Florida DOT
SECTION 455
STRUCTURES FOUNDATIONS

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C. DRILLED SHAFTS

455-13 Description.

Construct drilled shaft foundations consisting of reinforced, or unreinforced when indicated in the plans, concrete drilled shafts with or without bell footings.

455-14 Materials.

455-14.1 Concrete: For all concrete materials, meet the requirements of Section 346. Use concrete that is specified in the plans.

455-14.2 Reinforcing Steel: Meet the reinforcing steel requirements of Section 415. Ensure that reinforcing steel is in accordance with the sizes, spacing, dimensions, and the details shown in the plans.

455-16.4 Cross-Hole Sonic Logging (CSL) Tubes: Install CSL access tubes full length in all drilled shafts from the tip of shaft to a point high enough above top of shaft to allow cross-hole-sonic-logging testing, but not less than 30 inches above the top of the drilled shaft, ground surface or water surface, whichever is higher. Equally space tubes around circumference of drilled shaft. Securely tie access tubes to the inside of the reinforcing cage and align tubes to be parallel to the vertical axis of the center of the cage. Access tubes must be Schedule 40 steel with a minimum inside diameter of 1.5 inches. Couple tubes as required with threaded couplers, such that inside of tube remains flush. Seal the bottom and top of the tubes with threaded caps. The tubes, joints and bottom caps shall be watertight. Seal the top of the tubes with lubricated, threaded caps sufficient to prevent the intrusion of foreign materials. Stiffen the cage sufficiently to prevent damage or misalignment of access tubes during the lifting and installation of the cage. Repair or replace any unserviceable tube prior to concreting. Exercise care in removing the caps from the top of the tubes after installation so as not to apply excess torque, hammering or other stress which could break the bond between the tubes and the concrete. Provide the following number (rounded up to the next whole number of tubes) and configuration of crosshole sonic logging access tubes in each drilled shaft based on the diameter of the shaft. Insert simulated or mock probes in each cross-hole-sonic access tube prior to concreting to ensure the serviceability of the tube. Fill access tubes with clean potable water and recap prior to concreting. Repair or replace any leaking, misaligned or damaged tubes

as in a manner acceptable to the Engineer prior to concreting.

455-17.6 Non-Destructive Testing of Drilled Shaft Integrity:

455-17.6.1 Cross-Hole Sonic Logging (CSL) Tests: Perform all CSL testing in accordance with ASTM D 6760. Test all drilled shafts in bridge bents or piers considered non-redundant in the plans, using CSL. For all other drilled shafts, perform CSL testing only on drilled shafts selected by the Engineer. The minimum number of shafts tested is the number of shafts indicated in the plans. The Engineer may increase the number shafts tested as deemed necessary.

Engage a qualified Specialty Engineer to perform the CSL testing. The qualified CSL Specialty Engineer must have a minimum three years of experience of CSL testing and have a Florida Licensed Professional Engineer supervising the collection and interpretation of data. The Contractor shall provide all necessary assistance to the CSL Specialty Engineer to satisfactorily perform the testing. When a shaft contains four tubes, test every possible tube combination. For shafts with five or more tubes, test all pairs of adjacent tubes around the perimeter, and one-half of the remaining number of tube combinations, as chosen by the Engineer. After acceptance of production shafts by the Engineer, remove all water from the access tubes or core holes and fill the tubes or core holes with a structural non-shrink grout approved by the Engineer. If the Contractor determines at any time during the non-destructive testing and evaluation of the drilled shaft that the drilled shaft should be replaced, no further testing or evaluation of that shaft is required.

455-17.6.1.1 Equipment: Furnish Cross-Hole-Sonic logging test equipment as follows:
(1) Include ultrasonic transmitter and receiver probes for 1.5 inch or 2.0 inch I.D. pipe, as appropriate, which produce measurements with consistent signal strength and arrival time in uniform, good quality concrete with all tube spacing on the project.
(2) Include a microprocessor based data acquisition system for display, storage, and transfer of data. Graphically display First pulse Arrival Time (FAT) during data acquisition.
(3) Electronically measure and record the relative position (depth) of the probes in the tubes with each CSL signal.
(4) Print the CSL logs for report presentation.
(5) Provide report quality plots of CSL measurements that identify each individual test.
(6) Electronically store each CSL log in digital format, with shaft identification, date, time and test details, including the transmitter and receiver gain.

455-17.6.1.2 Procedure: Perform Cross-hole sonic logging between 72 hours and 25 calendar days of shaft concrete placement and after the concrete compressive strength exceeds 3,000 psi. Furnish information regarding the shaft, tube lengths and depths, construction dates, and other pertinent shaft installation observations and details to the Department at the time of testing. Verify access tube lengths and their condition in the presence of the Department, at least 24 hours prior to CSL testing. If the access tubes do not provide access over the full length of the shaft, repair the existing tube(s) or core additional hole(s), as directed by the Engineer, at no additional cost to the Department. Pull the probes simultaneously, starting from the bottoms of the tubes, over an electronic depth measuring device. Perform the CSL tests with the source and receiver probes in the same horizontal plane. Continuously record CSL signals at depth intervals of 2.5 inches or less from the bottom of the tubes to the top of each shaft. Remove all slack from the cables prior to pulling to provide accurate

depth measurements in the CSL records. Report any anomalies indicated by longer pulse arrival times and significantly lower amplitude/energy signals to the Engineer and conduct further tests as required to evaluate the extent of possible defects. Conduct offset CSL measurements between all tube pair combinations in any drilled shafts with 30% or greater in velocity reduction. Record offset measurements with source and receiver vertically offset in the tubes. These measurements add four measurements per tube combination to the horizontal measurements described in this section. Offset measurements are described by the angle (in degrees) and direction the signal travels between the probes with respect to the horizontal plane: +45, +22.5 (source below receiver), and -45, -22.5 (source above receiver). Record offset measurements from the point where the higher probe is at least 5 feet below the velocity reduction to the point where the lower probe is at least 5 feet above the velocity reduction. Provide offset CSL logs and 3-D tomographic analysis of all CSL data at no additional cost to the Department in the event 30% or greater in velocity reductions are detected.

455-17.6.1.3 Required Reports: Present the CSL testing and analysis results to the Engineer in a report. Include CSL logs with analyses of first pulse arrival time (FAT) versus depth and pulse energy/amplitude versus depth. Present a CSL log for each tube pair tested with any defect zones identified on the logs and discussed in the test report as appropriate. When offset measurements are required, perform 3-D tomographic analysis using all offset data, and include color coded 3-D tomographic images in the report.

455-17.6.1.4 Evaluation of CSL Test Results: The Engineer will evaluate the observations during drilled shaft construction and CSL test results to determine whether or not the drilled shaft construction is acceptable. Drilled shafts with velocity reduction exceeding 30% are not acceptable without an engineering analysis.

455-17.6.1.5 Coring and/or Repair of Drilled Shafts: If the Engineer determines a drilled shaft is unacceptable based on the CSL tests and tomographic analyses, or observes problems during drilled shaft construction, core the shaft to allow further evaluation and repair, or replace the shaft. If coring to allow further evaluation of the shaft and repair is chosen, one or more core samples shall be taken from each unacceptable shaft for full depth of the shaft or to the depth directed by the Engineer. The Engineer will determine the number, location, and diameter of the cores based on the results of 3-D tomographic analysis of offset and horizontal CSL data. Keep an accurate log of cores. Properly mark and place the cores in a crate showing the shaft depth at each interval of core recovery. Transport the cores, along with five copies of the coring log to the Engineer. Perform strength testing by an AASHTO certified lab on portions of the cores that exhibit questionable concrete as determined by the Engineer. If the drilled shaft offset CSL testing, 3-D tomographic analyses and coring indicate the shaft is defective, propose remedial measures for approval by the Engineer. Such improvement may consist of, but is not limited to correcting defective portions of the shaft, providing straddle shafts to compensate for capacity loss, or providing a replacement shaft. Repair all detected defects and conduct post repair integrity testing using horizontal and offset CSL testing and 3-D tomographic imaging as described in this Section. Engage a Specialty Engineer to perform gamma-gamma density logging to verify the integrity of the shaft outside the reinforcing cage in the same locations offset CSL data was/is required. Submit all results to the Engineer within five days of test completion for approval. Perform all work described in this Section at no additional cost to the Department, and with no increase in contract time.