## ITEM 16551.93 M - PRECAST FIBERGLASS-CONCRETE COMPOSITE PILES
## ITEM 16551.94 M - PRECAST FIBERGLASS-CONCRETE COMPOSITE TEST PILES

### DESCRIPTION

Design, furnish and install precast fiberglass-concrete composite piles at the locations and to the required capacities indicated on the plans or as directed by the Engineer. Engage a Professional Engineer registered in New York State to design the piles.

### DESIGN

Base the design on the current New York State Department of Transportation Standard Specifications for Highway Bridges.

### MATERIALS

The New York State Prestressed Concrete Construction Manual (PCCM) and the following shall apply:

**A. Concrete**

1. No. 2 size coarse aggregate may be used.

2. The use of admixtures which are not on the Materials Bureau Approved List will be subject to approval by the D. C. E. S.

3. Include pozzolan in the mix design in the range of 10% to 20% of total cementitious materials, by weight.

4. Design the 28 day concrete strength for 42 MPa.

**B. Fiberglass Tube**

Use fiberglass tubes in fabrication of composite piles, with sufficient cross section and strength to withstand stresses incurred by fabrication, handling and driving the piles to the required resistance.

1. Tolerances

| | | |
|---|---|---|
| Minimum Length (mm) | - | estimated/ordered length +/- 25 mm |
| Maximum Sweep (mm)* | - | 0.08% of total length |
| Ends out of Square (mm) | - | 1.0% of diameter |

* Sweep - deviation from straightness, measured at several points about the pile circumference while the pile is not subjected to bending stresses. Sweep is measured after the concrete is placed and cured.

2. Physical Properties

As defined in ASTM D 2310 or D 2996, use fiberglass products designated as follows:

Class: RTRP (Reinforced Thermosetting Resin Pipe)
Type: Type I (filament wound)
Grade: Grade 1 (Glass fiber reinforced epoxy resin pipe),
Grade 2 (Glass fiber reinforced polyester resin pipe) or
Vinylester resin, although there is no current ASTM Grade designation for vinylester resin.

Use resins containing ultraviolet (UV) inhibitors in the manufacture of fiberglass tubes. Apply a UV resistant color film of a minimum 0.076 mm thickness to portions of piles remaining exposed after installation. Unless otherwise specified on the contract plans use a black color film.

Use fiberglass tubes having the minimum physical properties in the following table.

| Nominal Tube Diameter (mm) | | 305 | 356 | 406 |
|---|---|---|---|---|
| Elastic Moduli (MPa) | axial-tensile [1] | 27580 | 23100 | 19240 |
| | axial-compressive [2] | 19300 | 16200 | 13100 |
| | hoop-tensile [3] | 31000 | 31000 | 31000 |
| Strength (MPa) | axial-tensile | 480 | 400 | 340 |
| | axial-compressive | 270 | 240 | 200 |
| | hoop-tensile | 240 | 240 | 240 |

[1] ASTM D 2105
[2] ASTM D 695 (modified - see Allowable Degradation)
[3] ASTM D 1599

3. Allowable Degradation

Total UV resistance of resin inhibitors and the color film shall be sufficient to limit loss of properties, as specified in the following table, after 3600 hours of exposure to light and water spray or salt spray. Provide certification of exposure testing conducted in accordance with at least one of the following ASTM methods: G 23, G 26, G 53 or B 117.

| Property | Allowable loss/change | Test Designation |
|---|---|---|
| axial tensile strength loss | æ 10% | ASTM D 2105 |
| axial compressive strength loss | æ 10% | ASTM D 695 (modified) * |
| hoop tensile strength loss | æ 10% | ASTM D 1599 |
| color film adhesion loss | æ 10% | ASTM D 4541 |
| color change | æ 25 E | ASTM E 308 and D 2244 |

* Modify ASTM D 695 as follows:

Test specimen dimensions:

diameter: full diameter of tube being tested
height: 25.4 mm

Do not use the compression tool described in ASTM D 695. Center the specimen in the compression test machine and place a steel plate on top of the specimen to evenly distribute the load from the test machine.

## FABRICATION DETAILS

The New York State Prestressed Concrete Construction Manual (PCCM) and the following shall apply:

**A. Shop Drawings (Working Drawings)**.

1. Submit shop drawings stamped and signed by the designer (Professional Engineer licensed and registered to practice in the State of New York).

2. Show on the shop drawings the method of placing concrete in fiberglass tubes, following the requirements of part **C**.

3. Show method of storage and of handling, following the requirements of part **D**.

4. Show details for splices, shoes and pile top connections as necessary following the requirements of parts **E** and **F**.

**B. Supporting Documents to the Shop Drawings**. Submit the following documentation and details along with the shop drawings:

1. Documentation indicating the fiberglass tubing designations as per ASTM D 2310 or D 2996, diameter and wall thickness.
2. Manufacturer's current technical literature for all admixtures not on the current Materials Bureau Approved List, which are to be used in the design mix.

3. Design calculations stamped and signed by the designer.

**C. Placing concrete**. Place the concrete in the fiberglass tubes in one continuous bottom to top operation in a manner that prevents voids from forming.

**D. Storage and Handling**. Store and handle piles to avoid damage to all components including fiberglass tubes, protective coatings and concrete. During storage and curing, place precast piles on 0.15 m minimum width timber cribbing arranged to give even support and to maintain straightness within the tolerance specified in the MATERIALS section above. Use only fabric slings for lifting. Do not use chain or cable in direct contact with the piles.

**E. Splices**. Use full length piles where practicable. Where splices are unavoidable their number and locations will be subject to written approval by the D.C.E.S. Make splices in conformance with details submitted to the D.C.E.S.

**F. Shoes**. Provide steel shoes for composite piles, when required. Install shoes on piles in conformance with details submitted to and approved by the D.C.E.S.

## CONSTRUCTION DETAILS

**A. Site Preparation**. For pile-supported footings, do not drive piles until after the excavation is completed to the elevation required for the bottom of the footing or bottom of tremie. Remove material forced up by driving, fill depressions caused by driving and establish the correct elevation of foundation before placing footing concrete, unless otherwise shown on the plans.

**B. Equipment for Driving Piles**

1. General - Drive piles with equipment which has prior approval from the D.C.E.S. Submit to the D.C.E.S., Form BD-138 M, "Pile Driving Equipment Data," for approval. The D.C.E.S. will require 15 working days upon receipt for review. Each separate combination of pile and pile driving equipment proposed by the Contractor requires the submission of a corresponding BD-138 M.

   Use a hammer with a minimum rated striking energy of 17.6 kJ per blow in driving composite piles. Provide the Engineer with manufacturer's charts and graphs required to calibrate hammer energy.

   Hammers having greater striking energy may be used upon approval by the D.C.E.S. These hammers shall produce a minimum of 20 blows/0.3 m and a maximum of 120 blows/0.3 m at the Ultimate Pile Resistance shown on the Contract Plans. However, if in the opinion of the D.C.E.S., satisfactory results are not obtained with the hammer furnished by the Contractor, a hammer meeting approval from the D.C.E.S. shall be furnished and used at no additional cost to the State.
2. Air/Steam Hammers - Provide sufficient boiler or compressor capacity at all times to maintain the rated speed of air/steam hammers during the full time of pile driving. Maintain the valve mechanism and other parts of a single or double-acting hammer such that the number of blows per minute for which the hammer is designated, is satisfied.

3. Diesel Hammers - Maintain the valves, pumps, ports, rings, and other hammer parts such that the following condition for which the hammer is designated is satisfied:

| Hammer Type | Designated Condition |
|---|---|
| Single Acting | Length of Stroke or Blows per Minute |
| Double Acting | Bounce Chamber Pressure |

Provide all Diesel Hammers with an acceptable means of measuring hammer energy. When pressure gages are included as normal equipment, they shall be furnished and

maintained in operable condition. Arrange easy access to the pressure gages so that readings may be conveniently taken by the Engineer.

A double acting hammer not operating at the required bounce chamber pressure shall be removed promptly from the work site. It shall be replaced by a hammer acceptable to the Engineer at no cost to the State.

4. Use an approved hammer cushion block to transfer pile hammer energy to the pile. Equip each hammer with a helmet/drive head to fit the diameter of the pile to be driven.

5. Use an approved pile cushion block to prevent damage to the pile. At a minimum frequency, inspect the pile cushion block after each pile is driven and replaced regularly as needed.

6. Provide pile driving leads constructed in such a manner as to afford freedom of movement of the hammer. The use of either swinging or hanging leads will be permitted provided the pile or leads are properly supported during driving and the required final position and batter of pile is achieved. In the event the Engineer determines that the use of swinging or hanging leads is producing unsatisfactory results, he may require the Contractor to hold the leads in position with guys or braces to give the required support. The Contractor may, as an alternative, replace the unsatisfactory equipment with equipment having fixed leads.

   Provide pile driving leads of sufficient length so that the use of a follower will not be necessary. The driving of piles with followers will generally not be permitted and shall be done only with written permission and direction of the D.C.E.S.

   When directed by the Engineer, use either approved steel or wooden spuds to penetrate consolidated material or obstructions in the upper 3 meters in order to assist in driving the piles to the required depth and resistance. Augers may be used for this purpose when written permission is obtained from the D.C.E.S.

7. Do not use water jets or vibratory hammers in driving any pile, unless written approval is given by the D.C.E.S. Piles installed with a water jet or vibratory hammer shall be impact driven to secure the final penetration.

**C. Methods of Driving**. Drive piles with an air/steam, diesel, or hydraulic hammer. Drive piles starting from the center of the foundation and proceeding outward from this point, or start at the outside row and drive progressively across the foundation.

**D. Length of Piles**

1. General. Drive piles at the locations shown on the contract plans and to the pile toe elevation and driving criteria established by the D.C.E.S. The location, number, lengths, and methods of driving piles may be changed as directed by the D.C.E.S. at any time during the progress of the work. Piles may be completely driven in one operation or, if

directed by the D.C.E.S., may be partially driven and allowed to set from 2 to 24 hours (or as indicated on the Contract Plans) before driving is resumed.

2. Test Piles. When a test pile item is specified on the contract plans, drive test piles to determine the ordered lengths of foundation piles to be used. An order list will be furnished after satisfactory completion of all test piles in the substructure. Furnish and place in the leads piles of the ordered lengths shown on the itemized list furnished by the Engineer.

   Test piles that are driven within the structure limits may be used as foundation piles, if properly located in accordance with the plans and driven to the driving criteria established by the D.C.E.S.

**E. Allowable Variation in Pile Alignment**. Install piles truly vertical or accurately battered as indicated on the Contract Plans. The top of any pile driven its full length into the ground shall not vary from the plan location by more than 100 mm, unless otherwise shown on the Contract Plans. The top of any pile partially exposed or included in an integral abutment shall not vary from the plan location by more than 25 mm, unless otherwise shown on the Contract Plans. In addition, piles may have a variation at their toe of not more than 6 mm per 0.3 m from the vertical or from the batter shown on the Contract Plans or permitted by the D.C.E.S.

**F. Defective Piles**. Redrive all piles forced up by any cause, as directed by the Engineer.

The following will be causes for rejection of a pile:

1. Incorrect pile location or batter.
2. Pile damage from any cause prior to driving.
3. Insufficient concrete strength, based on testing of cylinders.
4. Pile fails to attain the driving criteria determined by the D.C.E.S., or the driving resistance shown on the Contract Plans.
5. Pile toe elevation is outside the limits specified by the Contract Plans, or the Engineer.
6. Pile is determined by the Engineer to be unserviceable for other reasons related to the furnishing and installing of the pile.
7. Pile driven to final toe elevation is damaged below cut off elevation.
8. Pile broken by reason of internal defects (even if placed in the leads), or improper driving.
9. Pile which is driven so that when cut off, the butt is below the elevation fixed by the Contract Plans or established by the Engineer.

For pile-supported footings, do not place footing concrete until all piles within the footing are inspected by the Engineer. Remove such rejected piles or at the option of the Engineer an adjacent pile may be driven if this can be done without impairing the structure.

**G. Cutting Off Piles**. Cut off the tops of all piles at the elevation indicated on the Contract Plans, or as established by the Engineer. Cut the piles to a true plane, in accordance with the

detail shown on the Contract Plans. All cut off lengths become the property of the Contractor.

**H. Included Work**. Backfill all cavities left by the pile driving operation as specified by the Engineer.

## METHOD OF MEASUREMENT

**A. General**. When field conditions necessitate a change to the ordered length of test piles, the minimum additional length specified will be 1.5 meters. Any lengths of pile beyond the ordered length that is necessary to facilitate the Contractor's operation will be at his own expense.

**B. Test Piles**. The quantity of test piles to be paid for under the work specified will be the ordered number of linear meters of test pile shown on the contract plans and any additional lengths ordered placed in the leads by the Engineer.

**C. Piles (used in conjunction with test pile item).** The quantity will be the number of linear meters of piles placed in the pile driving leads, in accordance with the Engineer's order list. The pile lengths shown on the contract plans are for estimating purposes only.

**D. Piles (not used in conjunction with test pile item)**. The quantity will be the ordered number of linear meters of piles shown on the contract plans and any additional lengths ordered placed in the leads by the Engineer.

## BASIS OF PAYMENT

Piles. The unit price bid per linear meter for each of the respective pile items includes the cost of furnishing all labor (including the manipulation of pile driving equipment and materials), materials and equipment (excluding pile driving equipment) necessary to complete the work as prescribed in the Specifications including the following additions:

**A. Structure Excavation**. Work associated with the removal of any material forced up above the foundation by the driving of piles shall be included in the cost of the pile.

**B. Defective Piles**. No payment will be made for piles rejected in accordance with the requirements of CONSTRUCTION DETAILS -N. Defective Piles., of this Specification.

**C. Backfilling**. Payment for backfilling of all cavities left by the extraction of damaged piles or from auger holes or soil deformations necessary to place piles will be included in the work for the respective pile item.

**D. Redriving Piles**. The cost of driving piles that are forced up by any cause shall be included in the unit price bid for the respective pile item.

**E. Ordering Piles**. Any piles ordered by the Contractor prior to receipt of the Engineer's order list shall be the Contractor's responsibility and expense.

**F. Pile Splices, etc**. The cost of furnishing and using pile splices, followers, augers, or spuds shall be included in the unit price bid for the respective pile item.

Furnishing equipment for driving piles will be paid for separately under its appropriate item.

Progress Payments for Piles. Progress payments will be made when the piles are properly installed in accordance with the plans, specifications and orders of the Engineer. Payment will be made, at the unit price bid, for eighty (80) percent of the quantity properly installed exclusive of cutting off piles. The balance of the quantity will be paid for upon completion of the work including the cutting off of piles.