**Section 1817 through Section 1834 Florida Specific for the HVHZ**

**SECTION 1817**

**HIGH-VELOCITY HURRICANE ZONES –**

**EXCAVATIONS**

1817.1 General. Until provisions for permanent support have been made, all excavations shall be properly guarded and protected so as to prevent them from becoming dangerous to life and property and shall be sheet piled, braced and/or shored, where necessary, to prevent the adjoining earth from caving in; such protection to be provided by the person causing the excavation to be made. All excavations shall comply with the minimum requirements of Section 553.60, Florida Statute "Trench Safety Act," and 29 CFR 1926-650 (P) "Occupational Safety and Health Administration Excavation Safety Act." No excavation, for any purpose, shall extend within 1 foot (305 mm) of the angle of repose of any soil bearing footing or foundation unless such footing or foundation is first properly underpinned or protected against settlement.

1817.2 Permanent excavations. No permanent excavation shall be made nor shall any construction excavations be left on any lot that will endanger adjoining property or buildings or be a menace to public health or safety. Any such excavations made or maintained shall be properly drained and such drainage provisions shall function properly as long as the excavation exists. Permanent excavations shall have retaining walls of steel, masonry, concrete or similar approved material of sufficient strength to retain the embankment together with any surcharged loads.

1817.3 Enforcement. Where, in the opinion of the building official, an unsafe condition may result or damage may occur as the result of an excavation, he or she may order the work stopped or may approve the work of excavation subject to such limitations, as he or she may deem necessary.

**SECTION 1818**

**HIGH-VELOCITY HURRICANE ZONES—**

**BEARING CAPACITY OF SOIL**

1818.1 Design bearing capacity. Plans for new buildings, structures or additions shall clearly identify the nature of the soil under the structure and the allowable bearing capacity used in sizing the building foundation support system.

Exception: See Section 1822.1 for plans for new buildings, structures or additions that are to be supported on a piling foundation system.

1818.2 Allowable bearing capacity. Prior to the installation of any footing foundation system for new buildings, structures or additions, the building official shall be provided with a statement of allowable bearing capacity from an architect or professional engineer. Said statement shall clearly identify the allowable in-place bearing capacity of the building pad for the new building or addition and verify the existing soil conditions. The certified in-place bearing capacity shall have been determined using recognized tests or rational analysis and shall meet or exceed the design bearing capacity identified under Section 1818.1.

**SECTION 1819**

**HIGH-VELOCITY HURRICANE ZONES—**

**SOIL BEARING FOUNDATIONS**

1819.1 General. Footings shall be constructed of reinforced concrete, as set forth in Chapter 19 (High-Velocity Hurricane Zones) of this code and in this section, and shall, insofar as is practicable, be so designed that the soil pressure shall be reasonably uniform to minimize differential settlement.

1819.2 Continuous wall footings.

1819.2.1 Footings under walls shall be continuous or continuity otherwise provided and shall be not less than required to keep the soil pressure within that set forth in Section 1818 nor less than the following minimums:

|  |  |  |
| --- | --- | --- |
| **Allowable bearing capacity pounds per square foot** | **No. of Stories** | **Minimum Depth and Width2 (inches)** |
| 2000 2000 | 1 2 | 12 × 161 12 × 24 |

|  |
| --- |
| For SI: 1 inch = 25.4 mm; 1 pound per square foot 47.89 Pa.   Based on rational analysis and soil investigation as set forth in section [Section 1818](http://ecodes.citation.com/cgi-exe/cpage.dll?pg=x&rp=/indx/ST/fl/st/b200v07/st_fl_st_b200v07_18.htm&sid=2010122312103388048&aph=0&cid=iccf&uid=icsc0418&clrA=005596&clrV=005596&clrX=005596&ref=/nonindx/ST/fl/st/b200v07/index.htm#b=1818), the footing size or bearing capacity may vary, but the minimum width of a footing under the main walls of the building shall not be less than 16 inches nor less than 8 inches more than the width of the wall.   NOTES:   1. For single-story wood frame exterior walls, the minimum size continuous footing shall be 16 inches deep × 24 inches wide.   2. Any continuous wall footing acting as a shear wall foundation shall be specifically designed for that purpose. |

1819.2.2 Masonry fences, flower bins, steps and similar decorative structures shall have reinforced concrete foundations designed for all live, dead and wind loads as set forth in Chapter 16 (High-Velocity Hurricane Zones) of this code. The minimum size of these foundations shall be as follows:

|  |  |  |
| --- | --- | --- |
| **Allowable bearing capacity (pounds per square foot)** | **Unbraced Wall Above Grade (ft)** | **Minimum Depth and Width2 (inches)** |
| 2,000   2,000   2,000 | Less than or equal to 3 feet Greater than 3 feet but less than and including 6 feet Greater than 6 feet | 12 x 16   12 x 36   None Provided1 |

|  |
| --- |
| For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot = 47.88 kPa.   NOTES:   1. Foundations for masonry fences, flower bins, steps and similar decorative structures with unbraced heights in excess of six feet shall be based on rational analysis.   2. The minimum continuous footings specified in this section shall be reinforced in accordance with Section 1819.3. |

1819.2.3 Based on rational analysis and soil investigation as set forth in Section 1818, the footing size or bearing capacity may vary, but the minimum width of a footing under masonry fences, flower bins, steps and similar decorative structures shall not be less than 16 inches (406 mm) nor less than 8 inches (203 mm) more than the width of the wall.

Exception: Masonry fences, wing walls and other similar walls that are exposed to lateral wind forces and do not have any lateral restraint above grade, shall have their continuous wall footings placed so the top of footing is no less than 16 inches (406 mm) below grade.

1819.3 The minimum continuous footings specified in this section shall be reinforced as follows:

|  |  |
| --- | --- |
| **Reinforcing** | **Foundation Width** |
| 2 # 5 3 # 5 4 # 5 | 16" and 20" wide 24" and 30" wide 36" wide |

1819.3.1 Where footings are 30 inches (762 mm) or more in width, cross bars designed to resist bending at the face of the foundation wall shall be provided.

1819.3.1.1 Equivalent areas in #4 reinforcing bars may be substituted for the sizes as specified in Section 1819.3.

1819.3.1.2 Splices in reinforcing bars shall be not less than 36 bar diameters and reinforcement shall be continuous around all corners and changes in direction. Continuity shall be provided at corners or changes in direction by bending the longitudinal steel around the corner 48 bar diameters or by adding matching reinforcing steel, which shall extend 48 bar diameters from each corner or change in direction When three or more bars are required, the bars shall be held in place and aligned by transverse bars spaced not more than 4 feet (1219 mm) apart.

1819.3.1.3 The reinforcement for footings and other principal structural members in which concrete is deposited against the ground shall have not less than 3 inches (76 mm) of concrete between the reinforcement and the ground contact surface. If concrete surfaces after removal of the forms are to be exposed to the weather or be in contact with the ground, the reinforcement shall be protected with not less than 2 inches (51 mm) of concrete for bars larger than #5 and 11/2 (38 mm) for #5 or smaller bars.

1819.3.1.4 Excavations for continuous footings shall be cut true to line and grade and the sides of footings shall be formed, except where soil conditions are such that the sides of the excavation stand firm and square. Excavations shall be made to firm, clean bearing soil.

1819.4 Continuous footings shall be placed level and any changes in the grade of such footings shall be made with a vertical tie of the same cross section and design as the footings, or the smaller of the footings, so joined.

1819.4.1 Continuous footings with eccentric loading shall be designed to limit the soil pressure at the edges to within acceptable values by means of counterbalancing or by other approved methods.

1819.4.2 When foundation walls are to be poured separately from the footing, they shall be keyed and doweled to the footing with no less than #4 dowels, 20 diameters in length above and below the joint, spaced not more than 4 feet (1219 mm) apart. Where footing depth does not allow straight dowels, standard hooks will be allowable.

1819.4.3 Concrete footing and pads shall not receive superimposed loads until 12 hours or more after the concrete is placed.

1819.4.4 Excavations for footings and foundations, which are to serve as forms, shall be thoroughly wetted prior to the placement of concrete.

1819.4.5 The top of all continuous footings shall be a minimum of 8 inches (203 mm) below grade.

1819.5 Isolated footings. Dimensions for an isolated footing shall not be less than 12 inches (305 mm) deep and 24 inches square (.02 m2). Isolated footings in soil having low lateral restraint and isolated piers shall be provided with adequate bracing to resist lateral movement.

1819.5.1 Isolated footings with eccentric loading shall be designed to limit the soil pressure at the edges by means of footing straps or other approved methods.

1819.5.2 When isolated footings support reinforced concrete columns, dowels equivalent in number and area to the column reinforcement and having a length not less than 36 diameters above and below the joint shall be provided in the footing. Where the footing depth precludes straight dowels, standard ACI hooks will be allowable. Such dowels, or anchor bolts as required for steel columns, shall be held to proper grade and location during the pouring of the footing by means of templates or by other approved methods.

1819.5.3 The top of all isolated footings shall be a minimum of 8 inches (203 mm) below grade.

1819.5.4 Any isolated footing subjected to uplift and/or overturning forces shall be specifically designed for that purpose, as set forth in Section 1620.

1819.6 Lateral sliding resistance. The resistance of structural walls to lateral sliding shall be calculated by combining the values derived from the lateral bearing and the lateral sliding resistance shown in Table 1819.6 unless data to substantiate the use of higher values are submitted for approval. For clay, sandy clay and clayey silt, in no case shall the lateral sliding resistance exceed one-half the dead load.

**TABLE 1819.6 ALLOWABLE LATERAL PRESSURE**

|  |  |  |  |
| --- | --- | --- | --- |
| **CLASS OF MATERIALS** | **LATERAL BEARING (psf/ft BELOW NATURAL GRADE)** | **LATERAL SLIDING** | |
| **Coefficient of Friction (a)** | **Resistance (psf)(b)** |
| 1. Sedimentary and foliated rock 2. Sandy gravel and/or gravel 3. Sand, silty sand, clayey sand, silty gravel land clayey gravel 4. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt | 400 200 150 100 | 0.35 0.35 0.25 | 130 |

|  |
| --- |
| For SI: 1 pound per square foot = 47.88 Pa.   NOTES:   a. Coefficient to be multiplied by the dead load.   b. Lateral sliding resistance to be multiplied by the contact area, as limited by Section 1819.6. |

1819.6.1 Increases in allowable lateral sliding resistance. The resistance values derived from the table may be increased by the tabular value for each additional foot of depth to a maximum of 15 times the tabular value. Isolated poles for uses such as flagpoles or signs and poles used to support buildings which are not adversely affected by 1/2-inch (12.7 mm) motion at the ground surface because of short-term lateral loads may be designed using lateral bearing values equal to two times the tabular values.

1819.7 Designs employing lateral bearing. Designs to resist lateral loads employing posts or poles as columns embedded in earth or embedded in concrete footings in the earth shall conform to the requirements of Sections 1819.7.1 through 1819.7.2.1.

1819.7.1 Limitation. Posts embedded in earth shall not be used to provide lateral support for structural or non structural materials such as plaster, masonry or concrete unless bracing is provided that develops the limited deflection required.

1819.7.2 Design criteria. The depth to resist lateral loads shall be determined by the design criteria in Sections 1819.7.2.1 through 1819.7.2.2 or by other methods approved by the building official.

1819.7.2.1 Unconstrained. The following formula shall be used in determining the depth of embedment required to resist the lateral loads where no constraint is provided at the ground surface, such as a structural diaphragm.

d = 0.5A {1 + [1 + (4.36h / A )]1/2}

Where:

A = 2.34P /(S 1b )

b = diameter of round post or diagonal dimension of square post or footing, feet.

d = depth of embedment in earth in feet but not over 12 feet (3658 mm) for purpose of computing lateral pressure.

h = distance in feet from ground surface to point of application of P .

P = applied lateral force, pounds.

S 1 = Allowable lateral soil-bearing pressure as set forth in Table 1819.6 based on a depth of one-third the depth of embedment, pounds per square foot.

S 3 = Allowable lateral soil-bearing pressure as set forth in Table 1819.6 based on a depth equal to the depth of embedment, pounds per square foot.

1819.7.2.2 Constrained. The following formula shall be used in determining the depth of embedment required to resist the lateral loads where constraint is provided at the ground surface, such as a rigid floor or rigid ground surface pavement.

d 2 = 4.25(Ph / S 3b )

or alternately

d 2 = 4.25(Mg / S 3b )

Where:

Mg = Moment in the post at grade, foot-pounds.

**SECTION 1820**

**HIGH-VELOCITY HURRICANE ZONES-CONCRETE SLABS ON FILL**

1820.1 Concrete floors placed directly on the supporting soil shall comply with this section.

1820.2 Where it is proposed to place concrete slabs directly on the supporting soil, a subgrade shall be thoroughly compacted by approved methods. All fill placed under slabs shall be clean sand or rock, free of debris and other deleterious materials. The maximum size of rock within 12 inches (305 mm) below the floor slab in compacted fill shall be 3 inches (76 mm) in diameter. Where fill material includes rock, large rocks shall not be allowed to nest and all voids shall be carefully filled with small stones or sand, and properly compacted.

1820.3. Concrete floor slabs placed directly on the supporting soil shall be a minimum of 4 inches (102 mm) in thickness, reinforced with not less than 0.028 square inches (18 mm2) of reinforcing per linear foot of slab in each direction.

1820.3.1 Fill supporting such slabs shall be compacted under the supervision of a special inspector to a minimum of 95 percent of maximum dry density for all layers, as verified by field density tests specified in Section1820.3.2.

1820.3.2 Tests shall be made in accordance with Methods of Test for Moisture Density Relations of Soils, ASTM D 1557 modified to use 25 blows on five layers with a 10-pound (5 kg) hammer dropping 18 inches (457 mm). In addition, a minimum of one in-place field density test shall be performed for each 2,500 square feet (232 m2), or fraction thereof, for each lift of compacted soil, and such testing shall be performed in accordance with either ASTM D 1556, Standard Test Method for Density of Soil In-Place by the Sandcone; or ASTM D 2922, Standard Test Methods for Density of Soil and Soil Aggregate in-place by Nuclear Methods (Shallow Depth), or other approved methods.

1820.3.3 Where a concrete slab is supported by a foundation wall or continuous footing, the effect of the support shall be considered in the design.

1820.3.4 All concrete slab edges and concrete beams supporting exterior walls shall be recessed a minimum of 3/4 inch (19 mm) below top of slab for a width of the exterior wall, or provided with an alternate water-stop method approved by the building official.

1820.3.5 The discontinuous edges of all slabs surrounding swimming pools and floor slabs for screen patios and utility sheds shall be at least a minimum of 8 inches (203 mm) deep and 8 inches (203 mm) wide and shall be reinforced with one continuous #5 bar.

1820.3.6 Reinforced concrete slabs on fill for garbage containers shall be a minimum of 1 foot (305 mm) larger on all sides than the garbage receptacle (dumpster) and a minimum thickness of 6 inches (152 mm).

1820.4 When polyethylene sheets are used as a vapor barrier beneath a ground floor slab, the subgrade for that slab shall be considered a formed surface for the purpose of reinforcing steel coverage.

1820.5 Concrete slabs outside of buildings, other than patios and pool slabs, where placed directly on the supporting soil, for minor accessory uses such as, but not limited to, walkways, driveways, minor equipment pads, etc, shall be not less than 4 inches (102 mm) thick. Such slabs shall be placed on clean, thoroughly compacted sand or crushed rock free from organics, debris or other deleterious materials.

**SECTION 1821**

**HIGH-VELOCITY HURRICANE ZONES-**

**MONOLITHIC FOOTINGS**

1821.1 Monolithic footings under walls shall be continuous or continuity otherwise provided and shall be not less than required to keep the soil pressure within that set forth in Section 1818 nor less than the following minimums:

|  |  |  |
| --- | --- | --- |
| **Allowable bearing capacity (Pounds per square foot)** | **No. of Stories** | **Minimum Depth and Width(2)(inches)** |
| 2000 2000 | 1 2 | 12 x 16(1) 12 x 24 |

|  |
| --- |
| For SI: 1 inch = 25.4 mm, 1 pound per square foot = 47.88 Pa. |

Based on rational analysis and soil investigation as set forth in Section 1818, the footing size or bearing capacity may vary, but the minimum width of a footing under the main walls of the buildings shall not be less than 16 inches nor less than 8 inches more than the width of the foundation wall.

NOTES:

(1) For single story wood frame exterior walls, the minimum size continuous footing shall be 16 inches deep x 24 inches wide.

(2) Any continuous wall footing acting as a shear wall foundation shall be specifically designed for that purpose.

1821.1.1 A minimum outside finish grade of 8 inches (203 mm) above the bottom of the exterior monolithic footing shall be required, but in no case shall the outside finish grade be above the top of the finish slab surface unless sufficient means to minimize moisture intrusion into the structure have been provided to the satisfaction of the building official.

1821.1.2 Continuous monolithic footings shall be placed level and any change in the grade of such footings shall be made with a step of the same cross section and design as the monolithic footings, or the smaller of the monolithic footings, so joined.

1821.1.3 Continuous monolithic footings with eccentric loading shall be designed to limit the soil pressure at the edges to within acceptable values by means of counterbalancing or by other approved methods.

1821.1.4 Concrete monolithic footings and pads shall not receive superimposed loads until 12 hours or more after the concrete is placed.

1821.1.5 Excavations for monolithic footings and foundations, which are to serve as forms, shall be thoroughly wet prior to placing concrete.

1821.1.6 Monolithic foundation systems shall be limited for the support of a maximum of two stories and/or floors or a maximum mean roof height of 25 feet (7620 mm) above grade unless the monolithic foundation system has been designed by a professional engineer and ample consideration has been given to the eccentric loading, foundation rotation and shear cracking at the slab/foundation interface.

1821.1.7 The minimum continuous monolithic footings specified in this section shall be reinforced as follows:

|  |  |
| --- | --- |
| **Reinforcing** | **Minimum Width Foundation (in.)** |
| 2 # 5 3 # 5 4 # 5 | 16" and 20" wide 24" and 30" wide 36" wide |

|  |
| --- |
| For SI: 1 inch = 25.4 mm. |

1821.1.8 Where footings are 30 inches (762 mm) or more in width, cross bars designed to resist bending at the face of the foundation wall shall be provided.

1821.1.9 Equivalent areas in #4 reinforcing bars may be substituted for the sizes as specified in Section 1821.1.7.

1821.1.10 Splices in reinforcing bars shall be not less than 36 bar diameters and reinforcement shall be continuous around all corners and changes in direction. Continuity shall be provided at corners or changes in direction by bending the longitudinal steel around the corner 48 bar diameters or by adding matching reinforcing steel, which shall extend 48 bar diameters from each corner or change in direction. When three or more bars are required, the bars shall be held in place and alignment by transverse bars spaced not more than 4 feet (1219 mm) apart.

1821.1.11 The reinforcement for monolithic footings and other principal structural members in which concrete is deposited against the ground shall have not less than 3 inches (76 mm) of concrete between the reinforcement and the ground contact surface. If concrete surfaces after removal of the forms are to be exposed to the weather or be in contact with the ground, the reinforcement shall be protected with not less than 2 inches (51 mm) of concrete for bars larger than #5 and 11/2 inches (38 mm) for #5 or smaller bars.

1821.1.12 Excavations for continuous monolithic footings shall be cut true to line and grade and the sides of footings shall be formed, except where soil conditions are such that the sides of the excavation stand firm and square. Excavations shall be made to firm, clean bearing soil.

1821.1.13 Unless otherwise determined by rational analysis, monolithic footings shall have transfer reinforcement along the perimeter of the foundation. Said reinforcement shall be no less than #4 reinforcing steel bars spaced no greater than 12 inches (305 mm) on center and shall be no less than 5 feet (1524 mm) in length plus a standard ACI hook and shall be placed to transfer into the slab section commencing at a point no less than 3 inches (76 mm) from the edge form.

**SECTION 1822**

**HIGH-VELOCITY HURRICANE ZONES-PILE FOUNDATIONS**

1822.1 Pile foundations shall be designed and installed on the basis of a geotechnical exploration which shall include field and/or laboratory tests.

1822.1.1 Piles used for the support of any building or structure shall be driven to a resistance and penetration in accordance with the plans and/or specifications as set forth herein.

1822.1.2 Piles may be jetted under the supervision of a professional engineer. Immediately after completion of jetting, piles shall be driven below the depth jetted to the required resistance, but not less than 1 foot (305 mm), or to nominal refusal whichever comes first. No jetting will be permitted that may be detrimental to existing adjacent structures or piles that have been driven.

1822.1.3 When isolated columns, piers and other loads are supported on piles, a minimum of three piles shall be used for such support unless lateral bracing is provided at the pile cap to insure stability. Should a pile group be loaded eccentrically so as to produce an overload on any pile more than 10 percent of the allowable load, footing straps or other approved methods shall be required to counteract the effect of eccentric loading.

1822.1.4 The minimum center-to-center spacing of piles shall be not less than twice the average diameter of round piles or 13/4 times the diagonal dimensions of rectangular piles but in no case less than 30 inches (762 mm). Piles supporting structural walls shall have dowels installed to offer sufficient resistance for lateral restraint of a grade beam.

1822.1.5 Nonfluid soil shall be considered as providing full lateral support against column action. The portion of a pile that extends through air, water, fluid soil or other unstable material shall be designed as a structural column. Soils having a consistency stiffer than fluid soil may be considered as capable of providing lateral support. Where cast-in-place piles are used reinforcement shall extend 10 feet (3048 mm) below the plane where the soil provides lateral restraint. Sufficient reinforcement for all types of piles shall be provided at the junction of the pile and pile cap or grade beam to make a suitable connection. Shells conforming to Section 1826.1 may be considered as reinforcement.

1822.1.6 Reinforced concrete caps shall be provided for all pile clusters and such caps shall extend laterally not less than 6 inches (152 mm) beyond the extreme pile surface and vertically not less than 4 inches (102 mm) below the pile butt. Pile caps may be omitted when piles are used to support grade beams, provided that the spacing of Section 1822.1.4 is complied with, and provided that the portions of the grade beams acting in place of the pile cap shall be computed by a recognized method of analysis to properly carry the loads.

1822.1.7 Piles shall be driven using an approved cushion block consisting of material arranged to provide transmission of hammer energy equivalent to one-piece hardwood with the grain parallel to the axis of the pile and enclosed in a metal housing to prevent its lateral deformation between the hammer ram and the top of the pile.

1822.1.8 Friction piles shall be driven to a minimum penetration of 12 feet (3658 mm) below the cutoff or the existing ground, whichever is the lower.

1822.1.9 Diesel hammers may be used for driving piles if provided with one of the following means of determining the energy of the hammer's blow.

1822.1.10 Closed-top diesel hammers shall be used with a rating instrument and charts to measure the equivalent WH energy per blow of the hammer. The equivalent WH energy as measured by the instrument shall be the ram's weight times the equivalent ram plus an added value obtained from the energy stored in the bounce chamber. The energy per blow shall be the equivalent WH energy for the closed-top diesel.

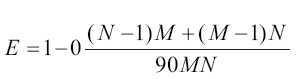
1822.1.11 Open-top diesel hammers shall be equipped with a ram stroke indictor rod that is striped in increments above the hammer body and fastened to the body of the hammer. The energy per blow for the open top diesel shall be computed as the ram's working stroke times the ram's weight.

1822.1.12 The load-bearing formula applicable for single-acting pile hammers shall be used to compute the bearing capacity of the driven pile.

1822.1.13 Followers shall be used only upon permission of the special inspector or engineer and only where necessary to effect installation of piles. A follower shall be of a size, shape, length, material and weight to permit driving the pile in the desired location and to the required depth and resistance without loss of hammer energy in the follower.

1822.1.14 Splices shall be avoided as far as practicable. Splices shall be constructed to provide and maintain true alignment and position of the component parts of the pile during installation and subsequent thereto. Splices shall develop the required strength of the pile.

1822.1.15 The safe capacity of a group of friction piles in plastic material may be determined by load testing the group to 150 percent of the proposed group load or by the formula given in Section 1822.2. When computed by formula, the allowable load for such a group shall be the allowable load for one pile times the number of piles in the group times the efficiency of the pile group determined as follows:



Where:

E = is the efficiency

S = the average spacing of the piles, inches

M = the number of rows

N = the number of piles in one row

D = the average diameter of the pile, inches

O = arc tan D /S , in degrees

1822.1.16 Types of piles that are not provided for in this section shall conform to the requirements herein for the type that it most nearly approximates, subject to such additional requirements as may be made by the building official.

1822.1.17 Pile driving hammers shall develop a minimum of 1 foot-pound of energy per pound of pile or mandrel, but not less than 7,000 foot-pounds of energy per blow.

1822.1.18 Piles may be driven with drop or gravity hammers provided the hammer shall weigh not less than 3,000 pounds (1362 kg) and the fall of the hammer shall not exceed 6 feet (1829 mm).

1822.1.19 Piles shall be driven with a variation of not more than 1/4 (6 mm) inch per foot from the vertical, or from the batter line indicted, with a maximum variation of the head of the pile from the position shown on the plans of not more than 3 inches (76 mm), subject to the provisions of Section 1822.1.3.

1822.1.20 The special inspector or engineer supervising the pile driving operations shall be required to keep an accurate record of the material and the principal dimensions of each pile; of the weight and fall of the hammer, if a single-acting hammer or drop hammer; the size and make, operating pressure, length of hose, number of blows per minute and energy per blow, if a double-acting hammer; together with the average penetration of each pile for at least the last five blows, and the grades at tip and cut-off. A copy of these records shall be filed with the building official and kept with the plans.

1822.1.21 Where piling must penetrate strata offering high resistance to driving or where jetting could cause damage, the inspector or supervising engineer may require that the piles be set in predrilled or punched holes. The equipment used for drilling or punching must be approved by the special inspector or engineer, and provided that all piles shall reach their final penetration by driving.

1822.1.22 The maximum load permitted on any driven pile shall not exceed 36 tons unless substantiated by a load test performed at the site, as set forth in Section 1829.

1822.1.23 The building official may require tests on any pile where performance is questionable.

1822.1.24 Piles shall be designed and driven to develop not less than 10 tons safe bearing capacity.

1822.1.25 In soils in which the installation of piles causes previously installed piles to heave, accurate level marks shall be put on all piles immediately after installation and all heaved piles shall be reinstalled to the required resistance.

1822.1.26 Piles shall not be driven closer than 2 feet (610 mm) nor jetted closer than 10 feet (3048 mm) to an existing building or structure unless approved by a special inspector or engineer.

1822.2 Driving formula load. Subject to pile load limitations contained in Sections 1823.1.8 and 1824.1.2 and in the absence of pile load test data satisfactory to the building official, the load on a pile shall not exceed that computed from the following driving formula:

Drop Hammer:

|  |
| --- |
| No alternative description is available for this graphic. Call Citation client support at 1-800-808-3372 for further assistance. |

Single Acting Hammers:

|  |
| --- |
| No alternative description is available for this graphic. Call Citation client support at 1-800-808-3372 for further assistance. |

Double Acting Hammers:

|  |
| --- |
| No alternative description is available for this graphic. Call Citation client support at 1-800-808-3372 for further assistance. |

Or differential in which:

A = area of piston, square inches

p = pressure at the hammer, pounds per square inch

P = allowable total load, pounds

W = weight of striking part of hammer, pounds

H = height of fall of striking part of hammer, feet, or stroke, feet

S = average penetration per blow of not less than the five final blows

**TABLE 1823**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SPECIES** | **COMPRESSION PARALLEL TO GRADE (psi)**4 | **BENDING (psi)**4 | **SHEAR HORIZ (psi)**4 | **COMP PERP TO GRAIN (psi)**4 | **MODULUS OF ELASTICITY** |
| Pacific Coast     Douglas Fir1 Southern Pine2 Red Oak3 Red Pine4 | 1,250 1,200 1,100 900 | 2,450 2,400 2,450 1,900 | 115 110 135 85 | 230 250 350 155 | 1,500,000 1,500,000 1,250,000 1,280,000 |

|  |
| --- |
| For SI: 1 pound per square inch = 0.0068 MPa.   1. Pacific Douglas Coast Fir values apply only to species as defined in ASTM Designation 01760-76, Standard Specification for Pressure Treatment of Timber Products. For faster design, use Douglas Fir-Larch design values.   2. Southern Pine values apply to Longleaf, Slash, Loblolly and Short Leaf Pines.   3. Red Oak values apply to Northern and Southern Red Oak.   4. Red Pine values apply to Red Pine grown in the United States. |

**SECTION 1823**

**HIGH-VELOCITY HURRICANE ZONES-WOOD PILES**

1823.1 Woodpiles shall conform to ASTM D 25, Round Timber Piles.

1823.1.1 Untreated wood piles in all cases shall be cut off not higher than mean low water table and shall be capped with concrete.

1823.1.2 Timber piles used to support permanent structures shall be treated in accordance with this section unless it is established that the top of the untreated timber piles will be below lowest ground water level assumed to exist during the life of the structure.

1823.1.3 Preservative and minimum final retention shall be in accordance with AWPA C3.

1823.1.4 When timber piles are used in salt water, the treatment shall conform to AWPA MP-1, MP-2 or MP-4. Pile cutoffs shall be treated in accordance with AWPA M-4.

1823.1.4.1 All preservative-treated wood piles shall have a metal tag, brand or other preservative treatment identification mark.

1823.1.4.2 Such mark shall identify the producer, and/or the appropriate inspection agency, and treatment specifications or quality mark.

1823.1.5 Wood piles which support a structure over water may project above the water to such height as may be necessary for structural purposes, provided that such piles used to support structures other than open wharves, boat landings, and other similar light structures shall have been treated in accordance with Section 1823.1.2

1823.1.6 Wood piles shall be driven with a protective driving cap or ring when necessary to prevent brooming or splitting of the butt. When brooming or splitting occurs, such piles shall be cut back to solid wood before the final resistance to penetrations is measured.

1823.1.7 If required, when driving through or to hard material or to rock, wood piles shall be fitted with a metal protective driving cap shown satisfactory to the building official.

1823.1.8 The maximum allowable load on a round timber pile shall be determined in accordance with Section 1822.1.22, provided the maximum allowable stresses of timber are not exceeded.

1823.1.8.1 The allowable stresses for timber piles shall not exceed the values in Table 1823 except as modified by Part 6 of the National Design Specification for Wood Construction.

**SECTION 1824**

**HIGH-VELOCITY HURRICANE ZONES-PRECAST CONCRETE PILES**

1824.1 Precast concrete piles shall be cast of concrete having a compressive strength of not less than 3,000 pounds per square inch (psi) (21 MPa) at the time of driving, and shall be reinforced with a minimum of four longitudinal steel bars having an area of not less than 1 percent nor more than 4 percent of the gross concrete area. All longitudinal bars shall be of uniform size and shall be tied by not less than #2 hoops spaced 8 inches (203 mm) in the body of the pile and not over 3 inches (76 mm) for the first 18 inches (437 mm) from both the butt and the tip. All reinforcement shall be protected by 2 inches (51 mm) or more of concrete, except that for piles subjected to the action of open water, waves or other severe exposure, a 3-inch (76 mm) protective covering shall be furnished in the zone of such exposure. For point bearing piles, the concrete area of the tip shall be not less than 75 percent of the area of the butt.

1824.1.1 All precast concrete piles shall have their date of manufacture and the lifting points clearly marked on the pile. Concrete piles shall not be driven until they have attained their full specification strength as verified by tests, nor shall the piles be removed from the forms until 50 percent of the specification strength has been attained. Piles shall not be transported nor driven until they have been cured not less than seven days for Type I cement and three days for Type III cement.

1824.1.2 In the absence of load tests, the maximum allowable load per pile shall not exceed the values set forth in Table 1824.

**TABLE 1824**

|  |  |
| --- | --- |
| **SIZE (INCHES)** | **MAXIMUM LOAD (TONS)** |
| 10 x 10 12 x 12 14 x 14 | 17 25 35 |

|  |
| --- |
| For SI: 1 inch = 25.4 mm. |

**SECTION 1825**

**HIGH-VELOCITY HURRICANE ZONES-**

**PRESTRESSED PRECAST CONCRETE PILES**

1825.1 Prestressed precast concrete piles shall conform to Chapter 19 (High-Velocity Hurricane Zones) and to Sections 1822.1.1, 1822.2, 1824 and 1828 except as specifically detailed in this section.

1825.1.1 Prestressed concrete piles shall be cast of concrete having a compressive strength of not less than 5,000 psi (34 MPa) at time of driving and 3,000 psi (21 MPa) before transfer of the prestressing force. The prestressing elements shall not be stressed initially in excess of 75 percent of ultimate strength. The elements shall transfer a compressive stress to the concrete, after losses, of not less than 0.08 percent of the specified strength at driving. Under loads other than handling no tension will be permitted in the concrete.

1825.1.2 Longitudinal reinforcing shall be protected by 2 inches (51 mm) of concrete and shall be tied by #2 hoops or #5 AS&W gauge spirals spaced at 8 inches (203 mm) in the body of piling 14 inches (356 mm) or smaller or 9 inches (22 mm) in the body of piling 16 inches (76 mm) or larger and not over 3 inches (76 mm) for the first 18 inches (457 mm) from both the butt and the tip.

**SECTION 1826**

**HIGH-VELOCITY HURRICANE ZONES-CAST-IN-PLACE**

1826.1 Cast-in place concrete piles shall consist of a steel shell driven in intimate contact with the surrounding soil and left in place and filled with concrete. Steel shells may be uniformly tapered, step-tapered, cylindrical or a combination of such shapes and may be laterally corrugated, spirally corrugated, longitudinally fluted or plain.

1826.1.1 Pile shells and end closures shall be of sufficient strength and rigidity to permit their driving in keeping with the driving method used, and to prevent harmful distortion caused by soil pressures or the driving of adjacent piles until filled with concrete. A reduction of cross sectional area in excess of 15 percent shall be cause for rejection. The shells shall also be sufficiently water tight to exclude water during the placing of concrete.

1826.1.2 The minimum diameter shall be 8 inches.

1826.1.3 Concrete for cast-in-place piles shall develop a compressive strength of not less than 3,000 psi (21 MPa) in 28 days. The concrete shall be deposited in a continuous operation to insure a full-sized pile without voids or separation. Concrete shall be placed in the dry. The pile may be sealed by depositing concrete by tremie or other approved method.

1826.1.4 Splices of shell sections shall be designed to insure the alignment of the shells and develop the full strength of the shell station.

1826.1.5 The load on the shell shall not exceed 25 percent of the minimum average tensile yield strength of the steel multiplied by the area of the shell.

1826.1.5.1 Shells having a wall thickness of 0.119 inch (3 mm) or more may be considered as carrying part of the load.

1826.1.5.2 Adequate allowance for corrosion shall be considered in the design but not less than the outer inch of the shell thickness shall be deducted before computing the area of the shell considered as carrying load.

1826.1.5.3 The metal for the shells shall conform to the Standards of Welded and Seamless Steel Pipe Piles, Grade 2, ASTM A 252, for Hot-Rolled Carbon Steel Sheets and Strip of Structural Quality, ASTM A 570 and Carbon Structural Steel, Cold-Rolled Sheet, ASTM A 611.

1826.1.5.4 The yield strength used in design shall be that of the material in the fabricated shell.

1826.1.6 For friction piles, the allowable load shall be computed at the cross section located at a point two-thirds of the embedded length of the pile, in material providing suitable lateral support, measured upward from the tip. The load on the concrete shall not exceed 25 percent of the 28-day strength of the concrete multiplied by the concrete area.

1826.1.7 For end-bearing piles, the concrete area of the critical section shall be such that the unit stress on the concrete does not exceed 0.25 f ¢c under the pile load. The area of the shell and the critical section of the concrete shall be taken at the elevation where the pile enters the stratum furnishing and bearing.

**SECTION 1827**

**HIGH-VELOCITY HURRICANE ZONES-ROLLED STRUCTURAL SHAPES**

1827.1 Rolled structural steel piles shall conform to the Standards for general requirements for Hot-Rolled and Cold-Finished Carbon and Alloy Steel Bars, ASTM A 29, and Carbon Steel Bars Subject to Mechanical Property Requirements, ASTM A 306, except that copper may be added to increase the corrosion-resistant properties of the material.

1827.1.1 Sections of such pile of H form shall have flange projections not exceeding 14 times the thickness of web or flange and total flange width not less than 85 percent of the depth of the section.

1827.1.2 No section shall have a nominal thickness of metal less than 3/8 inch (10 mm).

1827.1.3 For end-bearing piles, the allowable stress may be determined on the basis of an allowable stress of 25 percent of the yield value of the steel.

1827.1.4 In the absence of adequate corrosion protection, 1/16 inch (1.6 mm) shall be deducted from each face in determining the area of the pile section.

1827.1.5 The allowable load, when used as friction piles, shall be determined by load tests at the site.

**SECTION 1828**

**HIGH-VELOCITY HURRICANE ZONES-SPECIAL PILES OR SPECIAL CONDITIONS**

1828.1 The use of types of piles or conditions not specifically covered herein may be permitted, subject to the approval of the building official, upon submission of acceptable test data, calculations or other information relating to the properties and load-carrying capacity of such piles.

SECTION 1829

HIGH-VELOCITY HURRICANE ZONES-LOAD TESTS ON PILES

1829.1 Single piles tested shall be loaded to at least twice the desired design load and should pile groups be tested, the test load shall be not less than 11/2 times the total desired load for the group.

1829.1.1 The apparatus for applying known vertical loads to the top of the pile shall maintain constant load under increasing settlement, and shall apply the loads in such a way that no lateral forces or impact will occur. Hydraulic jacks when used shall be equipped with a calibrated pressure gauge. Uplift piles used to provide the jacking resistance shall be a sufficient distance from the test pile so as not to influence its behavior under test.

1829.1.2 The test load shall be applied in increments of not more than 25 percent of the design load until the total test load has been applied.

1829.1.3 The method for determining vertical movement shall be subject to the approval of the building official. Readings shall be sufficient in number to define the time settlement and rebound curve.

1829.1.4 Each load increment shall be maintained for a minimum of 1 hour, and until the rate of settlement is less than 0.01 inch (.25 mm) per hour. The total load shall be maintained until settlement does not exceed 0.01 (.25 mm) inch in 24 hours. Settlement readings shall be taken at regular intervals during the test period.

1829.1.5 After the maximum load has remained on the pile for 24 hours and final settlement readings have been taken, the pile shall be unloaded in 50-percent decrements of design load. Rebound readings shall be taken at regular intervals during the unloading period, and final reading taken approximately 12 hours after the entire load has been removed.

1829.1.6 The maximum allowable pile load shall be one-half of that load which causes a net settlement of not more than 0.005 inch (.13 mm) per ton of test load, a gross settlement of 1 inch (25 mm) (whichever is less) or a disproportionate increase in settlement.

1829.1.7 Control test piles shall be tested in accordance with ASTM D 1143, Method of Testing Piles Under Axial Compressive Load. If quick load test procedures are used, the applied test load shall be not less than three times the working pile capacity and in accordance with the standard.

**SECTION 1830**

**HIGH-VELOCITY HURRICANE ZONES-FOUNDATION WALLS AND GRADE BEAMS**

1830.1 Exterior foundation walls of buildings, where the character of the soil is such that allowable soil loads of 1,500 pounds per square foot (psf) (81 kN/m2) or less are used for design, shall be poured-in-place reinforced concrete from the footing to the bottom of the first or ground floor construction.

1830.1.1 Exterior foundation walls of building, where the character of the soil is such that allowable soil loads of more than 1,500 psf (71 kN/m2) are used for design, may be of unit masonry or concrete on continuous concrete footings.

1830.1.2 Under the exterior walls of buildings of Type V construction, in locations where extreme dampness exists, the building official may approve isolated piers, provided such piers are as otherwise set forth in Section 1823.1.1.

1830.2 Detailed requirements.

1830.2.1 The thickness of the foundation wall shall be not less than 8 inches (203 mm).

1830.2.2 Where wood joist construction is used for the first or ground floor, the thickness of the exterior foundation walls shall be not less than 8 inches (203 mm), plus 4 inches (102 mm) for the bearing of joists.

1830.2.3 Foundations of unit masonry supporting joists shall be capped with 4 inches (102 mm) of concrete.

1830.3 Interior bearing walls. Interior foundation walls shall be of the material and design as specified in Section 1830.1 except as follows.

1830.3.1 Interior foundation walls that support stud walls shall be exempted from the additional 4 inches (102 mm) of width required for the bearing of joists.

1830.3.2 The use of isolated piers, girders and beams may be substituted for interior foundation walls when designed by a registered architect and/or engineer.

1830.4 Grade beams.

1830.4.1 Grade beams supporting loads between piles or piers shall be reinforced concrete or structural steel protected by 2 inches (51 mm) of concrete cover.

1830.4.2 Grade beams shall be the thickness of the wall they support but never less than 8 inches (203 mm) nor less than set forth for foundation walls herein.

1830.4.3 Grade beams shall be suitably designed and reinforced around access openings and vents.

**SECTION 1831**

**HIGH-VELOCITY HURRICANE ZONES-GRADES UNDER BUILDINGS**

1831.1 The grade of the ground under buildings of joist or suspended slab construction having no basements shall not be lower than the lowest surrounding finished lot area grade in order to prevent the accumulation and standing of ground, storm or tide water under such buildings unless provided with other approved means of drainage.

1831.1.1 Plans for future raising of lots shall be taken into account in planning the grade of the ground under such buildings.

1831.1.2 The building official may establish grades under such buildings based on present or future street or sidewalk grades abutting the property.

**SECTION 1832**

**HIGH-VELOCITY HURRICANE ZONES-RETAINING WALLS**

1832.1 All walls exceeding 24 inches (610 mm) in height built to retain or support earth, or subject to pressure from adjoining earth, and any surcharge shall be designed to resist the pressure to which they are subjected, including water pressure that may exist.

**SECTION 1833**

**HIGH-VELOCITY HURRICANE ZONES-SEAWALLS AND BULKHEADS**

1833.1 All dredging, filling, excavation and waterfront construction such as docks, piers, wharves, bridges, groins, jetties, moles, breakwaters, seawalls, revetments, causeways, artificial nourishment of beaches or other deposition or removal of material in all water areas within the area of jurisdiction of this code shall be planned and designed by a professional engineer, except as noted in Section 1833.2, in accordance with this code and the applicable standards and requirements of the administrative authority.

1833.2 The requirement for professional design will not be required by the building official for bulkheads, docks, piers and similar structures constructed in conjunction with private residences on lakes, private canals and similar water frontage not subject to wind, wave or tidal action; do not involve unusual soil conditions, slopes or unstable soil and are not part of a foundation or support for an above-grade structure.

**SECTION 1834**

**HIGH-VELOCITY HURRICANE ZONES-SOIL IMPROVEMENT**

1834.1 The application of soil improvement techniques shall comply with this section.

1834.1.1 Methods of soil improvement for a specific site shall be determined by a registered professional engineer, hereinafter referred to as the geotechnical engineer, and such methods shall provide for field testing as required herein.

1834.1.2 A permit shall be required prior to the commencement of any soil improvement, and no building permit shall be issued until it has been determined that adequate bearing capacity has been obtained for the foundation, and the requirements of this section have been satisfied.

1834.2 Limits on application.

1834.2.1 Soil improvement shall not be permitted where subsurface conditions consist of zones of organic materials of sufficient quality above or below the ground water table which cannot be dispersed or displaced to levels not exceeding 5-percent dry weight of organic content in any undisturbed sample.

1834.2.2 Dynamic compaction, vibrocompaction, preloading, surcharging or other similar methods of soil improvements shall not be permitted near or within coastal areas subject to storm surge, scour or other forms of water erosion without suitable protection provided for the building foundation.

1834.3 Required testing.

1834.3.1 A rational program of field tests and soil analyses shall be part of the soil improvement treatment.

1834.3.2 Such tests shall determine the soil characteristics after treatment, and the results of the tests shall demonstrate whether the subsurface improvement has increased the bearing capacity of the soil to that which is capable of safely supporting the proposed construction.

1834.3.3 The testing shall be performed in accordance with the provisions of ASTM D 1586, Standard Penetration Test; ASTM D 3441, Static Cone Soundings; or by Menard Pressuremeter; Dilatometer or other on-site tests recognized by the industry.

1834.3.4 The test results shall be used to determine the achieved bearing capacity and the anticipated settlement.

1834.4 Requirements for acceptance. The efficacy of any application of soil improvement techniques shall be verified by appropriate calculations, testing and documentation as required in this section.

1834.4.1 All organics, including any organic lens, shall be displaced by the injection of sand or other suitable fill material, or otherwise dispersed in accordance with the provisions of this section, to levels not exceeding 5 percent by weight of organic content in any undisturbed sample.

1834.4.2 Complete documentation of required tests shall be required, and shall included as a minimum, but shall not be limited to:

1. A description of the stratigraphy and densification required and

2. Foundation bearing capacity and settlement analysis performed by an independent testing laboratory.

3. The anticipated settlement potential under superimposed loads shall be acknowledged and accepted by the engineer of record in writing prior to issuance of a building permit.

4. The results of testing to determine subsurface conditions shall be retained by the geotechnical engineer and submitted to the building official upon request.