Index D22600 Series Carbon Fiber Reinforced Polymer (CFRP) Concrete Piles

Design Criteria

ACI 440.4R-04; AASHTO LRFD Bridge Design Specifications, 6th Edition; Structures Design Guidelines (SDG); Structures Detailing Manual (SDM)

Design Assumptions and Limitations

Developmental Design Standard Index D22600 is the lead standard for the Square CFRP Prestressed Concrete Pile standard series which includes Developmental Design Standard Indexes D22600 through D22624. Use this standard with Developmental Design Standard Indexes D22601, D22614, and D22624.

Standard piles are designed to have 1,000 psi uniform compression after prestress losses without any applied loads to offset tensile stresses that occur during typical driving. The modulus of elasticity of each strand type used in the indexes can be found below.

Table 1 Strand Modulus of Elasticity

<table>
<thead>
<tr>
<th>CFRP Strand Diameter</th>
<th>Modulus of Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5&quot;</td>
<td>18,000 ksi</td>
</tr>
<tr>
<td>0.6&quot;</td>
<td>22,481 ksi</td>
</tr>
</tbody>
</table>

The piles are designed to have 0.0 psi tension using a load factor of 1.5 times the pile self-weight during pick-up, storage and transportation as shown in the "Table of Maximum Pile Pick-Up and Support Lengths" on the standard.

Plan Content Requirements

Insert the entire Developmental Design Standards Index, received from the Central Office monitor, into the appropriate component plan set in accordance with PPM, Volume 2, Section 3.8.

In the Structures Plans:

Show and label the piles on the Foundation Layout, End Bent, Intermediate Bent, Pier, Footing, Typical Section and other sheets as required.

Complete the following "Data Table", using the "20600 Pile Data Table" cell, in accordance with SDG 3.5 and SDM 11.4 and include it in the contract plans with the "Foundation Layout" sheets. Modify table and notes as required to accommodate the required number of piles, piers and/or bents, use of Test Piles and instrumentation. When not enough space is available on one plan sheet, continuations of the Data Table and/or separate pile cut-off elevation tables are acceptable. See Introduction I.3 for more information regarding use of Data Tables.

For projects without Test Piles change data table column heading "TEST PILE LENGTH (ft.)" to "PILE ORDER LENGTH (ft.)".
### Pile Data Table

<table>
<thead>
<tr>
<th>Installation Criteria</th>
<th>Design Criteria</th>
<th>Pile Cut-off Elevations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pier or Bent Number</td>
<td></td>
<td>PiLe 1</td>
</tr>
<tr>
<td>Pier Size (in.)</td>
<td></td>
<td>PiLe 2</td>
</tr>
<tr>
<td>Nominal Bearing Resistance ( tons)</td>
<td></td>
<td>PiLe 3</td>
</tr>
<tr>
<td>Nominal Drift Resistance ( tons)</td>
<td></td>
<td>PiLe 4</td>
</tr>
<tr>
<td>Minimum Tip Elevation (ft.)</td>
<td></td>
<td>PiLe 5</td>
</tr>
<tr>
<td>Test Pile Length (ft.)</td>
<td></td>
<td>PiLe 6</td>
</tr>
<tr>
<td>Required Net Elevation (ft.)</td>
<td></td>
<td>PiLe 7</td>
</tr>
<tr>
<td>Required Net Elevation (ft.)</td>
<td></td>
<td>PiLe 8</td>
</tr>
<tr>
<td>Factor Design Load (tons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor Design Load (tons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Down Drain (tons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Scour Resistance ( tons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Scour Resistance ( tons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 Year Scour Elevation (ft.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Term Scour Elevation (ft.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pile Installation Notes (Notes Date 7/4/1993)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Factor Design Load + Net Scour Resistance = Down Drain**

- **Nominal Bearing Resistance**: The ultimate side friction capacity that must be exceeded below the 100 year scour elevation to resist pullout of the pile

- **Tension Resistance**: The ultimate side friction capacity of the pile that must be exceeded below the 100 year scour elevation to resist pullout of the pile

- **Total Scour Resistance**: An estimate of the ultimate static side friction resistance provided by the scour resistance in the soil from the required preferred or jetting elevation to the scour elevation.

- **Net Scour Resistance**: An estimate of the ultimate static side friction resistance provided by the scour resistance in the soil from the required preferred or jetting elevation to the scour elevation.

- **100 Year Scour Elevation**: Estimated elevation of scour due to the 100 year storm event.

- **Long Term Scour Elevation**: Estimated elevation of scour used in design for extreme event loading.

- **Pile Installation Notes**: Contractor to verify location of all utilities prior to any pile installation activities.

- **Minimum Tip Elevation** is required for lateral stability.

- **Jetting will be allowed** when a required jetting elevation is shown. The jet shall be lowered to the elevation and continue to operate at this elevation until the jetting is completed. If jetting or precleaning operations differ from those shown on the plans, the Engineer shall be responsible for determination of the required jetting elevation.

- At each Bent, pile driving is to commence at the center of the Bent and proceed outward.
Payment

<table>
<thead>
<tr>
<th>Item number</th>
<th>Item description</th>
<th>Unit Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>455-34-AA</td>
<td>Prestressed Concrete Piling</td>
<td>LF</td>
</tr>
</tbody>
</table>

Design Aids

![](image)

**Design Assumptions:**

- Concrete compressive strength $f'c = 6$ ksi.
- Modulus of elasticity of prestressing strands, See Table 1.
- Resistance factor $\Phi$ based on ACI 440.4R-04
  (0.65 compression controlled, 0.85 tension controlled)
- All piles assumed to have spiral ties.
- Strand sizes and strand patterns used to create interaction curves correspond with those indicated in Developmental Design Standard Index 22614.
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- Modulus of elasticity of prestressing strands, See Table 1.
- Resistance factor $\Phi$ based on ACI 440.4R-04
  (0.65 compression controlled, 0.85 tension controlled)
- All piles assumed to have spiral ties.
- Strand sizes and strand patterns used to create interaction curves correspond with those indicated in Developmental Design Standard Index 22624.