Userguide Pole Embedment Calculator (PEC) Vsn. 1.974

The Pole Embedment Calculator is a Microsoft Excel spreadsheet developed to assist designers to determine pole butt embedment depth given a variety of soil and pole loading conditions. The code and model used within the spreadsheet have been developed based on the Brinch-Hansen method for simulation of piles under lateral loading. Although testing and validation have been performed, it cannot be guaranteed that the PEC code is free of errors. The accuracy at which reality is approximated depends highly on the expertise of the user regarding the modelling of the problem, the understanding of the soil models and their limitations, the selection of model parameters, and the ability to judge the reliability of the computational results. Hence PEC should only be used by professionals that possess the aforementioned expertise. The user must be aware of his/her responsibility when he/she uses the computational results for design purposes. Neither Ausgrid nor Foundation QA can be held responsible or liable for design errors that are based on the output of PEC calculations.

Foundation Design Process

The spreadsheet and this user guide can be found on Ausgrid's internal network location shown below.

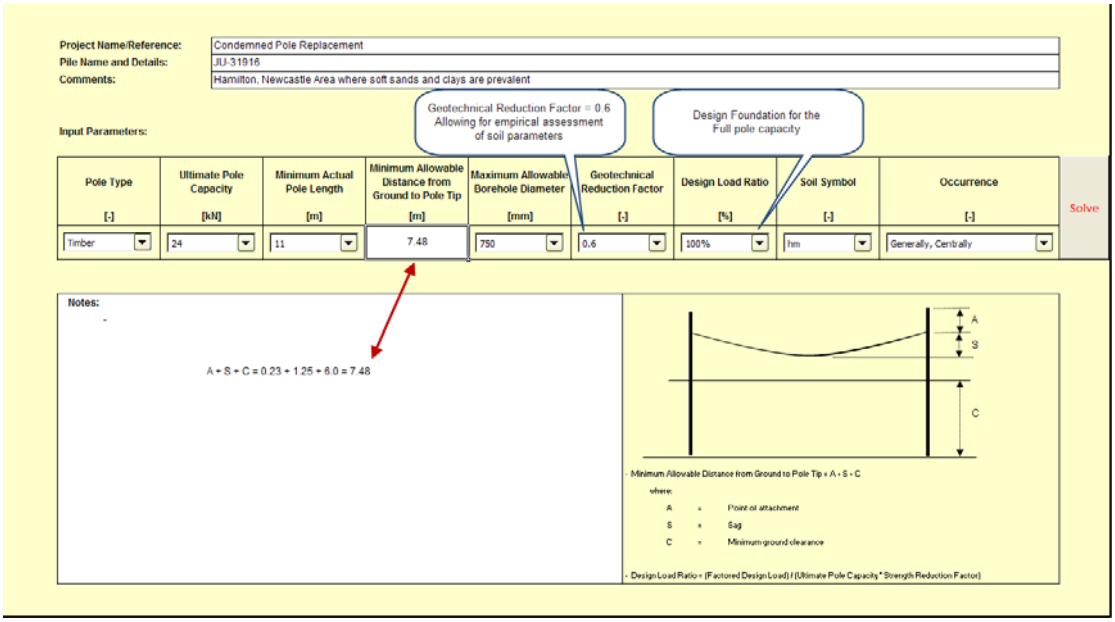
\\hydrogen\TL-Pro Libraries\Pole Embedment Calculator (Internal link)

It is also accessible via the BALIN web-site under the Network Standards link, then NS-220. In addition, it can also be downloaded from the publicly accessible Ausgrid web-site below:

http://www.ausgrid.com.au/Common/Our-network/Standards-and-Guidelines/Network-standards.aspx

(external link – listed on page adjacent entry for NS-220, towards the bottom of the page)

THE PEC spreadsheet consists of four tabbed sheets – Opening, Input, Soil Layers and Results. Enter relevant details to the 'Input' sheet of PEC:

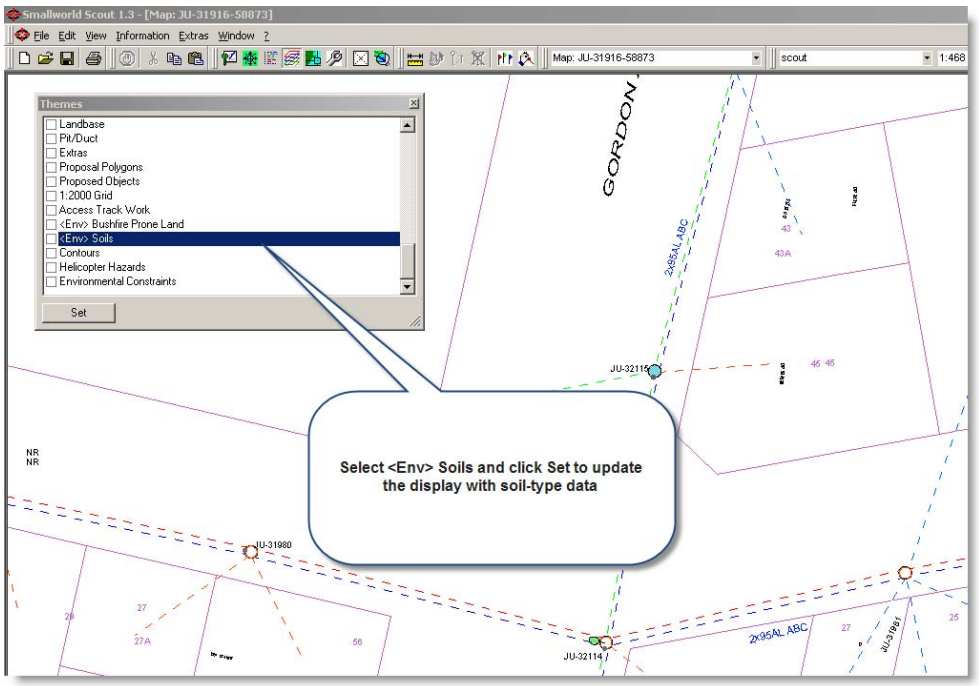


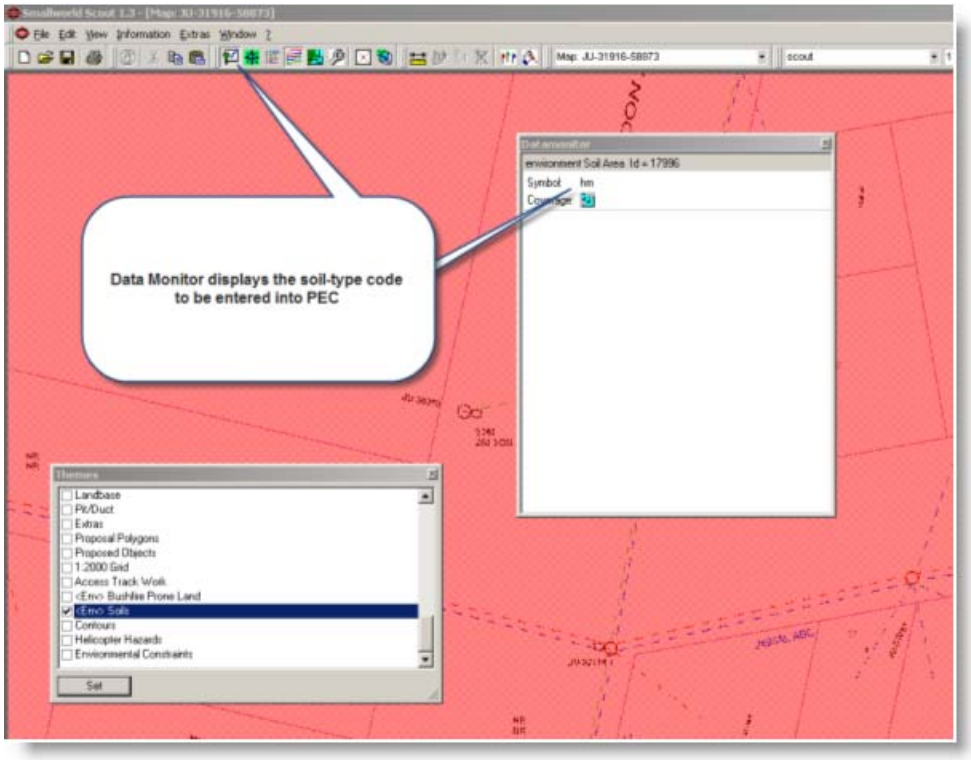
Notes:

1. *Pole foundation design is an integral part of the design process for overhead pole lines and pole embedment is best established as part of the optimal pole-spotting stage, where ground clearance checks and load analysis determine pole nominal lengths and strengths ("Minimum Pole Length" and "Ultimate Pole Capacity"). A nominal embedment of 0.1 * pole length + 1.0m is assumed for this part of the design process.*
2. *The "Maximum Allowable Distance from Ground to Pole Tip = A + S + C = 7.48m. This allows PEC to trial successive embedment depths, starting from a minimum depth of 1.0m, until this value (7.48) is reached and if the foundation is still inadequate, the next nominal pole length is selected.*
3. *Once a suitable embedment is established, load analysis on the pole should be repeated, since moments about ground level and pole diameter at ground level may have changed.*
4. *Soil strength data is based on empirical assessment rather than testing, therefore "Geotechnical Reduction Factor" = 0.6 (Reference AS/NZS7000 Table 6.2).*
5. *In high bearing strength soils an absolute minimum foundation depth of (0.1 * pole length + 0.6m) should be used, even if the PEC recommends a shallower foundation.*

Soil Data

Ausgrid's geotechnical data is contained within the Smallworld Scout GIS. The GIS data base provides a code which allows for the identification of soil strength design parameters at the pole site:





Enter relevant details to the 'Soil Layers' sheet of PEC.

Entry of the 'Soil Symbol' (hm) and the 'Occurrence' (related to the local terrain), automatically populates the relevant soil strength parameters in the 'Soil Layers' sheet:

No of Layers	2							
Depth of Water Table	12	[m]						
Layering Details								
Layer No.	Depth [m]		Soil Type	Soil Description	Soil Parameters	C	φ	γ
	From	To				[kPa]	[deg]	[kN/m3]
1	0	5	Sand	Loose to Medium Dense	Automatic	0.0	30.0	17.5
2	5	20	Clay	Soft to Firm	Automatic	28.1	0.0	16.2

These inputs can be manually adjusted if more detailed information, such as Cone Penetration Test data, is available.

Clicking on the 'Solve' button in the 'Input' sheet provides a set of foundation solutions in the 'Results' sheet:

Project Name/Reference:	Condemned Pole Replacement
Pile Name and Details:	JU-31916
Comments:	Hamilton, Newcastle area, where soft sands and clays are prevalent

Backfill type	Design Specification	Bore Diameter								
		450	500	600	750	900	1050	1200	1350	1500
Concrete	Pole Length	Not applicable	Not applicable	11	11	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Pole Butt Diameter	Not applicable	Not applicable	309	309	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Pole Head Diameter	Not applicable	Not applicable	203	203	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Required Penetration	Not applicable	Not applicable	3.27	3.08	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Compacted Selected Backfill	Pole Length	Not applicable	Not applicable	11	11	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Pole Butt Diameter	Not applicable	Not applicable	309	309	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Pole Head Diameter	Not applicable	Not applicable	203	203	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Required Penetration	Not applicable	Not applicable	3.48	3.36	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Excavated Soil	Pole Length	Not applicable	Not applicable	12.5	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Pole Butt Diameter	Not applicable	Not applicable	326	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Pole Head Diameter	Not applicable	Not applicable	206	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Required Penetration	Not applicable	Not applicable	3.98	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

* Note: If the pole length is typed in red, it means that the selected suitable pole is different from the initial nominated pole.

Notes:

1. *An allowance is made for 100mm clearance between the pole butt and the wall of the bored hole (i.e., minimum bore diameter = pole butt diameter + 200mm). There are therefore no solutions for a 450mm and 500mm bore.*
2. *The foundation solutions include for three types of backfill:*
    - *Excavated soil*
    - *Compacted Selected Soil (equivalent to road base)*
    - *Concrete (preferably supplied as a premix: Standard Strength Grade = 25MPa, Maximum Nominal Aggregate size = 20mm)*

Now assume that other underground services restrict the maximum bore diameter to 600mm.

Assume also that Cone Pressure and Borehole tests have been conducted at the pole site, the results of which are entered manually in the 'Soil Layers' sheet:

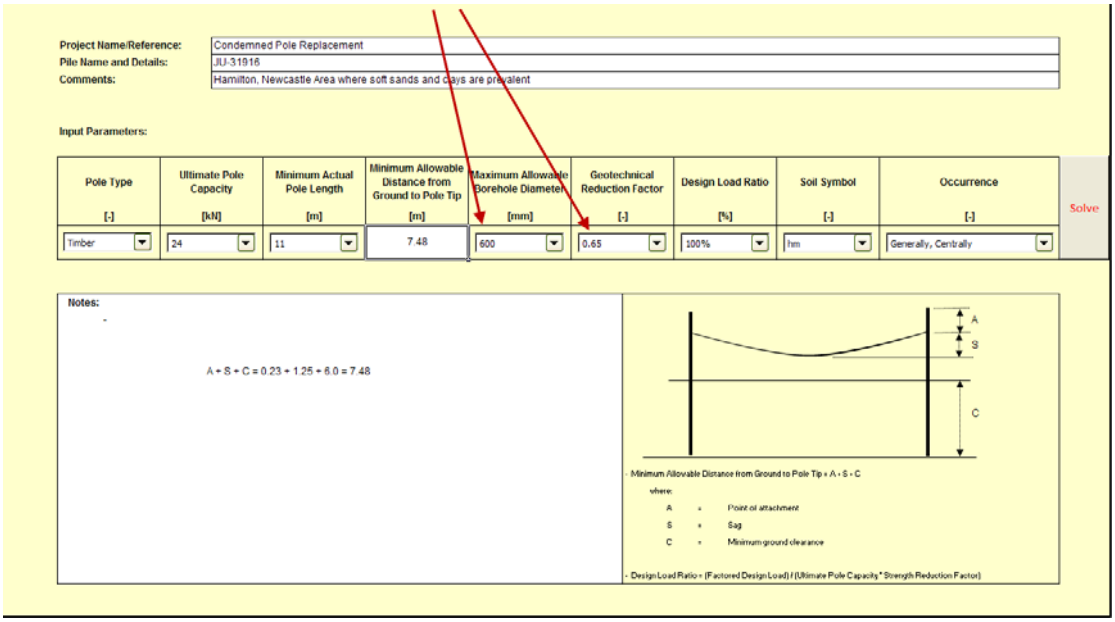
No of Layers	2	
Depth of Water Table	12	[m]

Layering Details

Layer No.	Depth [m]		Soil Type	Soil Description	Soil Parameters	C	φ	γ
	From	To				[kPa]	[deg]	[kN/m3]
1	0	4.5	Sand	Loose to Medium Dense	Manual		31.0	17.8
2	4.5	20	Clay	Soft to Firm	Manual	28.2		16.3

Change the Maximum Bore Diameter to 600 and

Change the Geotechnical Reduction Factor to 0.65 (conventional soil testing):



Click on the ‘Solve‘ button (which appears after any input is changed) to calculate a new set of solutions:

Project Name/Reference:	Condemned Pole Replacement
Pile Name and Details:	JU-31916
Comments:	Hamilton, Newcastle area, where soft sands and clays are prevalent

Backfill type	Design Specification	Bore Diameter								
		450	500	600	750	900	1050	1200	1350	1500
Concrete	Pole Length	Not applicable	Not applicable	11	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Pole Butt Diameter	Not applicable	Not applicable	309	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Pole Head Diameter	Not applicable	Not applicable	203	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Required Penetration	Not applicable	Not applicable	3.23	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Compacted Selected Backfill	Pole Length	Not applicable	Not applicable	11	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Pole Butt Diameter	Not applicable	Not applicable	309	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Pole Head Diameter	Not applicable	Not applicable	203	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Required Penetration	Not applicable	Not applicable	3.44	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Excavated Soil	Pole Length	Not applicable	Not applicable	12.5	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Pole Butt Diameter	Not applicable	Not applicable	326	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Pole Head Diameter	Not applicable	Not applicable	206	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Required Penetration	Not applicable	Not applicable	3.86	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

The set of solutions allows the Designer to choose the type of backfill, which may be influenced by economics or constructability.

Pole embedment depth, borehole size and type of backfill should be noted on the Construction Drawing.

In this case, influenced by the practicalities of boring a hole to greater depths in poor holding soils, the most suitable solution specified on the construction plan is an embedment depth of 3.23m with concrete backfill, using a 600mm auger.