



STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

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GOVERNOR

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November 28, 2011

MEMORANDUM TO: K. J. Kim, P.E.
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Western Regional Geotechnical Manager

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Geotechnical Contracts and Statewide Services Manager

FROM: *Njoroge Wainaina*
Njoroge W. Wainaina, P.E.
State Geotechnical Engineer

SUBJECT: **Geotechnical Design Guidelines for Bridges using Structure Design Standard Loads**

Please find attached the Geotechnical Engineering Unit design guidelines for bridges that use the Structure Design Standard Loads. Please distribute these guidelines to the proper personnel. The guidelines will also be made available on our website at

<http://www.ncdot.org/doh/preconstruct/highway/geotech/contractserv/StandardDesignGuidelines.pdf>

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www.ncdot.gov/doh/preconstruct/highway/geotech

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Required Pile Length for Lateral Stability Design Charts for Standard Bridges (Revised 11/28/2011)

LPILE 5.0 was used to develop charts that may be used for standard bridges to determine the required pile length for lateral stability based on a given unbraced length. The charts were developed using the following assumptions;

1. Axial, longitudinal, and transverse loads, pile spacing, and number of piles are based on the Structure Design Loads for Standard Bridges.
2. The groundwater table is at or above the ground surface.
(When using the charts for design, it is ok if the groundwater table is below the ground surface.)
3. Lateral deflection at the top of the pile is limited to 6 inches for steel piles and 3 inches for concrete piles.
4. Soil parameters are listed in the table below;

Soil Type	p-y Curve Model for LPile	Total Unit Wt. (pcf)	Effective Unit Wt.		Friction Angle (deg)	Cohesion, c		Modulus k (pci)	Strain Factor E_{50}
			Geotech (pcf)	LPile (pci)		Geotech (psf)	LPile (psi)		
Soft Clay	Soft Clay (Matlock)	110	50	0.029	N/A	400	2.8	N/A	0.02
Medium Clay	Stiff Clay w/ Free Water (Reese)	120	60	0.035	N/A	800	5.6	100	0.01
Loose Sand	Sand (Reese)	120	60	0.035	30	N/A	N/A	20	N/A
Dense Sand	Sand (Reese)	130	70	0.041	38	N/A	N/A	125	N/A

Directions for using the design charts

1. Determine the soil type.

For pile bent locations where the majority of the foundation material is clay, select the cohesive chart.

The chart gives required total pile lengths for both piles in soft clay and piles in medium clay as a function of unbraced length. If the foundation material is in between soft and medium clay, the required total pile length can be estimated by taking the average of the value for soft clay and medium clay.

For pile bent locations where the majority of the foundation material is sand, select the cohesionless chart. The chart gives required total pile lengths for both piles in loose sand and piles in dense sand as a function of unbraced length. If the foundation material is medium sand, the required total pile length can be estimated by taking the average of the value for loose sand and dense sand.

For pile bent locations where the soil is mix of sand and clay, select the cohesionless chart.

2. Determine the unbraced length of the pile.

For bents not subject to scour

Unbraced Length = Bottom of Cap Elevation – Ground Elevation + 5 ft

For all bents subject to scour

Unbraced Length = Bottom of Cap/Bottom of Footing Elevation – Design Scour Elevation

3. Determine the average span length based on the length of the two spans that are supported by the pile.

For average span lengths up to 70 ft, use a pile that is identified by a line.

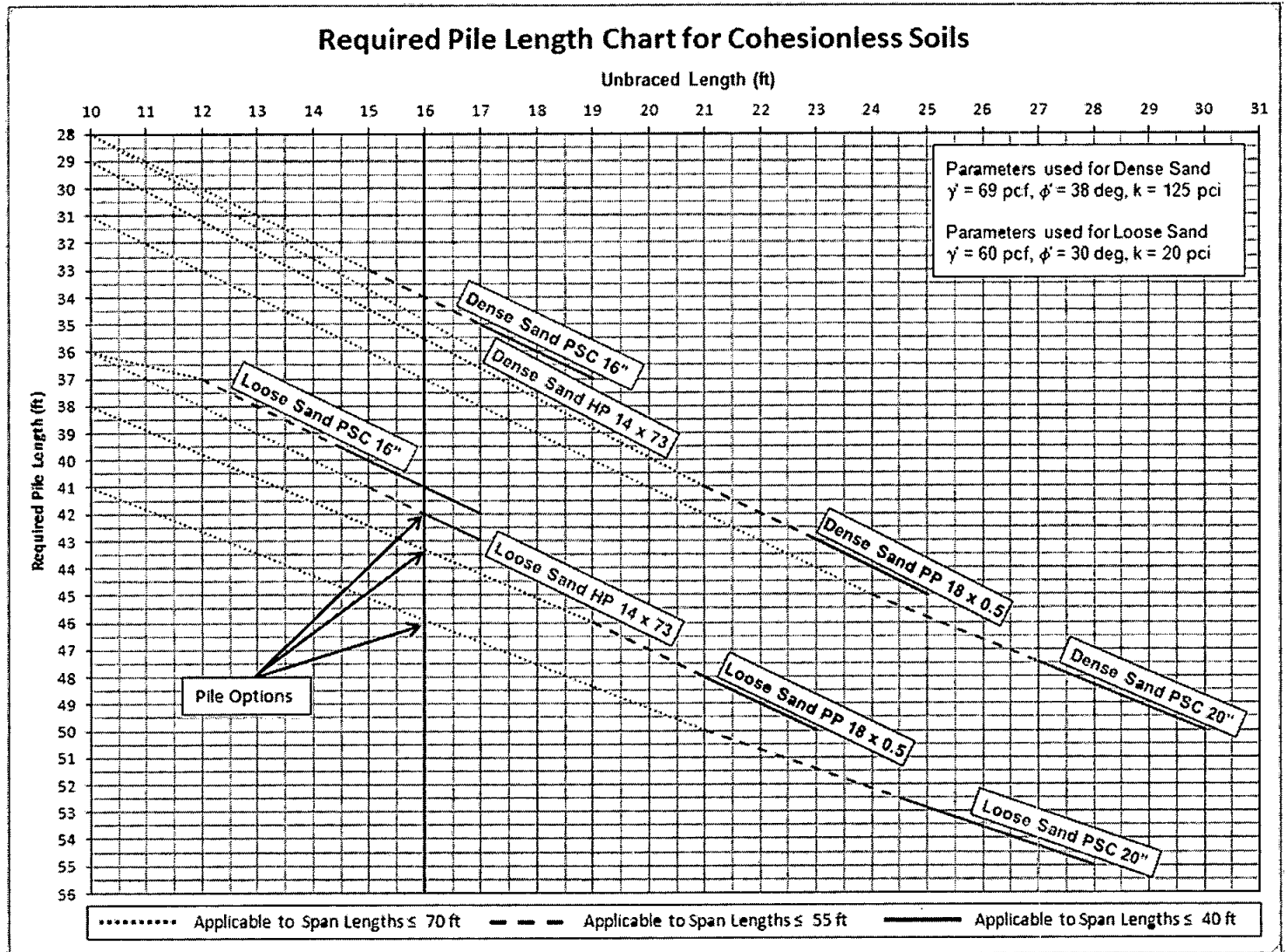
For average span lengths up to 55 ft, use a pile that is identified by a line or a --- line.

For average span lengths up to 40 ft, use a pile that is identified by a line or a --- line, or a ——— line.

4. Determine the total pile length using a pile that satisfies the conditions established in steps 1 – 3.

Example

Given: The foundation material is loose sand
 The unbraced length = 16 ft
 The average bridge span length = 50 ft



Based on the given information and the *Required Pile Length Charts*, there are three piles that may be used. These three options are listed below and also shown on the chart above. The 16" Prestressed Concrete Pile is not an option because in loose sand with an unbraced length of 16 ft, it can only be used for average span lengths less than or equal to 40 ft.

Option 1 - HP 14 x 73 Steel Pile – Required Total Pile Length = 42 ft.

The chart shows that in loose sand with an unbraced length of 16 ft, this pile can be used for average span lengths less than or equal to 55 ft.

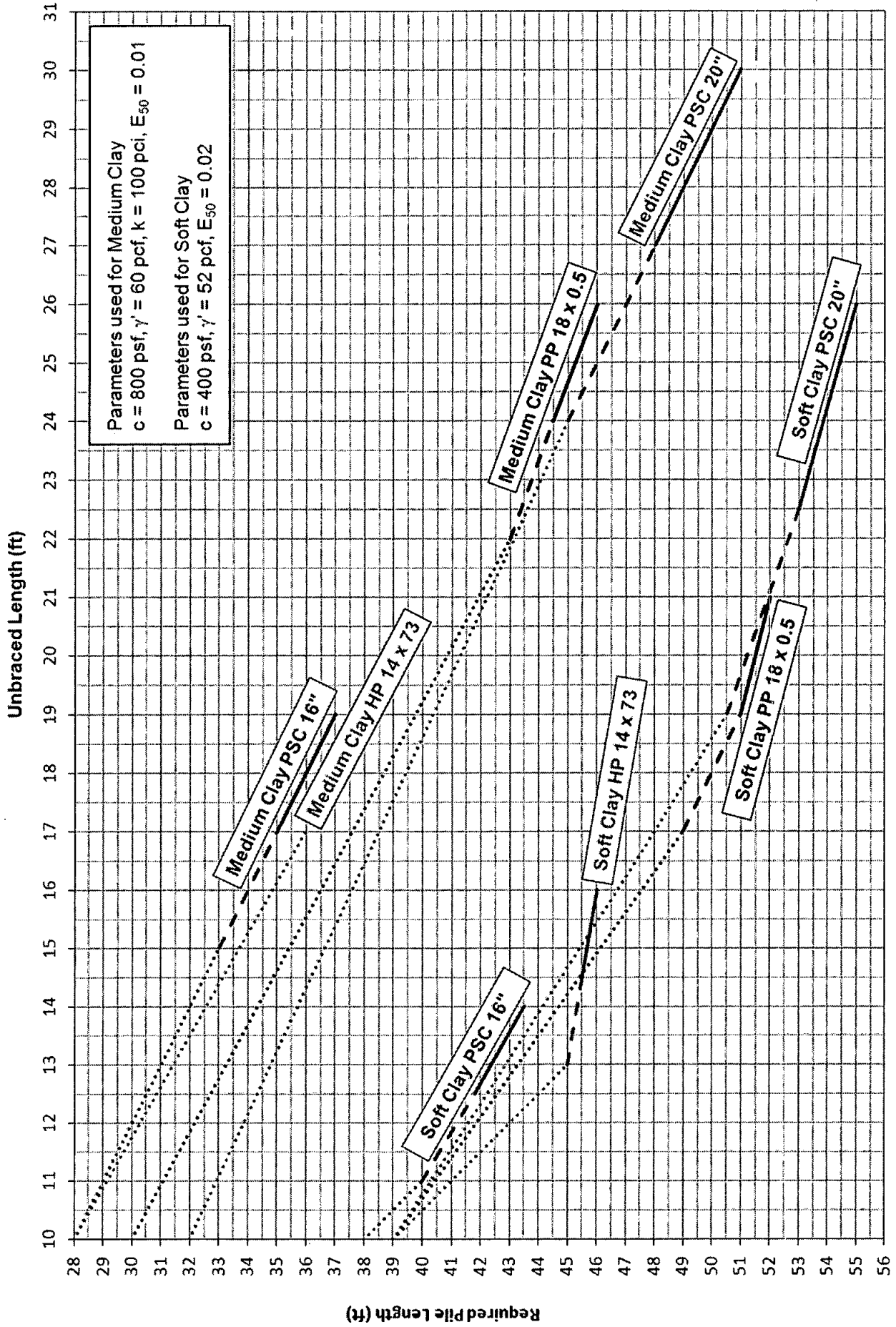
Option 2 - PP 18 x 0.5 Pipe Pile – Required Total Pile Length = 43.5 ft.

The chart shows that in loose sand with an unbraced length of 16 ft, this pile can be used for average span lengths less than or equal to 70 ft.

Option 3 - PSC 20" Prestressed Concrete Pile – Required Total Pile Length = 46 ft

The chart shows that in loose sand with an unbraced length of 16 ft, this pile can be used for average span lengths less than or equal to 70 ft.

Required Pile Length Chart for Cohesive Soils



..... Applicable to Span Lengths ≤ 70 ft - - - Applicable to Span Lengths ≤ 55 ft — Applicable to Span Lengths ≤ 40 ft

