IBC 1810.4.11: Installation

- Specified embedment depth, and...
- Torsional resistance criteria
- Torque applied  $\leq$  Allowable torque of pile

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## Helical Piles

### ○ Submittals:

- Review stamp by design professional in responsible charge
- Allowable capacity determination (see previous slide)
- Location plan
- Details of connection to foundation
- The design professional must specify the embedment depth and torsional resistance criteria
- Load test criteria (F.S.  $\geq$  2.0)
- Special inspection criteria (see next slide)

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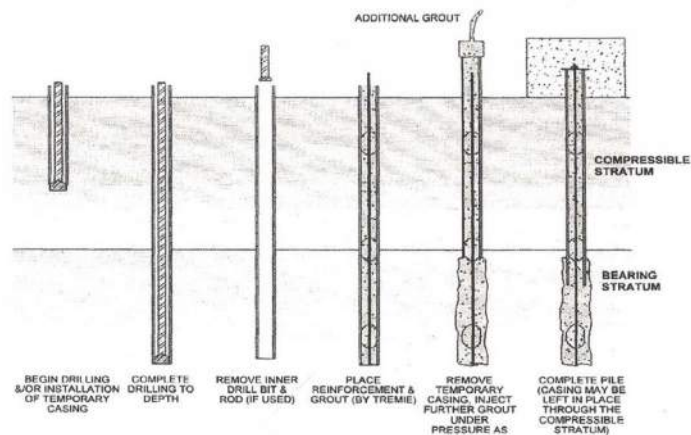
## Helical Piles

### o IBC 1705.9: Special Inspections

- Continuous
- Shall record the following...
  - Installation equipment used
  - Pile dimensions
  - Tip elevations
  - Final depth
  - Final installation torque
- The geotechnical report and approved construction documents shall be used to determine compliance

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## Micropiles



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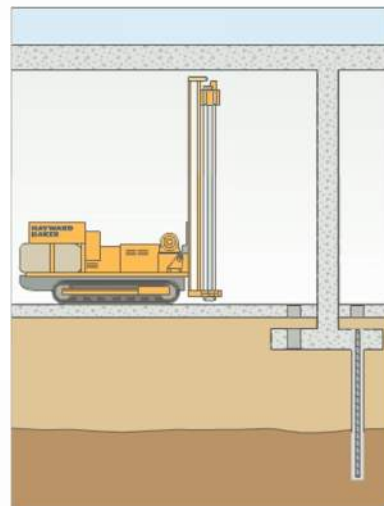
## Micropiles

- Small diameter pile (12"Ø max)
- Tailored design for specific need
  - 3-30 tons: Push piles
  - 15-75 tons: Compaction-grouted piles
  - 50-150 tons: Jet-grouted piles
  - 40-100 tons: Post-grouted piles
  - 25-75 tons: Pressure-grouted piles
  - 50-500+ tons: Drilled End-bearing piles

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## Micropiles

- Applications
  - Congested areas
  - Arresting settlement
  - Resist uplift
  - Excavation support
  - (i.e. tie-backs)
  - Underpinning
  - Seismic retrofit
  - Stabilizing slopes





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## Micropiles

### ○ IBC 1810.3.10: Designed & Detailed

- Develop load-carrying capacity by means of bond zone with soil or bedrock
- Reinforcement:
  - ASTM A615 Grade 60 or 75; ASTM A722 Grade 150, or...
  - Steel pipe or tube having 3/16-inch wall thickness
  - Cased  $\geq 40\%$  design compression load
  - Uncased = 100% design compression load

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## Micropiles

### ○ IBC 1810.4.10: Installation

- Fluid cement grout pumped through tremie pipe
- Reinforcing bars shall be inserted prior to withdrawal of casing
- Casing removed in a controlled manner and grout level monitored
- If no casing, the diameter shall be verified
- Bottom shall be cleaned for end bearing piles
- Subsequent micropiles shall not be drilled near elements until grout has had sufficient time to harden

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## Micropiles

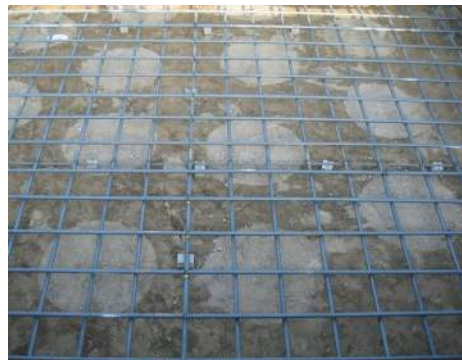
### ○ Submittals:

- Review stamp by design professional in responsible charge
- Geotechnical recommendations
- Location plan
- Details of connection to pile cap
- Load test criteria (F.S.  $\geq 2.0$ )
- Special inspections per IBC Table 1705.8

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## Ground Improvement Methods

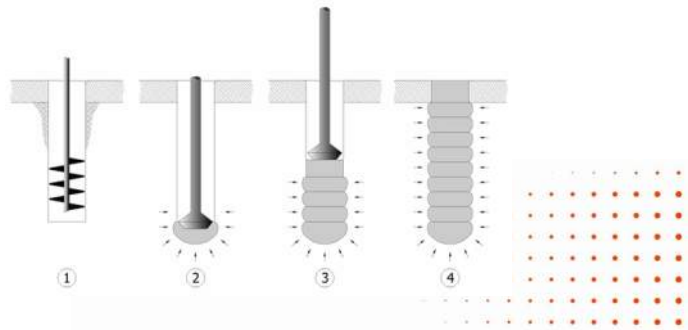
- Dynamic compaction
- Soil mixing
- Pre-loading
- RAPs



## RAPs

### ○ Geopiers (ESR 1685)

- Constructed from 6-12" above bottom of footing
- Special Inspections : Verify the following...
  - Aggregate properties
  - Type & number of lifts
  - Hole size and depths
  - Top elevations
  - Rammer energy
  - Review load tests on
  - confirmation piers



## Part 5: Special Inspections



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## Statement of Special Inspections (SSI)

- Where special inspections are required a “Statement of Special Inspections” must be submitted (IBC 107.1, IBC 1704.2.3, and IBC 1704.3).
- This shall include...
  - Materials, systems and components requiring inspection or testing.
  - Type or extent of each special inspection or test.
  - Additional items per 1705.11, 1705.12, and 1705.13
  - Identify the required frequency (i.e. continuous or periodic)

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## Special Inspections

- In relation to footings & foundations, may include...
  - Special cases (IBC 1705.1.1)
  - Concrete construction (IBC 1705.3)
  - Soils (IBC 1705.6)
  - Driven deep foundations (IBC 1705.7)
  - Cast-in-place deep foundations (IBC 1705.8)
  - Helical pile foundations (IBC 1705.9)

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## Exemptions

- There are still several instances when special inspections are not required.
- **IBC 1704.2: Exceptions include...**
  - B.O. waives the requirement as work is deemed minor in nature.
  - Group U occupancies that are accessory to a residential occupancy.
  - "Conventional" cold-formed or wood light-framed construction.

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## Exemptions

- **IBC 1705.3: Concrete Construction**
  - Isolated spread footings for buildings 3-stories or less.
  - Continuous footings for buildings 3-stories or less where...
    - Supporting light-framed walls, or...
    - Design considers a compressive strength of 2,500psi.
  - Nonstructural concrete slabs and other flatwork.
    - Including PT slabs with effective prestress < 150psi
  - Foundation walls per IBC Table 1807.1.6.2.

# Exemptions

## o IBC 1705.6: Soils

- If < 12-inch depth of structural fill (IBC 1803.5.8)
  - This still requires in-place dry density of ≥ 90%.

Revise the Exception in Section 1705.5 to read as follows:

**Exception:** Where Section 1803 does not require reporting of materials and procedures for fill placement, the in-place dry density of the compacted fill shall not be less than 90% of the maximum dry density at optimum moisture content determined in accordance with ASTM D 1557.

# Deep Foundations

## o IBC 1810.4.12: Special Inspections

- Do IBC Tables cover all of the special inspection requirements that may be necessary for deep foundations?
- What other special inspection items may be required?

**ICC-ES EVALUATION SERVICE**  
**ICC-ES Evaluation Report**  
**EER-1888**  
 Prepared January 2024

Subject to revised demands 2023

ICC-ES Evaluation Service, LLC is an independent laboratory providing a wide range of testing and consulting services. See www.iccses.com for a complete list of services. This report is intended for informational purposes only. It is not a contract and does not constitute a warranty. For more information, please contact your local ICC-ES office.

<b>DIVISION: 31 05 00—</b> <b>FOUNDATION</b> Section: 31 05 00— Special Foundations	<b>REPORT HOLDER:</b> <b>GEOSIM FOUNDATION COMPANY</b>	<b>EVALUATION SUBJECT:</b> <b>RAMMED AGGREGATE PIER INTERMEDIATE FOUNDATION/SOIL REINFORCEMENT SYSTEM</b>	
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**1.0 EVALUATION SCOPE**  
 Compliance with the following codes:  
 • 2018, 2015, 2012, 2009, 2006 and 2003 International Building Code® (IBC)  
 • 2013 Abu Dhabi International Building Code (ADIBC)  
 \*The ADIBC is based on the 2009 IBC, 2006 IBC code sections referenced in this report as the same sections in the IBC®.  
 Property evaluated:  
 Structural

**2.0 USES**  
 The Rammed Aggregate Pier Intermediate Foundation/Soil Reinforcement System (hereinafter referred to as Rammed Aggregate Pier System or RAP System) is a geotechnical foundation system for the shallow foundations specified in Section 1808 of the 2018, 2015, 2012 and 2009 IBC, Section 1808 of the 2006 and 2003 IBC, as applicable. The Rammed Aggregate Pier Intermediate Foundation/Soil Reinforcement System is used to support shallow footings, reinforced concrete mat foundations, and reinforced concrete floor slabs on grade.

**3.0 DESCRIPTION**  
 The RAP system is constructed by placing a volume of unconsolidated aggregate into and compacted by a compacted vertical column of earth-grated aggregate. The elements of Rammed Aggregate Pier Systems are constructed from generally available graded stone aggregate through use of procedures proprietary to Geosim Foundation Company. Aggregates must comply with ASTM D1241. The geotechnical investigation described in Section 4.1 of this report may specify additional requirements. Aggregate is installed by ramming, forming rammed aggregate piers with a standard base.

**4.0 DESIGN AND INSTALLATION**  
**4.1 Design**  
 The Rammed Aggregate Pier Intermediate Foundation/Soil Reinforcement System, including aggregate type and size and pier diameter and depth, must be designed for its intended use, in accordance with Chapter 18 of the IBC, and account for the site-specific geotechnical investigation, described in Section 4.1. The design must be provided by a registered design professional, retained by the owner, licensed RAP system installer.

Page 1 of 1

**TABLE 1705.7  
REQUIRED SPECIAL INSPECTIONS AND TESTS OF DRIVEN DEEP FOUNDATION ELEMENTS**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Verify element materials, sizes and lengths comply with the requirements.	X	—
2. Determine capacities of test elements and conduct additional load tests, as required.	X	—
3. Inspect driving operations and maintain complete and accurate records for each element.	X	—
4. Verify placement locations and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and document any damage to foundation element.	X	—
5. For steel elements, perform additional special inspections in accordance with Section 1705.2.	—	—
6. For concrete elements and concrete-filled elements, perform tests and additional special inspections in accordance with Section 1705.3.	—	—
7. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge.	—	—

**TABLE 1705.8  
REQUIRED SPECIAL INSPECTIONS AND TESTS OF CAST-IN-PLACE DEEP FOUNDATION ELEMENTS**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Inspect drilling operations and maintain complete and accurate records for each element.	X	—
2. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable) and adequate end-bearing strata capacity. Record concrete or grout volumes.	X	—
3. For concrete elements, perform tests and additional special inspections in accordance with Section 1705.3.	—	—

## Summary

- There is not one way to perform an inspection.
- Each project will be different.
- Understand basic code requirements.
- Review the plans.
- Write clear comments.
- You will not catch everything.

# Thank You!

✉ [ckimball916@gmail.com](mailto:ckimball916@gmail.com)

☎ (801) 682-5031