NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

STANDARD SPECIFICATIONS FOR ROADS AND STRUCTURES

JANUARY 2018

411-2 MATERIALS

Refer to Division 10.

Item	Section
Grout, Type 2	1003
Portland Cement Concrete, Class Drilled Pier	1000
Reinforcing Steel	1070

Provide Type 3 material certifications in accordance with Article 106-3 for permanent casings and roller, chair, steel pipe and cap materials. Store steel materials on blocking at least 12 inches above the ground and protect it at all times from damage; and when placing in the work make sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials. Load, transport, unload and store drilled pier materials so materials are kept clean and free of damage.

(A) Steel Casing

Define "casing" as a temporary or permanent casing. If permanent casing is required for an excavation, the largest diameter casing in the hole is the permanent casing. This does not apply to working casings around permanent casings as approved by the Engineer. Use smooth non-corrugated clean watertight steel casings of ample strength to withstand handling and installation stresses and pressures imposed by concrete, earth, backfill and fluids.

(1) Temporary Casings

Provide temporary casings with a nominal wall thickness of at least 0.375 inch and an outside diameter equal to or larger than the design pier diameter for which temporary casing is used.

(2) Permanent Casings

Use permanent casings with a yield strength of at least 36 ksi and a nominal wall thickness that meets Table 411-1.

TABLE 411-1
MINIMUM PERMANENT CASING WALL THICKNESS

Casing Diameter	Nominal Wall Thickness
< 48"	0.375"
48" - 78"	0.500"
> 78"	0.625"

Provide permanent casings with an outside diameter equal to the design pier diameter for which permanent casing is used unless larger diameter permanent casings are approved.

(B) Slurry

Define "slurry" as bentonite or polymer slurry. Mix bentonite clay or synthetic polymer with water to make bentonite or polymer slurry.

(1) Bentonite Slurry

Provide bentonite slurry that meets Table 411-2.

TABLE 411-2 BENTONITE SLURRY REQUIREMENTS[A]		
Property	**ANSI/API RP[B] 13B-1**	**Requirement**
Density[C] (Mud Weight)	Section 4 Mud Balance	64.3 - 72.0 lb/cf
Viscosity	Section 6.2 Marsh Funnel	28 - 50 sec/qt
Sand Content	Section 9	≤ 4 %[D]
		≤ 2 %[E]
pH	Section 11 Glass Electrode pH Meter[F]	8 - 11

A. Slurry temperature of at least 40°F required.
B. American National Standards Institute/American Petroleum Institute Recommended Practice,
C. Increase density requirements by 2 lb/cf in saltwater,
D. In tanks before pumping slurry into excavations,
E. In excavations immediately before placing concrete,
F. pH paper is also acceptable for measuring pH,

(2) Polymer Slurry

Use polymer slurry products qualified by the Department. Provide polymer slurry with density, viscosity, sand content and pH properties that meet the product requirements. The polymer slurry QPL with the property requirements for each qualified polymer slurry product is available on the Geotechnical Engineer Unit's website.

(C) Rollers and Chairs

Use rollers and chairs that are non-metallic and resistant to corrosion and degradation. Provide rollers with the necessary dimensions to maintain the minimum required concrete cover shown in the plans and center rebar cages within excavations. Use chairs of sufficient strength to support rebar cages in excavations and of the size necessary to raise cages off bottom of holes to maintain the minimum required distance shown in the plans.

(D) Steel Pipes and Caps

Use Schedule 40 black steel pipes for access tubes for crosshole sonic logging (CSL). Provide CSL tubes with an inside diameter of at least 1.5 inches. Use CSL tubes with a round, regular inside diameter free of defects and obstructions, including any pipe joints, in order to permit free, unobstructed passage of probes for CSL testing. Provide watertight CSL tubes free of corrosion with clean internal and external faces to ensure a good bond between concrete and tubes. Fit CSL tubes with watertight plastic caps on the bottom and removable caps on top.

411-3 PRECONSTRUCTION REQUIREMENTS

(A) Drilled Pier Construction Plan

Submit the proposed drilled pier construction plan for all drilled piers for acceptance. Provide 2 copies of this plan at least 30 days before starting drilled pier construction. Do not begin drilled pier construction until a construction plan is accepted. Provide detailed project specific information in the drilled pier construction plan that includes the following:

(1) Overall description and sequence of drilled pier construction;

(2) List and sizes of equipment including cranes, drill rigs, vibratory and downhole hammers, Kelly bars, augers, core barrels, casings (diameters, thicknesses and lengths), cleanout buckets, air lifts, pumps, slurry equipment, tremies, pump pipes and other equipment;

(1) Tip Resistance

If the Engineer determines that the material below an excavation does not provide the minimum required tip resistance, increase the drilled pier length and lengthen reinforcing steel as directed. One of the following methods may be required to check the conditions and continuity of material below excavations.

(a) Test Hole

If excavations are in rock, drill a 1.5 inch diameter test hole at least 6 feet below bottom of holes for the Engineer to determine the continuity of rock below holes.

(b) Standard Penetration Test

Standard penetration tests (SPT) may be required as noted in the plans. When required, drive a split-barrel sampler 18 inches below bottom of holes or to refusal in accordance with ASTM D1586. Perform SPT in holes at least 12 inches away from casing walls and support drill rods so rods remain vertical and straight. Report the number of blows applied in each 6 inch increment and provide recovered samples to the Engineer. The Engineer will determine the standard penetration resistance required.

(2) Bottom Cleanliness

Holes are clean if at least 50% of bottom of holes has less than 0.5 inch of sediment and no portions of bottom of holes have more than 1.5 inches of sediment. If bottom of holes does not meet this cleanliness criteria, remove sediment from holes until the Engineer determines holes are clean. One or more of the following methods may be required to inspect the bottom cleanliness of holes.

(a) Steel Probe

If drilled pier excavations are not dewatered or as directed, provide a #10 rebar steel probe that is 24 inches long with a flat tip on one end and a non-stretch cable connected to the other end. Provide a cable long enough to lower the steel probe to the bottom of holes for the Engineer to determine the amount of sediment in holes.

(b) Shaft Inspection Device

The Engineer may use the shaft inspection device (SID) as noted in the plans. The Engineer provides the SID and personnel to operate it. Notify the Engineer at least 2 days before finishing holes that will be inspected with the SID.

Assist the Engineer in handling the SID and associated equipment and supporting the SID during inspections. Provide working areas large enough for the SID, associated equipment and SID personnel within reach of the SID cables and clear view of holes being inspected. If necessary, provide a secure location to store the SID and associated equipment onsite overnight.

Approximately one hour is required to inspect a hole with the SID after the SID and associated equipment are set up. The Engineer will use the SID to measure the amount of sediment at 5 locations around the bottom of holes.

(E) Reinforcing Steel and Concrete

Assemble rebar cages consisting of bar and spiral reinforcing steel shown in the plans. Securely cross tie reinforcing steel at each intersection with double wire. Attach a chair under each reinforcing bar and rollers near the top and bottom of rebar cages and every 10 feet along cages in between. The number of rollers required at each location along rebar cages is one roller per foot of design pier diameter with at least 4 rollers per location. Space rollers equally around rebar cages at each location. Attach rollers so rollers are supported

across 2 adjacent reinforcing bars and will freely rotate when rebar cages are lowered into excavations.

If CSL tubes are required, securely attach CSL tubes to spiral reinforcing steel on the inside of rebar cages with at least 3 inches of clearance to reinforcing bars. Extend CSL tubes from 6 inches above pier tip elevations to at least 2 feet above the ground line or top of permanent casings, whichever is greater. The number of CSL tubes required for each drilled pier is one tube per foot of design pier diameter with at least 4 tubes per pier. Space CSL tubes equally around rebar cages so distances between tubes measured around spiral reinforcing steel are uniform. Install CSL tubes as straight and parallel to each other as possible. Fit caps on top and bottom of CSL tubes.

After the Engineer determines that the material below excavations provides the minimum required tip resistance and holes are clean, place rebar cages and then concrete in excavations. Do not rack or distort rebar cages and CSL tubes when lifting and handling cages. Set rebar cages directly on bottom of holes or, as approved by the Engineer, hang cages from permanent casings. When hanging rebar cages, leave devices supporting cages in place until Drilled Pier concrete attains a compressive strength of at least 3,000 psi.

Do not delay placing cages or concrete unless excavations are cased to rock or otherwise approved. If delays occur, the Engineer may require removal of rebar cages to reinspect bottom cleanliness of holes. If bottom of holes does not meet the cleanliness criteria in Subarticle 411-4(D)(2), remove sediment from holes until the Engineer determines holes are clean before resetting rebar cages.

After placing rebar cages with CSL tubes, remove top caps, fill tubes with clean water and reinstall caps before placing concrete. Check for correct cage position before placing concrete and keep rebar cages plumb during concrete placement. Maintain cage position so rebar cages do not move vertically more than 6 inches and columns or footings have the minimum required concrete cover shown in the plans.

Remove all temporary casings during concrete placement. Do not twist, move or otherwise disturb temporary casings until the concrete depth inside casings is at least 10 feet or half the head, whichever is greater, above the bottom of casing being disturbed. Define "head" as the difference between the highest piezometric head along the drilled pier length and the static water elevation inside the excavation.

When removing temporary casings, maintain the required concrete depth above the bottom of casing being removed except when the concrete level is at or above top of piers. Sustain sufficient concrete depths to overcome pressures imposed by earth, backfill and fluids. As temporary casings are withdrawn, ensure fluids trapped behind casings is displaced upward and discharged out of excavations without contaminating or displacing concrete.

Pour concrete in excavations to form uniform jointless monolithic drilled piers. Do not trap soil, air, fluids or other contaminants in concrete. Remove contaminated concrete from top of piers at time of concrete placement.

Inform the Engineer of the volume of concrete placed for each pier. For piers constructed with slurry or as directed, record a graphical plot of depth versus theoretical and actual concrete volumes.

Dry or wet placement of concrete is at the Contractor's option for piers constructed with only casings if the water inflow rate into excavations is less than 6 inches per half hour after removing any pumps from holes. Wet placement of concrete is required for all other drilled pier construction.

(1) Dry Placement

If holes are filling with water for dry placement of concrete, dewater excavations as much as possible before placing concrete. For drilled piers less than 80 feet long, pour concrete down the center of excavations so concrete does not hit reinforcing steel or