CITY OF CHICAGO

DEPARTMENT OF BUILDINGS

CODE MEMORANDUM

To: Department of Buildings Plan Examiners and Inspectors

From: Judith Frydland
Commissioner

Date: June 15, 2017

Re: Pile Deep Foundations

STEEL PILES:

1. Structural steel piles, steel pipe and fully welded steel piles fabricated from plates shall conform to ASTM A36, A252, A283, A500, A572, A588, A913, A992, A53 Grade B or other designated technical standard as accepted by the Commissioner of Buildings.

2. The allowable axial compressive stress of driven steel piles shall not exceed 35 percent of the minimum specified yield strength (fy). The allowable stress may be increased up to a maximum of 42 percent of the minimum specified yield strength (fy) if a production pile is load tested per the ASTM procedure D1143 procedure B static load for axial compression. The allowable stress may be increased to a maximum of 50 percent of the minimum specified yield strength if a separate sacrificial, higher grade steel pile of the same size as a production pile is load tested per ASTM procedure D1143 procedure B static load test for axial compression regardless of the load supported by the pile. The maximum allowable compressive stress shall not exceed 30,000 psi.

3. Load tests are required for pile loads at or exceeding: 30 tons for timber piles, 60 tons for all driven structural steel piles in soil, 100 tons for piles driven to rock. For micro piles and all non-driven piles, such as auger cast piles a load test is required regardless of pile capacity.

4. Load tests (all pile types):

   The Compression Load Test: The compression load test shall be performed in accordance with ASTM D1143 using the Static Load Test Procedure B for all friction piles and the Quick Test Loading Procedure A for rock bearing piles. The proposed allowable load shall be considered acceptable if the net settlement of the applied test load does not exceed (1/5) x Square root (D)/Log(D). Where D = the pile diameter or diagonal pile depth in inches. The Net settlement is defined as the gross settlement due to the total test load less the amount of elastic shortening in the pile section due to the total test load (PL/AE) where P = applied load on the pile, L = pile length, A = cross sectional area of the pile and E = modulus of elasticity of the pile. The allowable load shall be determined by dividing the total test load with applicable factor of safety for the given pile type. A minimum factor of safety of 2.0 is required unless otherwise noted for the pile type.

5. Tension Load Test: For a pile subjected to tension, the uplift capacity of a single deep foundation shall be determined in accordance with ASTM D3689. Where uplift load tests are performed, the maximum allowable uplift load shall not exceed the ultimate load capacity divided by a factor of safety of two. A Tension Load Test shall not be done on a production pile unless the pile is reseated to the original design driving criteria with the same pile hammer. The allowable uplift load for a pile group shall not exceed the sum of the allowable uplift loads of the individual piles in the group.

6. Pipe used for piles shall have the minimum outside diameter and wall thickness as shown in the following table:

Pile Type	Minimum Outside Diameter	Minimum Wall Thickness
Jacked Pile	3.5 inches	0.219 inches
Micro-Pile	4.5 inches	0.300 inches
Driven Pile	7.0 inches	0.219 inches

7. Corrosion protection: Steel piles subjected to a corrosive environment shall be protected by a suitable protective coating or encapsulation method. In the absence of a protective coating, one-sixteenth inch of steel shall be deducted from the thickness of the metal in computing the allowable load. The engineer must provide testing results of the corrosive environment in the soil.

MICRO PILES:

1. Micro piles are drilled piles composed of cement grout subjected to pressure and having some form of steel reinforcing to carry the compressive design load.
2. Micro piles allowable stress: The maximum allowable stress on the cement grout or concrete shall be 25 percent of the specified 28-day unconfined compressive strength if poured against the soil but shall not exceed 1,600 psi. For cement grout or concrete within a permanent casing, the maximum allowable design stress can be increased to 40 percent of the specified 28-day unconfined compressive strength. The maximum stress on steel reinforcing, including permanent a steel casing, shall be 35 percent of the minimum specified yield strength, but shall not exceed 28,000 psi.
3. For micro piles, the maximum allowable design tensile stress on the center bar shall be 50 percent of the minimum specified yield strength. The casing shall not be counted to resist the tension force. The allowable design tensile stress on the cement grout shall be zero.
4. For a micro pile or a portion of a micro pile which has been grouted inside a temporary casing, grouted inside a hole drilled into rock or grouted with a hollow-stem auger, the reinforcing steel shall be designed to carry not less than 40 percent of the design compression load.
5. Micro piles shall not be drilled within the five feet of an existing micro pile until the grout has had 12 hours or sufficient time for the initial set.

JACKED PILES:

1. For steel jacked piles with non-welded or partially welded connections, the maximum allowable design compressive stress on the steel reinforcing, including the permanent casing shall be 35 percent of the minimum specified yield strength but shall not exceed 19,000 psi. For cement grout within a permanent casing, the maximum allowable design stress shall be 40 percent of the 28 day unconfined compressive strength but shall not exceed 2,400 psi.
2. For installation of all production jacked piles, at least 150 percent of design load shall be applied. The jacked piles shall be grouted with a fluid cement grout. The grout shall be pumped through a tremie tube extending to the bottom of the jacked pile until grout of suitable quality returns at the top of the jacked pile.

AUGERED CAST PILES:

1. Auger cast piles: The minimum diameter for an augured cast pile shall not be less than 12 inches with a mandatory load test to be performed on the production or a sacrificial pile of the same diameter per ASTM D1143 procedure B static load test for axial compression.
2. The allowable load on the augured cast pile shall be determined by load testing to no less than 2.5 times the design load. The load test shall be performed per ASTM D1143 procedure B static load for axial compression.

3. Auger cast piles: Compression load: The maximum allowable design stress on the cement grout or concrete shall be 25 percent of the specified 28-day unconfined compressive strength, but shall not exceed 1,600 psi. The maximum allowable design steel reinforcing stress shall be 35 percent of the minimum specified yield strength, but shall not exceed 21,000 psi.
4. Auger cast piles: Tension loads: the maximum allowable design tensile stress on the steel reinforcing shall be 50 percent of the minimum specified yield strength. The allowable design stress on the cement grout shall be zero.
5. Auger cast piles shall have a tied reinforcing cage with a bar length of not less than 8 feet and shall have one full-length center reinforcement bar with reinforcing spacers at a minimum of every 10'- 0" on center. The spacer(s) shall have a diameter that is 2 inches smaller than the design diameter of the augured cast pile. The minimum concrete cover over the reinforcing steel shall be 2.5 inches.
6. Auger cast piles shall not be installed within eight pile diameters (center line to center line) of a pile filled with grout or concrete for 12-hours or until the initial set is achieved.

PRECAST PILES:

1. Precast pre-stressed piles shall be designed to resist the stresses induced by handling and driving as well as by structural loads. Piles shall be designed per the requirements of the ACI318 code.

HELICAL PILES:

1. Helical Pier: Hollow shaft helical piers under compression loading shall be fully treamie grouted to minimize movement in the connections.
2. The allowable load shall be determined by load testing conforming to the ASTM D1143 procedure B static test as follows:
    - For a pile capacity of 10 tons or less, no compression load test is required
    - For a pile capacity greater than 10 tons up to 30 tons, a load test is required with a safety factor of 2.0.
    - The allowable axial tension and compression loads shall not exceed 30 tons.
    - The allowable lateral load resisted by a helical pile shall not exceed 3 tons.
    - All helical piles designed for tension will require a tension load test regardless of the pile capacity.
3. Following each compression or tension load test, the test pile shall be removed by unscrewing and inspected for any deformations to the helices in order to verify the structural integrity of the shaft and its connections. If any structural deformation is found, an additional load test shall be performed using a larger size helical pile.
4. At least one load test shall be performed in each area of the foundation site within subsurface conditions that are "substantially similar" in character as determined by the engineer and at least one test shall be performed for each pile type for the entire foundation installation or group of buildings on the site. For an equation considering acceptable settlement: D = the diameter of the helix shaft and not the helix plate diameter.
5. The Lateral Load Test shall be performed in conformance with ASTM D 3966.
6. The results of the load test and the photographs of the unscrewed pile and its components shall be submitted to the Department of Buildings for review prior to the installation of any production piles.
7. For underpinning, 100 percent of the compression piers shall be loaded to 1.5 times the design total load.
8. Allowable stress in a helical pier: The maximum allowable compressive stress on the cement grout inside of the shaft shall be 40 percent of the specified 28 day compressive strength but shall not exceed 1600 psi. The allowable design stress on the cement grout outside of the shaft shall be zero. The

maximum allowable design stress on the steel reinforcing including the steel shaft shall be 35 percent of the minimum specified yield strength but shall not exceed 16,000 psi.

9. Helical Piles for tension loads: The maximum allowable tensile strength in the steel shall be 50 percent of the minimum specified yield strength or 50 percent of the strength of the connection capacity, whichever is less. The allowable design stress on the cement grout shall be zero.
10. Helical bearing plates shall be properly sized and affixed to the shaft with adequate welds to develop their proportional share of the load. For the permanent compression elements, calculations shall be submitted to the Department of Buildings demonstrating the adequacy of the connections to resist shear, flexure and compression.
11. In addition to service loads, helical piers / anchors shall be designed and manufactured to resist all the stresses induced by the installation of the helical pier into the ground. The maximum installation stress shall remain below the yield stress.

TIMBER PILES:

1. Timber piles shall be designed in accordance with the AWPA NDS.

MANDREL DRIVEN SHELL PILES:

1. Mandrel driven shell pile: The allowable design compressive stress in the concrete shall not exceed 33 percent of the 28 day specified compressive strength (f'c). The thickness of the steel shell shall not be less than N0. 14 gauge (0.068 inch).