

2021 Virginia Construction Code

CHAPTER 18 SOILS AND FOUNDATIONS

SECTION 1808 FOUNDATIONS

1808.1 General.

Foundations shall be designed and constructed in accordance with [Sections 1808.2](#) through [1808.9](#). *Shallow foundations* shall satisfy the requirements of [Section 1809](#). *Deep foundations* shall satisfy the requirements of [Section 1810](#).

Exception: One-story detached accessory structures not exceeding 256 square feet (23.78 m²) of *building area*, provided all of the following conditions are met:

1. The *building* eave height is 10 feet (3048 mm) or less.
2. The maximum height from the finished floor level to grade does not exceed 18 inches (457.2 mm).
3. The supporting structural elements in direct contact with the ground shall be placed level on firm soil and when such elements are wood they shall be approved pressure-preservative-treated wood suitable for ground contact use.
4. The structure is anchored to withstand wind loads as required by this code.
5. The structure shall be of light-frame construction with walls and roof of light weight material, not slate, tile, brick or masonry.

1808.2 Design for capacity and settlement.

Foundations shall be so designed that the allowable bearing capacity of the soil is not exceeded, and that differential settlement is minimized. Foundations in areas with expansive soils shall be designed in accordance with the provisions of [Section 1808.6](#).

1808.3 Design loads.

Foundations shall be designed for the most unfavorable effects due to the combinations of *loads* specified in [Section 2.3](#) or [2.4](#) of ASCE 7 or the alternative allowable stress design load combinations of [Section 1605.2](#). The *dead load* is permitted to include the weight of foundations and overlying fill. Reduced *live loads*, as specified in [Sections 1607.12](#) and [1607.14](#), shall be permitted to be used in the design of foundations.

1808.3.1 Seismic overturning.

Where foundations are proportioned using the load combinations of [Section 2.3](#) or [2.4](#) of ASCE 7 and the computation of seismic over turning effects is by equivalent lateral force analysis or modal analysis, the proportioning shall be in accordance with [Section 12.13.4](#) of [ASCE 7](#).

1808.3.2 Surcharge.

Fill or other surcharge *loads* shall not be placed adjacent to any building or structure unless such building or structure is capable of withstanding the additional *loads* caused by the fill or the surcharge. Existing footings or foundations that will be affected by any excavation shall be underpinned or otherwise protected against settlement and shall be protected against detrimental lateral or vertical movement or both.

Exception: Minor grading for landscaping purposes shall be permitted where done with walk-behind equipment, where the grade is not increased more than 1 foot (305 mm) from original design grade or where *approved* by the *building official*.

1808.4 Vibratory loads.

Where machinery operations or other vibrations are transmitted through the foundation, consideration shall be given in the foundation design to prevent detrimental disturbances of the soil.

1808.5 Shifting or moving soils.

Where it is known that the shallow subsoils are of a shifting or moving character, foundations shall be carried to a sufficient depth to ensure stability.

1808.6 Design for expansive soils.

Foundations for buildings and structures founded on expansive soils shall be designed in accordance with [Section 1808.6.1](#) or [1808.6.2](#).

Exceptions: Foundation design need not comply with [Section 1808.6.1](#) or [1808.6.2](#) where one of the following conditions is satisfied:

1. The soil is removed in accordance with [Section 1808.6.3](#).
2. The *building official* approves stabilization of the soil in accordance with [Section 1808.6.4](#).

1808.6.1 Foundations.

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Foundations placed on or within the active zone of expansive soils shall be designed to resist differential volume changes and to prevent structural damage to the supported structure. Deflection and racking of the supported structure shall be limited to that which will not interfere with the usability and serviceability of the structure.

Foundations placed below where volume change occurs or below expansive soil shall comply with the following provisions:

1. Foundations extending into or penetrating expansive soils shall be designed to prevent uplift of the supported structure.
2. Foundations penetrating expansive soils shall be designed to resist forces exerted on the foundation due to soil volume changes or shall be isolated from the expansive soil.

1808.6.2 Slab-on-ground foundations.

Moments, shears and deflections for use in designing slab-on-ground, mat or raft foundations on expansive soils shall be determined in accordance with [WRI/CRSI Design of Slab-on-Ground Foundations](#) or [PTI DC 10.5](#). Using the moments, shears and deflections determined above, nonprestressed slabs-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with [WRI/CRSI Design of Slab-on-Ground Foundations](#) and post-tensioned slab-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with [PTI DC 10.5](#). It shall be permitted to analyze and design such slabs by other methods that account for soil-structure interaction, the deformed shape of the soil support, the plate or stiffened plate action of the slab as well as both center lift and edge lift conditions. Such alternative methods shall be rational and the basis for all aspects and parameters of the method shall be available for peer review.

1808.6.3 Removal of expansive soil.

Where expansive soil is removed in lieu of designing foundations in accordance with [Section 1808.6.1](#) or [1808.6.2](#), the soil shall be removed to a depth sufficient to ensure a constant moisture content in the remaining soil. Fill material shall not contain expansive soils and shall comply with [Section 1804.5](#) or [1804.6](#).

Exception: Expansive soil need not be removed to the depth of constant moisture, provided that the confining pressure in the expansive soil created by the fill and supported structure exceeds the swell pressure.

1808.6.4 Stabilization.

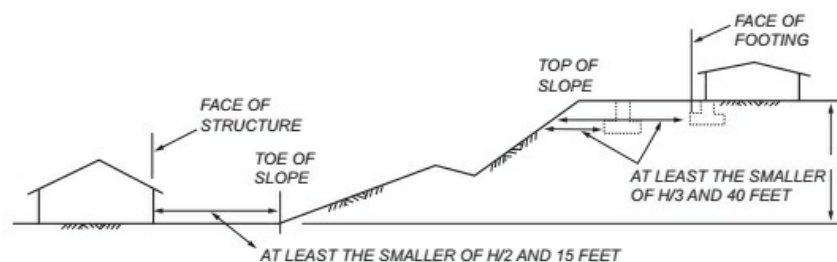
Where the active zone of expansive soils is stabilized in lieu of designing foundations in accordance with [Section 1808.6.1](#) or [1808.6.2](#), the soil shall be stabilized by chemical, dewatering, presaturation or equivalent techniques.

1808.7 Foundations on or adjacent to slopes.

The placement of buildings and structures on or adjacent to slopes steeper than one unit vertical in three units horizontal (33.3-percent slope) shall comply with [Sections 1808.7.1](#) through [1808.7.5](#).

1808.7.1 Building clearance from ascending slopes.

In general, buildings below slopes shall be set a sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures. Except as provided in [Section 1808.7.5](#) and [Figure 1808.7.1](#), the following criteria will be assumed to provide this protection. Where the existing slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the toe of the slope shall be assumed to be at the intersection of a horizontal plane drawn from the top of the foundation and a plane drawn tangent to the slope at an angle of 45 degrees (0.79 rad) to the horizontal. Where a retaining wall is constructed at the toe of the slope, the height of the slope shall be measured from the top of the wall to the top of the slope.



For SI: 1 foot = 304.8 mm.

FIGURE 1808.7.1
FOUNDATION CLEARANCES FROM SLOPES

1808.7.2 Foundation setback from descending slope surface.

Foundations on or adjacent to slope surfaces shall be founded in firm material with an embedment and set back from the slope surface sufficient to provide vertical and lateral support for the foundation without detrimental settlement. Except as provided for in [Section 1808.7.5](#) and [Figure 1808.7.1](#), the following setback is deemed adequate to meet the criteria.

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Where the slope is steeper than 1 unit vertical in 1 unit horizontal (100-percent slope), the required setback shall be measured from an imaginary plane 45 degrees (0.79 rad) to the horizontal, projected upward from the toe of the slope.

1808.7.3 Pools.

The setback between pools regulated by this code and slopes shall be equal to one-half the building footing setback distance required by this section. That portion of the pool wall within a horizontal distance of 7 feet (2134 mm) from the top of the slope shall be capable of supporting the water in the pool without soil support.

1808.7.4 Foundation elevation.

On graded sites, the top of any exterior foundation shall extend above the elevation of the street gutter at point of discharge or the inlet of an *approved* drainage device not less than 12 inches (305 mm) plus 2 percent. Alternate elevations are permitted subject to the approval of the *building official*, provided that it can be demonstrated that required drainage to the point of discharge and away from the structure is provided at all locations on the site.

1808.7.5 Alternate setback and clearance.

Alternate setbacks and clearances are permitted, subject to the approval of the *building official*. The *building official* shall be permitted to require a geotechnical investigation as set forth in [Section 1803.5.10](#).

1808.8 Concrete foundations.

The design, materials and construction of concrete foundations shall comply with [Sections 1808.8.1](#) through [1808.8.6](#) and the provisions of [Chapter 19](#).

Exception: Where concrete footings supporting walls of *light-frame construction* are designed in accordance with [Table 1809.7](#), a specific design in accordance with [Chapter 19](#) is not required.

1808.8.1 Concrete or grout strength and mix proportioning.

Concrete or grout in foundations shall have a specified compressive strength (f'_c) not less than the largest applicable value indicated in [Table 1808.8.1](#).

Where concrete or grout is to be pumped, the mix design including slump shall be adjusted to produce a pumpable mixture.

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 Seismic Design Category A, B or C	2,500 psi
2a. Foundations for Group R or U occupancies of light-frame construction, two stories or less in height, assigned to Seismic Design Category D, E or F	2,500 psi
2b. Foundations for other structures assigned to Seismic Design Category D, E or F	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

For SI: 1 pound per square inch = 0.00689 MPa.

1808.8.2 Concrete cover.

The concrete cover provided for prestressed and nonprestressed reinforcement in foundations shall be not less than the largest applicable value specified in [Table 1808.8.2](#). Longitudinal bars spaced less than 1½ inches (38 mm) clear distance apart shall be considered to be bundled bars for which the concrete cover provided shall be not less than that required by Section 20.5.1.3.5 of [ACI 318](#). Concrete cover shall be measured from the concrete surface to the outermost surface of the steel to which the cover requirement applies. Where concrete is placed in a temporary or permanent casing or a mandrel, the inside face of the casing or mandrel shall be considered to be the concrete surface.

TABLE 1808.8.2
MINIMUM CONCRETE COVER

FOUNDATION ELEMENT OR CONDITION	MINIMUM COVER
1. Shallow foundations	In accordance with Section 20.5 of ACI 318
2. Precast nonprestressed deep foundation elements	
Exposed to seawater	3 inches
Not manufactured under plant conditions	2 inches

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Manufactured under plant control conditions	In accordance with Section 20.5.1.3.3 of ACI 318
3. Precast prestressed deep foundation elements	
Exposed to seawater	2.5 inches
Other	In accordance with Section 20.5.1.3.3 of ACI 318
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

For SI: 1 inch = 25.4 mm.

1808.8.3 Placement of concrete.

Concrete shall be placed in such a manner as to ensure the exclusion of any foreign matter and to secure a full-size foundation. Concrete shall not be placed through water unless a tremie or other method *approved* by the *building official* is used. Where placed under or in the presence of water, the concrete shall be deposited by *approved* means to ensure minimum segregation of the mix and negligible turbulence of the water. Where depositing concrete from the top of a *deep foundation* element, the concrete shall be chuted directly into smooth-sided pipes or tubes or placed in a rapid and continuous operation through a funnel hopper centered at the top of the element.

1808.8.4 Protection of concrete.

Concrete foundations shall be protected from freezing during depositing and for a period of not less than 5 days thereafter. Water shall not be allowed to flow through the deposited concrete.

1808.8.5 Forming of concrete.

Concrete foundations are permitted to be cast against the earth where, in the opinion of the *building official*, soil conditions do not require formwork. Where formwork is required, it shall be in accordance with Section 26.11 of [ACI 318](#).

1808.8.6 Seismic requirements.

See [Section 1905](#) for additional requirements for foundations of structures assigned to *Seismic Design Category C, D, E or F*.

For structures assigned to *Seismic Design Category D, E or F*, provisions of Section 18.13 of [ACI 318](#) shall apply where not in conflict with the provisions of [Sections 1808 through 1810](#).

Exceptions:

1. Detached one- and two-family dwellings of *light-frame construction* and two stories or less above *grade plane* are not required to comply with the provisions of Section 18.13 of [ACI 318](#).
2. Section 18.13.4.3(a) of [ACI 318](#) shall not apply.

1808.9 Vertical masonry foundation elements.

Vertical masonry foundation elements that are not *foundation piers* as defined in [Section 202](#) shall be designed as piers, walls or columns, as applicable, in accordance with [TMS 402](#).