A SunCam online continuing education course

2024 IBC
Soils and Foundations Changes

by

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2024 IBC Soils and Foundations Changes
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Course Outline:

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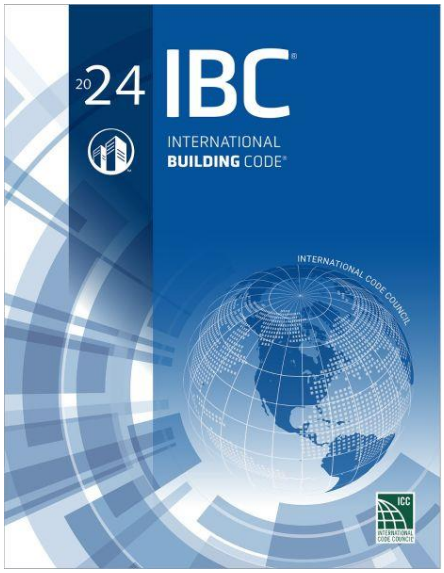
IBC Overview



The International Building Code (IBC) by the International Code Council (ICC) is a detailed set of regulations that are used to govern construction and design standards. The main objective of the IBC code is to protect public health, welfare, and safety by establishing minimum quality standards for building improvements. The code also helps ensure that important features such as bathrooms are accessible to everyone including those in wheelchairs.

When the IBC was formed in 2000, it was a merging of the following codes which are now discontinued:

- Uniform Building Code (UBC)
- BOCA National Building Code (BOCA/NBC)
- Standard Building Code (SBC)

The IBC is adopted in all 50 states, Canada, and many other countries. Most states adopt the latest IBC with amendments for additional requirements. Often it takes a few years for the latest IBC to be officially adopted by a state.

The IBC is updated every three years (2018, 2021, 2024, 2027, etc.). This course covers the changes between the 2021 to 2024 editions.

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The IBC is part of a larger collection of volumes by the International Code Council (ICC). The full collection of (15) ICC volumes include the following:

- **2024 International Building Code (IBC)**
- 2024 International Residential Code without Energy (IRC)
- 2024 International Fire Code (IFC)
- 2024 International Plumbing Code (IPC)
- 2024 International Mechanical Code (IMC)
- 2024 International Fuel Gas Code (IFGC)
- 2024 International Existing Building Code (IEBC)
- 2024 International Property Maintenance Code (IPMC)
- 2024 International Zoning Code (IZC)
- 2024 International Swimming Pool and Spa Code (ISPSC)
- 2024 International Private Sewage Disposal Code (IPSDC)
- 2024 International Wildland Urban Interface Code (IWUIC)
- 2024 ICC Performance Code for Buildings and Facilities (ICCPC)
- 2024 International Green Construction Code (IgCC)
- 2024 International Energy Conservation Code (IECC)

All codes are available online at this ICC website, although a subscription is required to be able to select and copy-paste the code text:

https://www.iccsafe.org/about/2024-i-code-upd

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The covers of the (15) IBC volumes/books are shown in Figure 1, with the volumes addressed in this course circled in red.

Figure 1: Covers of the full collection of 2024 ICC volumes/books, with the IBC volume addressed in this course circled in red.
Source: https://codes.iccsafe.org/codes/i-codes/2024-icodes

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2024 IBC Contents

The following is the 2024 IBC table of contents with the chapter covered by this course in **bold**:

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Chapter 18 Soils and Foundations - Contents

The contents of Chapter 18 are pasted below, with those in **bold** with changes in 2024.

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Chapter 18 Soils and Foundations - Changes

The following is a paste of all Chapter 18 changes from 2021 to 2024, with the text changes highlighted yellow.

1803.5.1 Classification

2021 IBC:

1803.5.1 Classification.

Soil materials shall be classified in accordance with ASTM D2487.

2024 IBC:

1803.5.1 Classification. P

Soil materials shall be classified in accordance with ASTM D2487. Rock shall be classified in accordance with ASTM D5878.

1803.5.2 Questionable soil and rock

2021 IBC:

1803.5.2 Questionable soil. P

Where the classification, strength or compressibility of the soil is in doubt or where a load-bearing value superior to that specified in this code is claimed, the *building official* shall be permitted to require that a geotechnical investigation be conducted.

2024 IBC:

1803.5.2 Questionable soil and rock. P

Where the classification, strength, moisture sensitivity or compressibility of the soil or rock is in doubt or where a load-bearing value superior to that specified in this code is claimed, the *building official* shall be permitted to require that a geotechnical investigation be conducted.

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1803.5.4 Groundwater.

2021 IBC:

1803.5.4 Ground-water table.

A subsurface soil investigation shall be performed to determine whether the existing ground-water table is above or within 5 feet (1524 mm) below the elevation of the *lowest floor* level where such floor is located below the finished ground level adjacent to the foundation.

Exception: A subsurface soil investigation to determine the location of the ground-water table shall not be required where waterproofing is provided in accordance with Section 1805.

2024 IBC:

1803.5.4 Groundwater.

A geotechnical investigation shall be performed to determine if:

1. Groundwater is above or within 5 feet (1524 mm) below the elevation of the *lowest floor* level where such floor is located below the finished ground level adjacent to the foundation.
2. The groundwater depth will affect the design and construction of *buildings* and *structures*.

1803.5.6 Rock strata

2021 IBC:

1803.5.6 Rock strata.

Where subsurface explorations at the project site indicate variations in the structure of rock on which foundations are to be constructed, a sufficient number of borings shall be drilled to sufficient depths to assess the competency of the rock and its load-bearing capacity.

2024 IBC:

1803.5.6 Rock strata. P

Where foundations are to be constructed on or in rock, the geotechnical investigation shall assess variations in rock strata depth, competency and load-bearing capacity.

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1806.2 Presumptive load-bearing values.

2021 IBC:

1806.2 Presumptive load-bearing values. P

The load-bearing values used in design for supporting soils near the surface shall not exceed the values specified in Table 1806.2 unless data to substantiate the use of higher values are submitted and *approved*. Where the *building official* has reason to doubt the classification, strength or compressibility of the soil, the requirements of Section 1803.5.2 shall be satisfied.

Presumptive load-bearing values shall apply to materials with similar physical characteristics and dispositions. Mud, organic silt, organic clays, peat or unprepared fill shall not be assumed to have a presumptive load-bearing capacity unless data to substantiate the use of such a value are submitted.

Exception: A presumptive load-bearing capacity shall be permitted to be used where the *building official* deems the load-bearing capacity of mud, organic silt or unprepared fill is adequate for the support of lightweight or temporary structures.

2024 IBC:

1806.2 Presumptive load-bearing values. P

The load-bearing values used in design for supporting soils and rock near the surface shall not exceed the values specified in Table 1806.2 unless data to substantiate the use of higher values are submitted and *approved* . Where the *building official* has reason to doubt the classification, strength or compressibility of the soil or rock, the requirements of Section 1803.5.2 shall be satisfied.

Presumptive load-bearing values shall apply to materials with similar physical and engineering characteristics. Mud, organic silt and organic clays (OL, OH), peat (Pt) and undocumented fill shall not be assumed to have a presumptive load-bearing capacity unless data to substantiate the use of such a value are submitted.

Exception: A presumptive load-bearing capacity shall be permitted to be used where the *building official* deems the load-bearing capacity is adequate for the support of lightweight or *temporary structures*.

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1807.2.5 Guards

The following section and subsections were added in 2024 IBC.

2024 IBC:

1807.2.5 Guards. CDP P

Guards shall be provided at retaining walls in accordance with Sections 1807.2.5.1 through 1807.2.5.3.

Exception: *Guards* are not required at retaining walls not accessible to the public.

1807.2.5.1 Where required. P

At retaining walls located within 36 inches (914mm) of walking surfaces, a *guard* shall be required between the walking surface and the open side of the retaining wall where the walking surface is located more than 30 inches (762 mm) measured vertically to the surface or grade below at any point within 36 inches (914mm) horizontally to the edge of the open side. *Guards* shall comply with Section 1607.9.

1807.2.5.2 Height. P

Required *guards* at retaining walls shall comply with the height requirements of Section 1015.3.

1807.2.5.3 Opening limitations. P

Required *guards* shall comply with the opening limitations of Section 1015.4.

Figure 2: Example of guardrail on a retaining wall.
Source: commons.wikimedia.org/wiki/File:Sea_Wall_at_Overstrand_-_geograph.org.uk_-_3855070.jpg, Finlay Cox

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1807.3 Embedded posts and poles

2021 IBC:

1807.3 Embedded posts and poles. P

Designs to resist both axial and lateral *loads* employing posts or poles as columns embedded in earth or in concrete footings in earth shall be in accordance with Sections 1807.3.1 through 1807.3.3.

2024 IBC:

1807.3 Embedded posts and poles. P

Designs to resist both axial and lateral *loads* employing posts or poles as columns embedded in earth or in concrete footings in earth shall be in accordance with Sections 1807.3.1 through 1807.3.3 or ASABE EP 486.3.

ANSI/ASAE EP486.3 SEP2017
Shallow Post and Pier Foundation Design

American Society of
Agricultural and Biological Engineers

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1807.3.2.2 Constrained

2021 IBC:

1807.3.2.2 Constrained. P

The following formula shall be used to determine the depth of embedment required to resist lateral *loads* where lateral constraint is provided at the ground surface, such as by a rigid floor or pavement.

$$d = \sqrt{\frac{4.25Ph}{S_3 b}} \qquad \textbf{(Equation 18-2)}$$

or alternatively

$$d = \sqrt{\frac{4.25M_g}{S_3 b}} \qquad \textbf{(Equation 18-3)}$$

2024 IBC:

1807.3.2.2 Constrained. P

The following formula shall be used to determine the depth of embedment required to resist lateral *loads* where lateral constraint is provided at the ground surface, such as by a rigid floor or slab-on-ground.

$$d = \sqrt{\frac{4.25Ph}{S_3 b}} \qquad \textbf{(Equation 18-2)}$$

or alternatively

$$d = \sqrt{\frac{4.25M_g}{S_3 b}} \qquad \textbf{(Equation 18-3)}$$

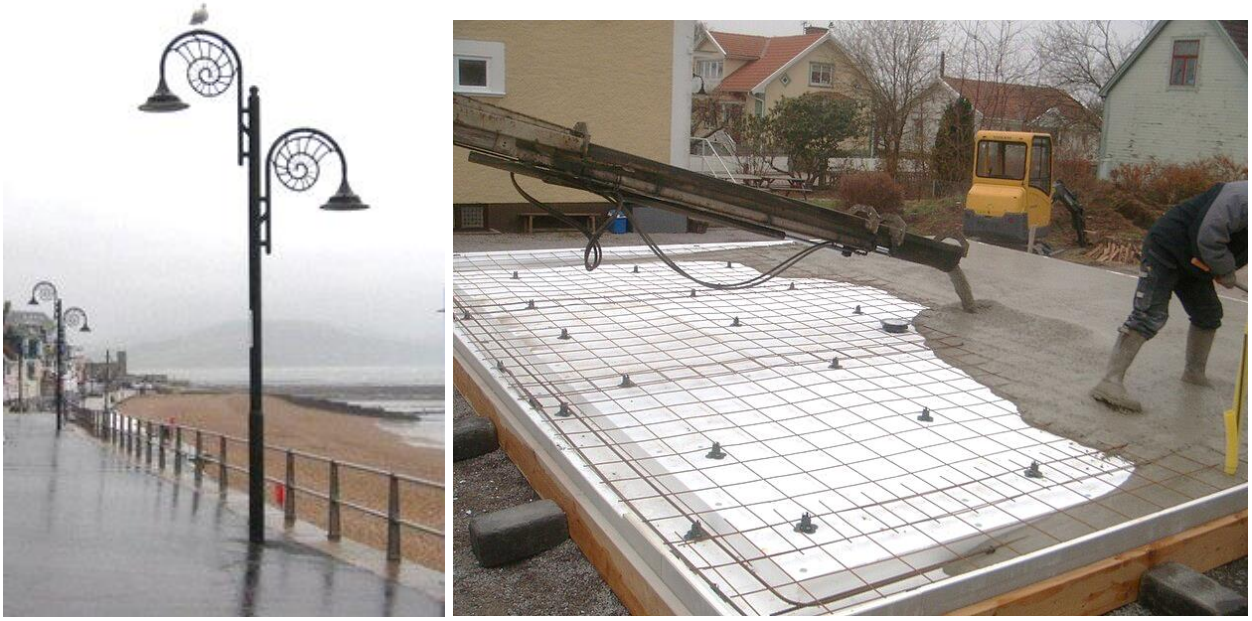

Figure 3: Light pole through a rigid floor (left) and slab on grade (right).

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1809.6 Location of footings

2021 IBC:

1809.6 Location of footings.

Footings on granular soil shall be so located that the line drawn between the lower edges of adjoining footings shall not have a slope steeper than 30 degrees (0.52 rad) with the horizontal, unless the material supporting the higher footing is braced or retained or otherwise laterally supported in an *approved* manner or a greater slope has been properly established by engineering analysis.

2024 IBC:

1809.6 Location of footings. P

Footings on granular soil shall be so located that the line drawn between the lower edges of adjacent footings shall not have a slope steeper than 30 degrees (0.52 rad) with the horizontal, unless the material supporting the higher footing is braced or retained or otherwise laterally supported in an *approved* manner or a greater slope has been properly established by engineering analysis.

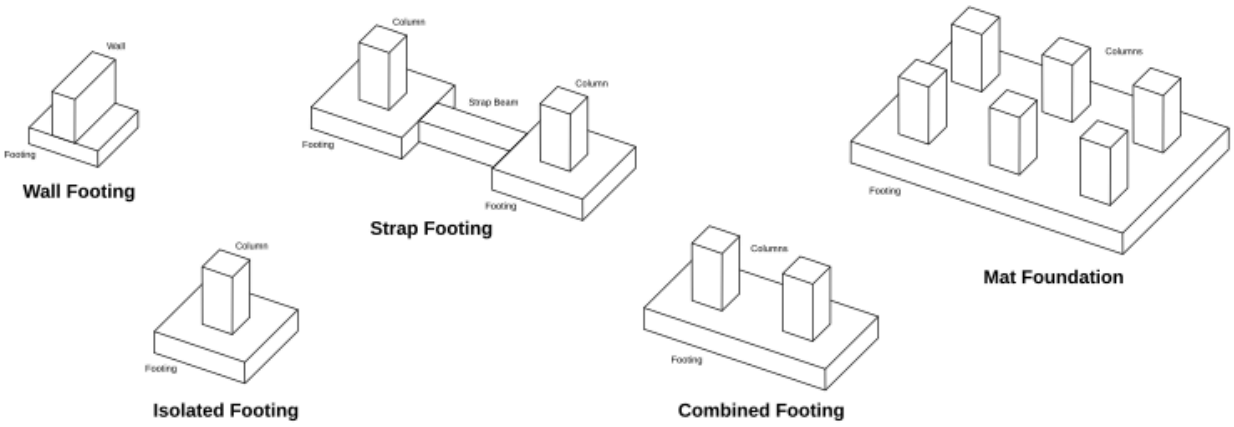

Figure 4: Types of shallow footings
Source: https://commons.wikimedia.org/wiki/File:Types_of_Shallow_Foundations.svg, Jethrude Hipolito

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1809.14 Grade beams

The following section was added in 2024 IBC.

2024 IBC:

1809.14 Grade beams. P

Grade beams shall comply with the provisions of ACI 318.

Exception: Grade beams not subject to differential settlement exceeding one-fourth of the thresholds specified in ASCE 7 Table 12.13-3 and designed to resist the seismic *load effects* including overstrength factor in accordance with Section 2.3.6 or 2.4.5 of ASCE 7 need not comply with ACI 318 Section 18.13.3.1.

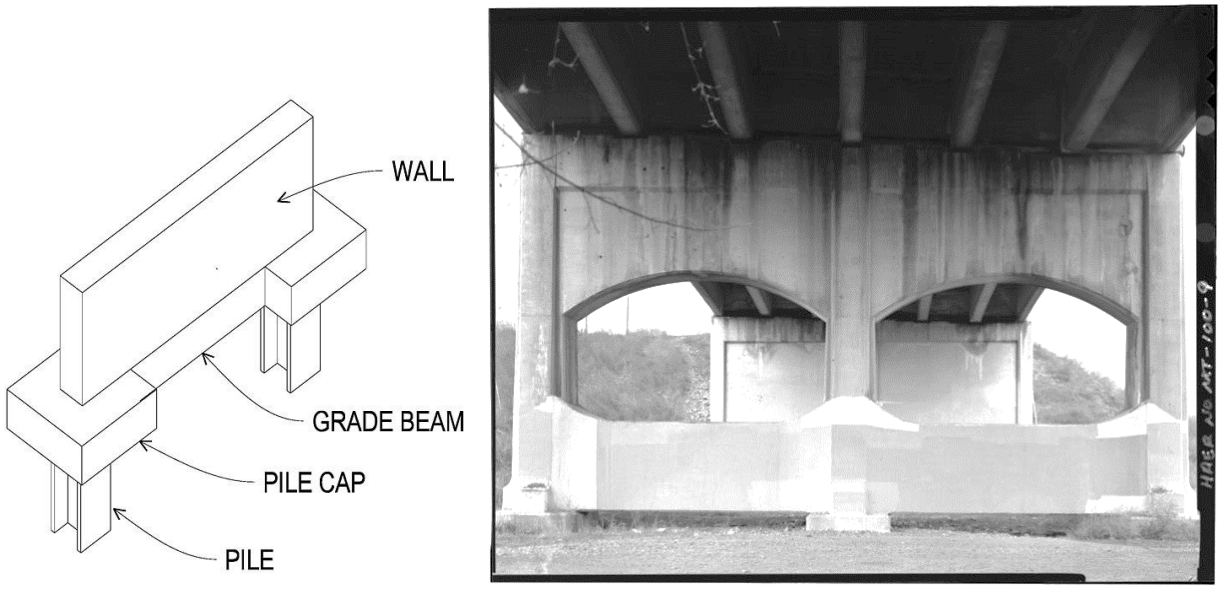

Figure 5: Depict of a grade beam (left) and example (right).
Source: commons.wikimedia.org/wiki/File:Grade_beam.jpg, WikiDork78

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1810.2.2 Stability

2021 IBC:

1810.2.2 Stability.

Deep foundation elements shall be braced to provide lateral stability in all directions. Three or more elements connected by a rigid cap shall be considered to be braced, provided that the elements are located in radial directions from the centroid of the group not less than 60 degrees (1 rad) apart. A two-element group in a rigid cap shall be considered to be braced along the axis connecting the two elements. Methods used to brace *deep foundation* elements shall be subject to the approval of the *building official*.

Deep foundation elements supporting walls shall be placed alternately in lines spaced not less than 1 foot (305 mm) apart and located symmetrically under the center of gravity of the wall load carried, unless effective measures are taken to provide for eccentricity and lateral forces, or the foundation elements are adequately braced to provide for lateral stability.

Exceptions:

1. Isolated cast-in-place *deep foundation* elements without lateral bracing shall be permitted where the least horizontal dimension is not less than 2 feet (610 mm), adequate lateral support in accordance with Section 1810.2.1 is provided for the entire height and the height does not exceed 12 times the least horizontal dimension.
2. A single row of *deep foundation* elements without lateral bracing is permitted for one- and two-family dwellings and lightweight construction not exceeding two *stories above grade plane* or 35 feet (10 668 mm) in *building height*, provided that the centers of the elements are located within the width of the supported wall.

2024 IBC:

1810.2.2 Stability. P

Deep foundation elements shall be braced to provide lateral stability in all directions. Three or more elements connected by a rigid cap shall be considered to be braced, provided that the elements are located in radial directions from the centroid of the group not less than 60 degrees (1 rad) apart. A two-element group in a rigid cap shall be considered to be braced along the axis connecting the two elements. Methods used to brace *deep foundation* elements shall be subject to the approval of the *building official*.

Deep foundation elements supporting walls shall be placed alternately in lines spaced not less than 1 foot (305 mm) apart and located symmetrically under the center of gravity of the wall load carried, unless effective measures are taken to provide for eccentricity and lateral forces, or the foundation elements are adequately braced to provide for lateral stability.

Exceptions:

1. Isolated cast-in-place *deep foundation* elements without lateral bracing shall be permitted where the least horizontal dimension is not less than 2 feet (610 mm), adequate lateral support in accordance with Section 1810.2.1 is provided for the entire height and analysis demonstrates that the element can support the required loads, including mislocations required by Section 1810.3.1.3, with neither harmful distortion nor instability in the *structure*.
2. A single row of *deep foundation* elements without lateral bracing is permitted for one- and two-family *dwellings* and lightweight construction not exceeding two *stories above grade plane* or 35 feet (10 668 mm) in *building height*, provided that the centers of the elements are located within the width of the supported wall.

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1810.3.2.8 Justification of higher allowable stresses

2021 IBC:

1810.3.2.8 Justification of higher allowable stresses.

Use of allowable stresses greater than those specified in Section 1810.3.2.6 shall be permitted where supporting data justifying such higher stresses is filed with the *building official*. Such substantiating data shall include the following:

1. A geotechnical investigation in accordance with Section 1803.
2. Load tests in accordance with Section 1810.3.3.1.2, regardless of the load supported by the element.

The design and installation of the deep foundation elements shall be under the direct supervision of a *registered design professional* knowledgeable in the field of soil mechanics and deep foundations who shall submit a report to the *building official* stating that the elements as installed satisfy the design criteria.

2024 IBC:

1810.3.2.8 Justification of higher allowable stresses.

Use of allowable stresses in Table 1810.3.2.6 that must be justified in accordance with this section shall be permitted where supporting data justifying such higher stresses is submitted to and *approved* by the *building official*. Such substantiating data shall include the following:

1. A geotechnical investigation in accordance with Section 1803.
2. Load tests in accordance with Section 1810.3.3.1.2, regardless of the load supported by the element.

The design and installation of the *deep foundation* elements shall be under the direct supervision of a *registered design professional* knowledgeable in the field of soil mechanics and deep foundations who shall submit a report to the *building official* stating that the elements as installed satisfy the design criteria.

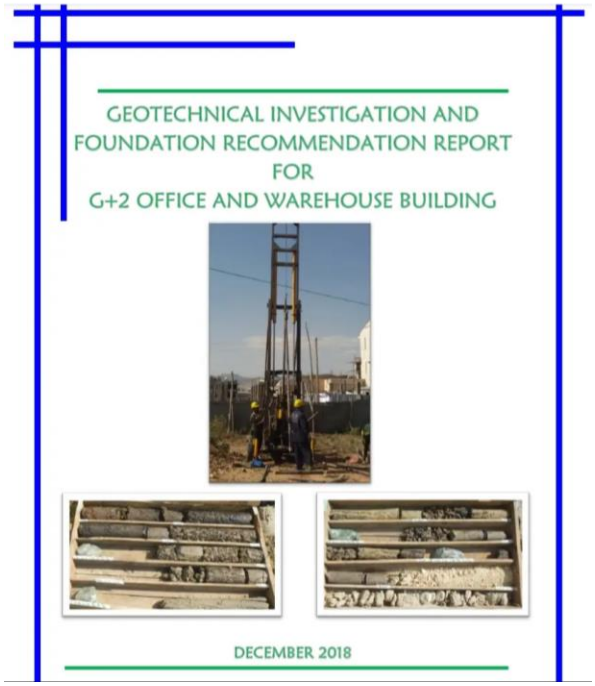

Figure 6: Example geotechnical investigations report cover.
Source: public domain

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1810.3.3.2 Allowable lateral load

2021 IBC:

1810.3.3.2 Allowable lateral load.

Where required by the design, the lateral load capacity of a single *deep foundation* element or a group thereof shall be determined by an *approved* method of analysis or by lateral load tests to not less than twice the proposed design working *load*. The resulting allowable *load* shall not be more than one-half of the *load* that produces a gross lateral movement of 1 inch (25 mm) at the lower of the top of foundation element and the ground surface, unless it can be shown that the predicted lateral movement shall cause neither harmful distortion of, nor instability in, the structure, nor cause any element to be loaded beyond its capacity.

2024 IBC:

1810.3.3.2 Allowable lateral load. P

Where required by the design, the lateral load capacity of a single *deep foundation* element or a group thereof shall be determined by an *approved* method of analysis or by lateral load tests to not less than twice the proposed design working *load*. The resulting allowable lateral *load* shall not be more than one-half of the *load* that produces a gross lateral movement of 1 inch (25 mm) at the lower of the top of the foundation element and the ground surface, unless it can be shown that the predicted lateral movement shall cause neither harmful distortion of, nor instability in, the *structure*, nor cause any element to be loaded beyond its capacity. Group effects shall be evaluated where required by Section 1810.2.5.

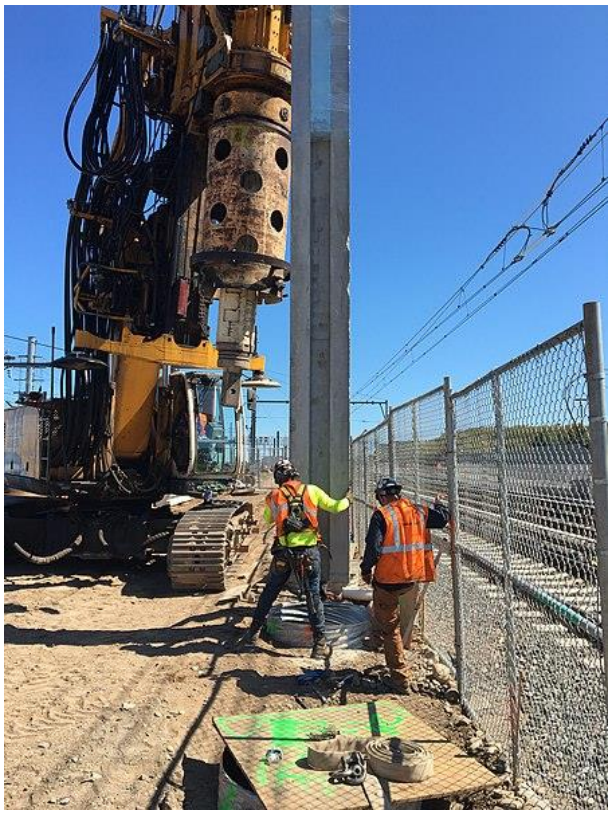

Figure 7: Setting a precast pile, a type of deep foundation.

Source: commons.wikimedia.org/wiki/File:Setting_precast_piles_at_the_east_end_of_the_final_approach_structure.jpg, MTA Capital Construction Mega Projects, CC-BY-SA-2.0

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1810.3.8 Precast concrete piles

2021 IBC:

1810.3.8 Precast concrete piles. P

Precast concrete piles shall be designed and detailed in accordance with ACI 318.

Exceptions:

1. For precast prestressed piles in *Seismic Design Category* C, the minimum volumetric ratio of spirals or circular hoops required by Section 18.13.5.10.4 of ACI 318 shall not apply in cases where the design includes full consideration of load combinations specified in ASCE 7, Section 2.3.6 or Section 2.4.5 and the applicable overstrength factor, Ω_0. In such cases, minimum transverse reinforcement index shall be as specified in Section 13.4.5.6 of ACI 318.
2. For precast prestressed piles in *Seismic Design Categories* D through F, the minimum volumetric ratio of spirals or circular hoops required by Section 18.13.5.10.5(c) of ACI 318 shall not apply in cases where the design includes full consideration of load combinations specified in ASCE 7, Section 2.3.6 or Section 2.4.5 and the applicable overstrength factor, Ω_0. In such cases, minimum transverse reinforcement shall be as specified in Section 13.4.5.6 of ACI 318.

2024 IBC:

1810.3.8 Precast concrete piles. P

Precast concrete piles shall be designed and detailed in accordance with ACI 318.

Exceptions:

1. For precast prestressed piles in *Seismic Design Category* C, the minimum volumetric ratio of spirals or circular hoops required by Section 18.13.5.10.4 of ACI 318 shall not apply in cases where the design includes full consideration of load combinations specified in ASCE 7, Section 2.3.6 or Section 2.4.5 and the applicable overstrength factor, Ω_0. In such cases, minimum transverse reinforcement index shall be as specified in Section 13.4.5.6 of ACI 318.
2. For precast prestressed piles in *Seismic Design Categories* D through F and in *Site Class* A, B, BC, C, CD, D or DE sites, the minimum volumetric ratio of spirals or circular hoops required by Section 18.13.5.10.5(c) of ACI 318 shall not apply in cases where the design includes full consideration of load combinations specified in ASCE 7, Section 2.3.6 or Section 2.4.5 and the applicable overstrength factor, Ω_0. In such cases, minimum transverse reinforcement shall be as specified in Section 13.4.5.6 of ACI 318.

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1810.3.9.2 Required reinforcement

2021 IBC:

1810.3.9.2 Required reinforcement.

Where subject to uplift or where the required moment strength determined using the load combinations of ASCE 7, Section 2.3 exceeds the design cracking moment determined in accordance with Section 1810.3.9.1 , cast-in-place deep foundations not enclosed by a structural steel pipe or tube shall be reinforced.

2024 IBC:

1810.3.9.2 Required reinforcement. P

Where subject to uplift or where the required moment strength determined using the load combinations of ASCE 7, Section 2.3 exceeds the design cracking moment determined in accordance with Section 1810.3.9.1 , cast-in-place deep foundations not enclosed by a structural steel pipe or tube shall be reinforced. Where reinforcement is required, it shall be in compliance with Chapter 20 of ACI 318.

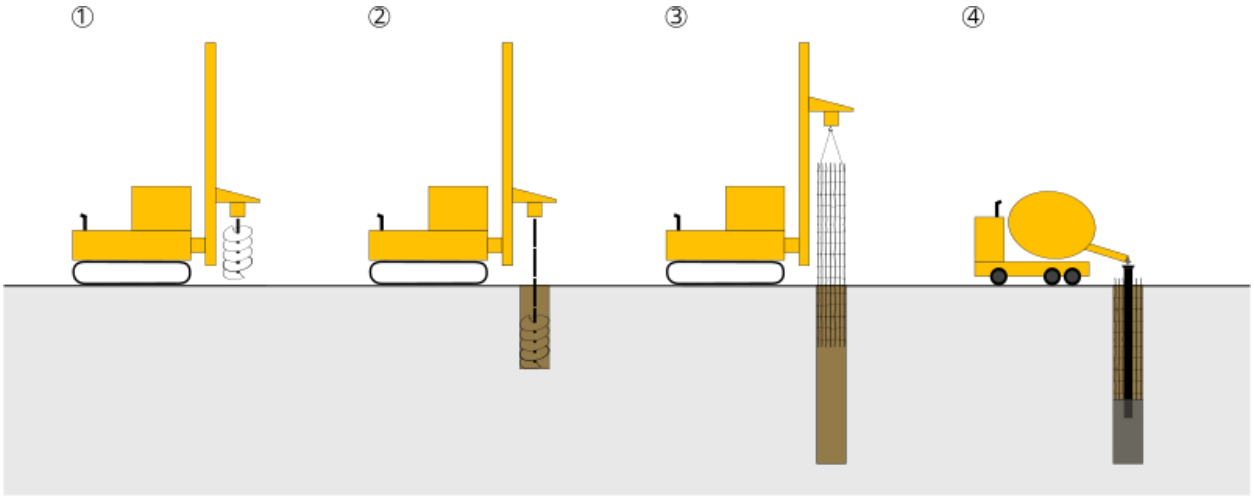

Figure 8: Drilling and setting a bored pile with a reinforcement cage.
This is a type of deep foundation.
Source: commons.wikimedia.org/wiki/File:Foundation_pile_scheme.svg, 5gon12eder, CC-BY-SA-4.0

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1810.3.9.4.2.1 Site Classes A through DE

2021 IBC:

1810.3.9.4.2.1 Site Classes A through D.

For *Site Class* A, B, C or D sites, transverse confinement reinforcement shall be provided in the element in accordance with Sections 18.7.5.2, 18.7.5.3 and 18.7.5.4 of ACI 318 within three times the least element dimension of the bottom of the pile cap. A transverse spiral reinforcement ratio of not less than one-half of that required in Table 18.10.6.4(g) of ACI 318 shall be permitted.

2024 IBC:

1810.3.9.4.2.1 Site Classes A through DE.

For *Site Class* A, B, BC, C, CD, D or DE sites, transverse confinement reinforcement shall be provided in the element in accordance with Sections 18.7.5.2, 18.7.5.3 and 18.7.5.4 of ACI 318 within three times the least element dimension of the bottom of the pile cap. A transverse spiral reinforcement ratio of not less than one-half of that required in Table 18.10.6.4(g) of ACI 318 shall be permitted.

Figure 9: Installing forms for a cast-in-place pile cap on two piles.

Source: commons.wikimedia.org/wiki/File:Installation_of_pile_cap_forms_for_the_Personnel_Access_Footbridge_in_the_future_LIRR_Mid-day_Storage_Yard_(CQ033,_5-22-2018)_(42447648522).jpg, MTA Capital Construction Mega Projects, CC-2.0

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1810.3.12 Grade beams

2021 IBC:

1810.3.12 Grade beams.

Grade beams shall comply with the provisions of ACI 318.

Exception: Grade beams designed to resist the seismic load effects including overstrength factor in accordance with Section 2.3.6 or 2.4.5 of ASCE 7.

2024 IBC:

1810.3.12 Grade beams.

Grade beams shall comply with the provisions of ACI 318.

Exception: Grade beams not subject to differential settlement exceeding one-fourth of the thresholds specified in ASCE 7 Table 12.13-3 and designed to resist the seismic *load effects* including overstrength factor in accordance with Section 2.3.6 or 2.4.5 of ASCE 7 need not comply with ACI 318 Section 18.13.3.1.

Figure 10: Reinforcement for cast-in-place grade beams.
Source: https://www.flickr.com/photos/san_andreas/54230390, Chris McSorley, CC BY-NC-SA 2.0

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1810.4.5 Vibratory driving

2021 IBC:

1810.4.5 Vibratory driving. P

Vibratory drivers shall only be used to install *deep foundation* elements where the element load capacity is verified by load tests in accordance with Section 1810.3.3.1.2. The installation of production elements shall be controlled according to power consumption, rate of penetration or other *approved* means that ensure element capacities equal or exceed those of the test elements.

Exceptions:

1. The pile installation is completed by driving with an impact hammer in accordance with Section 1810.3.3.1.1.
2. The pile is to be used only for lateral resistance.

2024 IBC:

1810.4.5 Vibratory driving. P

Vibratory drivers shall only be used to install *deep foundation* elements where the element load capacity is verified by load tests in accordance with Section 1810.3.3.1.2.

Exceptions:

1. The pile installation is completed by driving with an impact hammer in accordance with Section 1810.3.3.1.1.
2. The pile is to be used only for lateral resistance.

The installation of production elements shall be controlled according to power consumption, rate of penetration or other *approved* means that ensures element capacities equal or exceeding those of the test elements.

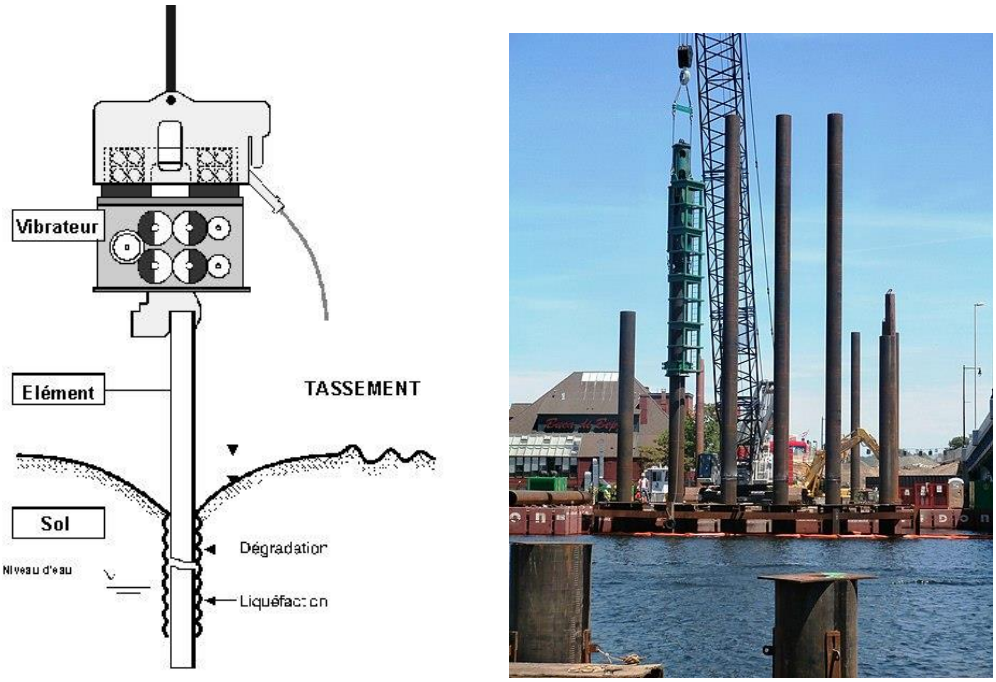

Figure 11: Depiction of vibratory driving (left) and example installation (right).
Source: https://commons.wikimedia.org/wiki/File:Worcester-Shrewsbury,_Burns_Bridge,_July_2014_(14434240807).jpg, p.d.

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Helpful References

2021 IBC:
https://codes.iccsafe.org/content/IBC2021P2

2024 IBC:
https://codes.iccsafe.org/content/IBC2024P1

2024 IBC, Chapter 18:
https://codes.iccsafe.org/content/IBC2024P1/chapter-18-soils-and-foundations#IBC2024P1_Ch18

2024 IBC Significant Non-structural Changes
https://www.iccsafe.org/wp-content/uploads/Session-30-and-58-2024-IBC-Significant-Changes.pdf

Significant Changes to 2024 International Codes:
https://www.larimer.gov/building/2024-building-codes-are-coming/significant-changes-2024-international-codes

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