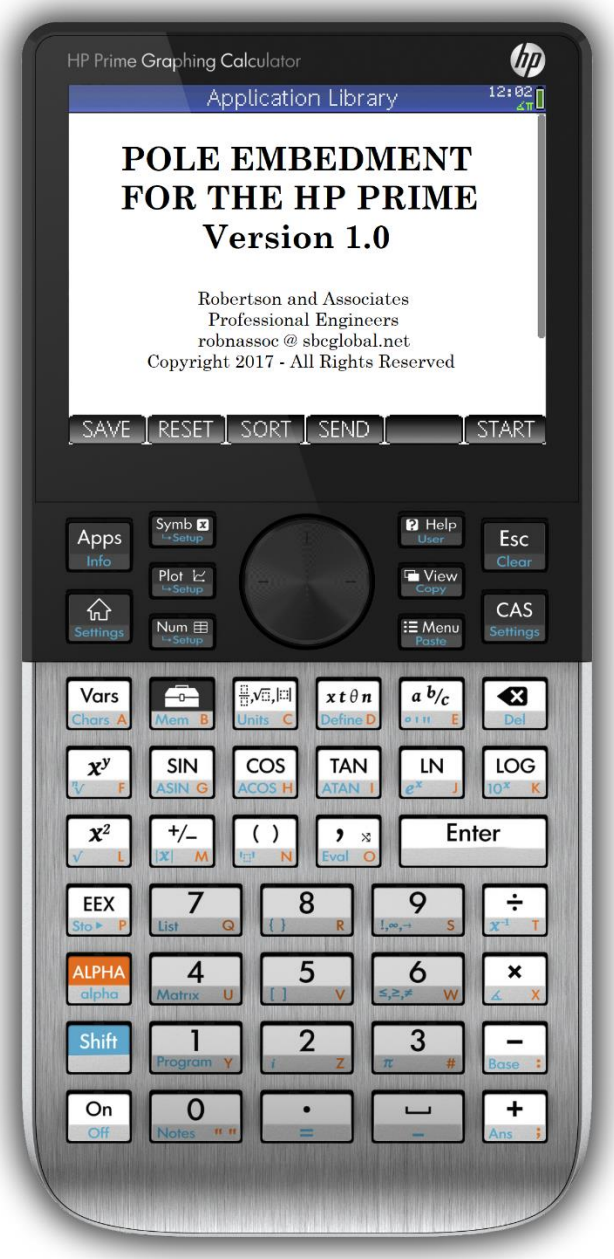
POLE EMBEDMENT FOR THE HP PRIME USER MANUAL



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POLE EMBEDMENT FOR THE HP PRIME

ROBERTSON AND ASSCOIATES
PROFESSIONAL ENGINEERS
19744 BEACH BLVD #431
HUNTINGTON BEACH, CA 92648
robnassoc@sbcglobal.net

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SYMBOLS AND NOTATION

The system of units used in the "Pole Embedment for the HP Prime Calculator" is the English (inch-pound) System. The following general symbols and units are used in the program:

Symbol/Notation	Definition	Units
a1, a2	*Start/End Location of Uniform Lateral Load*	*ft*
b	*Diameter of Round Pole*	*in*
b, d	*Dimensions of Rectangular Pole*	*in*
De	*Required Pole Embedment Depth*	*ft*
H	*Height of Pole*	*ft*
h1, h2	*Location of Concentrated Lateral Loads*	*ft*
LDFE	*Load Duration Factor for Seismic Loads*	
LDFW	*Load Duration Factor for Wind Loads*	
M	*Moment at Base of Pole*	*ft-lbs*
P1, P2	*Concentrated Lateral Loads on Pole*	*lbs*
PaDL	*Axial Dead Load on Pole*	*lbs*
PaLL	*Axial Live Load on Pole*	*lbs*
Sb	*Vertical Soil Bearing Capacity*	*psf*
SbAct	*Actual Vertical Soil Bearing Pressure*	*psf*
Smax	*Maximum Lateral Soil Bearing Capacity*	*psf*
Sp	*Lateral Soil Bearing Capacity*	*pcf*
SpAct	*Actual Lateral Soil Bearing Pressure*	*psf*
SpAllow	*Allowable Lateral Soil Bearing Pressure*	*psf*
V	*Shear at Base of Pole*	*lbs*
w	*Uniform Lateral Load on Pole*	*plf*
Δ Error	*Error of Convergence for De Calculation*	*%*

INTRODUCTION

This User Manual is intended for those users experienced with the operation of the HP Prime Calculator and an extensive background in structural engineering analysis and design. This User Manual also provides a discussion regarding program development and validation.

The "Pole Embedment for the HP Prime" is intended to assist Professional Engineers with routine analysis and determination of required embedment depth of poles embedded in earth or concrete. It is not intended to be used in place of more rigorous computer programs where required. The program can be used where portability is desired and is a great tool for structural engineering students and those preparing for the Professional Engineers and Structural Engineers Exams.

Other similar programs covering Concrete, Steel, Aluminum and Masonry Design, Properties of Composite Materials Sections, Structural Analysis and Frame Stability Analysis are also available.

OVERVIEW OF PROGRAM

The Pole Embedment Program performs calculations to determine the required embedment depth for both round and rectangular shaped poles embedded in earth or concrete. Pole configurations that the program can evaluate include laterally restrained, laterally unrestrained and isolated poles. Loading conditions that the program can evaluate include axial dead and live loads, multiple concentrated lateral loads and uniformly distributed lateral loads, and seismic and wind loads. The user inputs the physical characteristics of the pole, soil design data and lateral and axial load data. The program calculates the following results for the pole:

- Shear at Base of Pole
- Moment at Base of Pole
- Required Pole Embedment
- Actual Lateral Soil Bearing Pressure
- Allowable Lateral Soil Bearing Pressure
- Vertical Soil Bearing Pressure

LIMITATIONS OF PROGRAM

The Pole Embedment for the HP Prime Program is intended to be used for the analysis and design of poles subjected to lateral and axial loads constructed of wood, steel, aluminum or other similar materials which are embedded in earth or concrete. ***The program should not be used for the analysis or design of drilled piers or caissons***.

Additionally, the program analyzes the pole conditions based upon the methodology set forth in Chapter 18 of the International Building Code. The analysis performed by the program considers only the adequacy of the soil strata in relation to the applied loading. The program does not analyze the structural adequacy of the pole itself in relation to the applied loading. Specifically, the program does not evaluate the following:

- Flexural Stresses in the Pole
- Shear Stresses in the Pole
- Axial Stresses in the Pole
- Deflection of the Pole Due to Lateral Loads
- Buckling of the Pole
- Corrosion of Embedded Portion of Pole

When surface restraint is specified, the restraint is assumed to be rigid and able to resist lateral reactions.

The Engineer should evaluate the above factors by separate means prior to finalizing the design. A Geotechnical Engineer should be consulted to determine the appropriate soil design data.

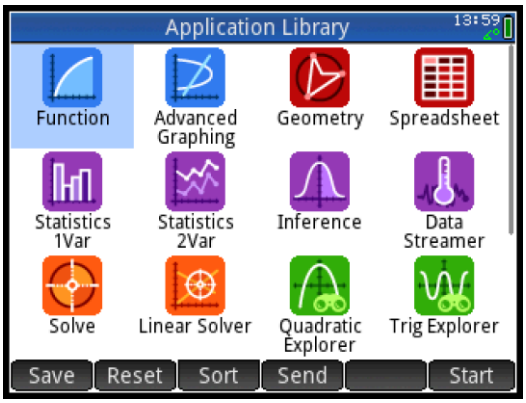
USE OF PROGRAM

Program usage consists of the following steps:

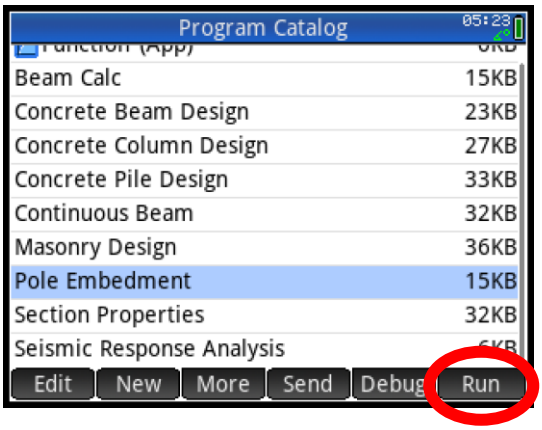
1. Input of Pole Characteristics
2. Input of Loading Conditions
3. Input of Soil Design Data
4. Display of Results

The following pole design will be considered for purposes of illustrating the use of the program:

Pole Shape – Round
Lateral Constraint – Laterally Constrained at Surface
Isolated Pole – Not an Isolated Pole
Pole Height – 5 ft
Pole Diameter – 6 in
Axial Dead Load – 300 lbs
Axial Live Load – 100 lbs
Concentrated Lateral Load 1 – 600 lbs, 3 ft Above Pole Base
Concentrated Lateral Load 2 – 800 lbs, 5 ft Above Pole Base
Uniform Lateral Load – 25 plf, Starts 1 ft/Ends 5 ft Above Pole Base
Allowable Lateral Soil Capacity – 100 pcf
Maximum Allowable Lateral Soil Capacity – 1500 psf
Maximum Allowable Soil Vertical Capacity – 1500 psf
Seismic Load Duration Factor – 1.00
Wind Load Duration Factor – 1.00

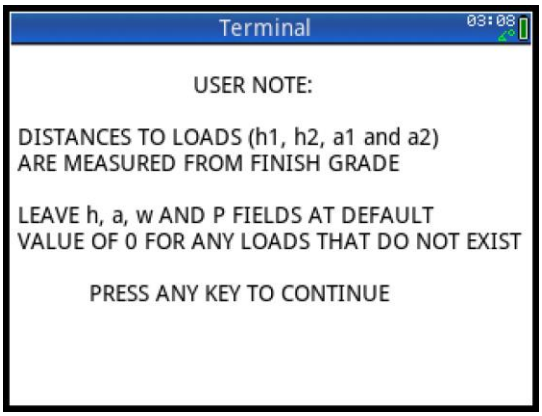


From the calculator's Main Screen or Home Screen enter ***[Shift] [1]*** to display the Program Catalog

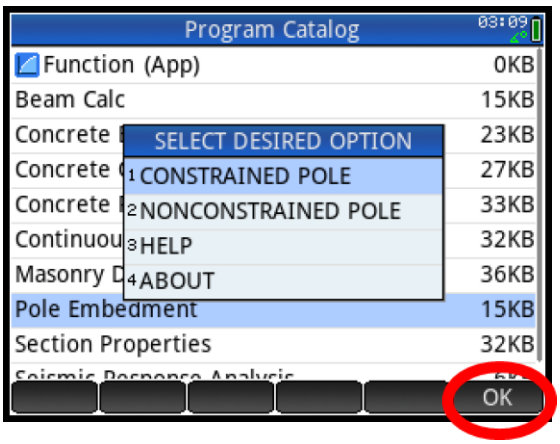


From the Program Catalog screen highlight ***Pole Embedment*** and press ***Run***

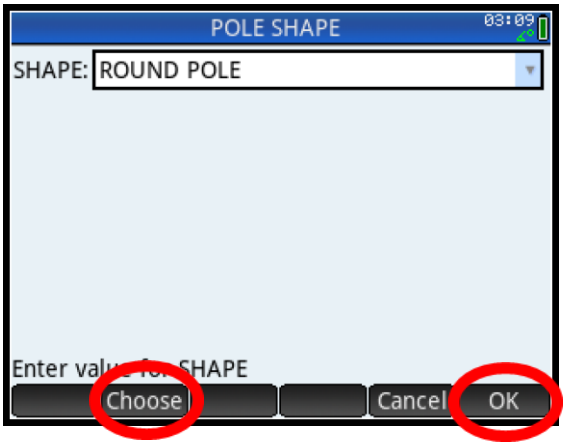
A brief introduction screen will be displayed



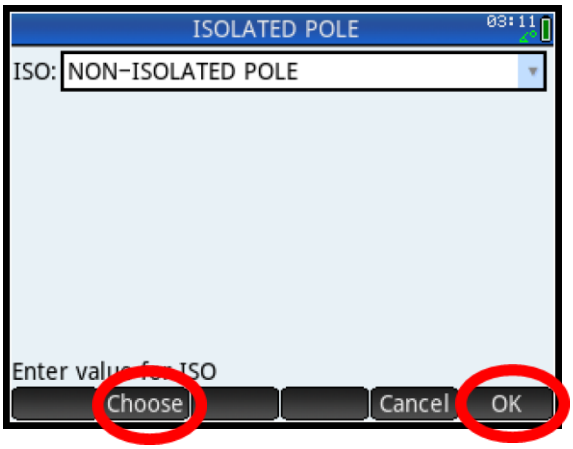
Following the introduction screen a User Note will be displayed regarding the entry of data. ***Press any key to continue.***



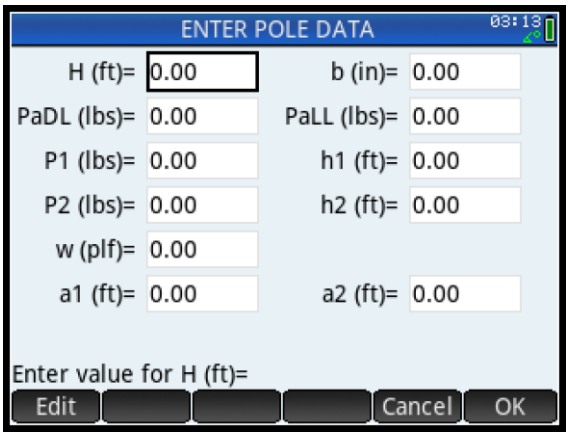
A menu will be displayed listing the available options. For purposes of the example highlight ***CONSTRAINED POLE*** and press ***OK***.



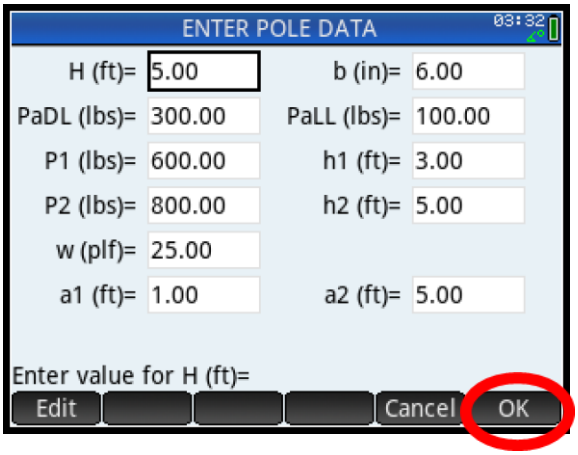
A drop down menu will be displayed allowing selection of pole shape. Select ***CHOOSE*** to display options. Otherwise select ***OK*** to accept displayed option.



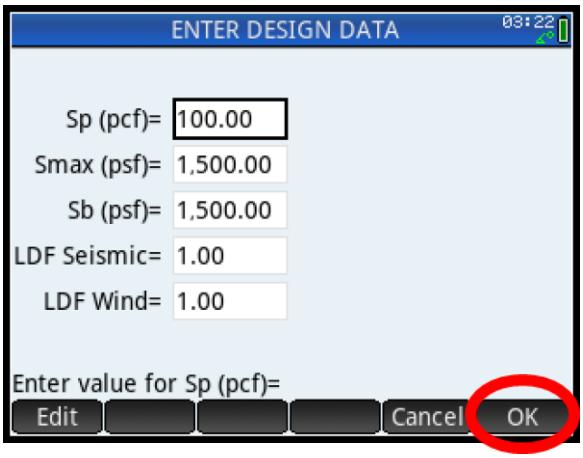
A drop down menu will be displayed allowing selection of an isolated or non-isolated pole. Select ***CHOOSE*** to display options. Otherwise select ***OK*** to accept displayed option.



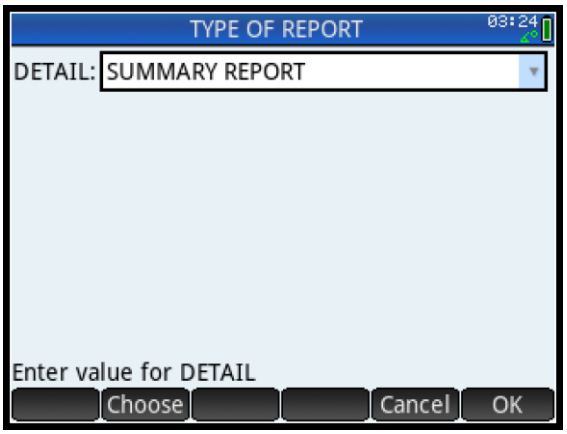
A data input screen will then be displayed. Cursor through the data fields and enter the appropriate values. If a load does not exist leave its data field at the default value of zero.



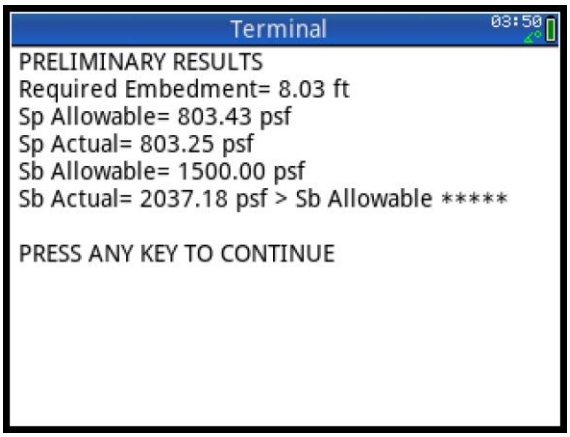
The data used for the example is displayed. Select ***OK*** to accept and continue.



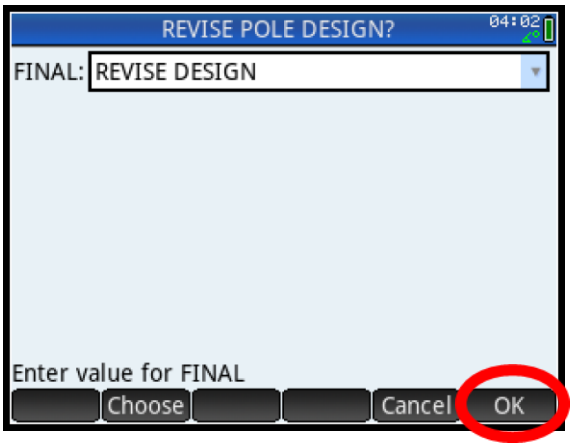
The next screen that will be displayed allows for the entry of design data. Cursor through the fields and enter the appropriate values. For the example the default values shown are appropriate. Select ***OK*** to accept and continue.



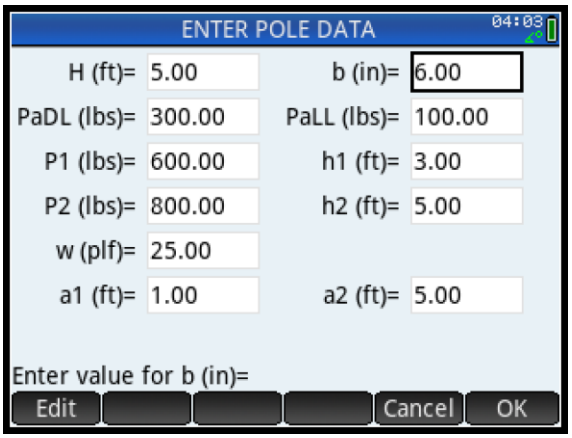
The next screen to be displayed is the Report Selection Screen. The drop down menu allows the user to select a Summary Report or Detailed Final Report. Initially, select Summary Report to review preliminary results of analysis. Select ***OK*** to accept and continue.



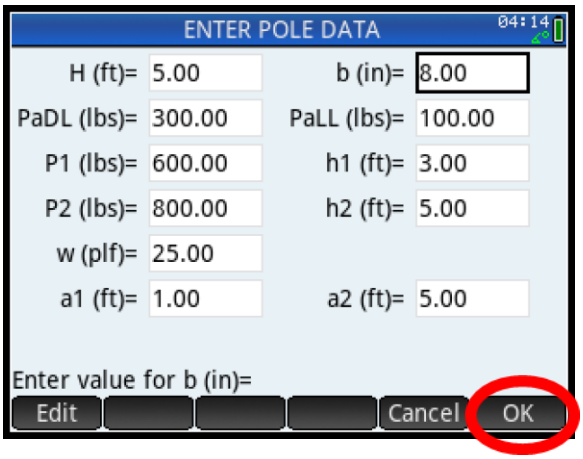
Preliminary Results will be display allowing the user to review the reasonableness of the results of the analysis. For the example, the Actual Vertical Bearing Pressure exceeds the allowable limit, so a larger pole is required. A larger pole will also reduce the required embedment depth. ***Press any key to continue***.



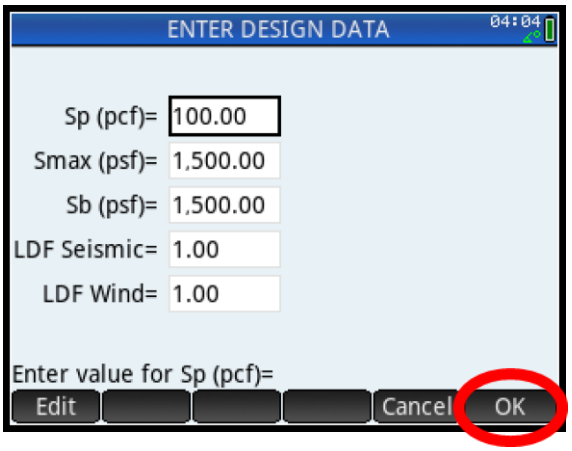
The user will then be given an opportunity to revise the design. Since a revised design is required for the example, leave the drop menu selection at Revise Design and select ***OK***.



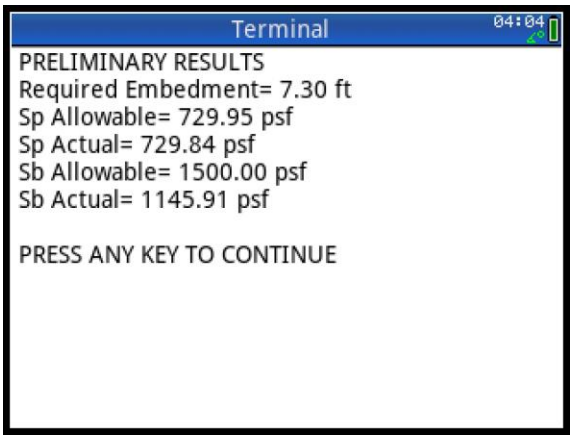
The program will return to the Pole Data Input Screen with the previous values shown as defaults. For the example change the pole diameter to 8 inches.



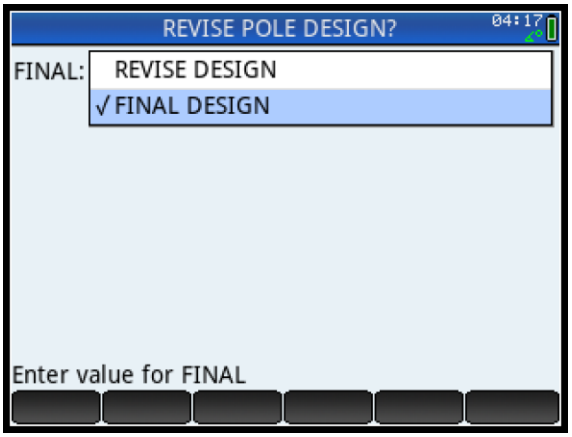
Move cursor to the ***"b"*** field and enter 8 and select ***OK*** to continue.



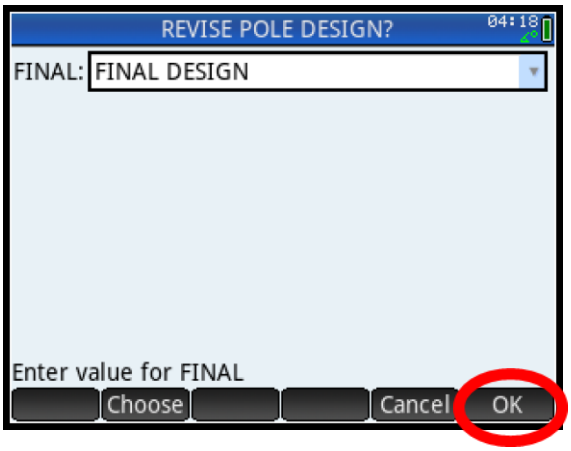
No revisions to the Design Data are required. Select ***OK*** to continue.



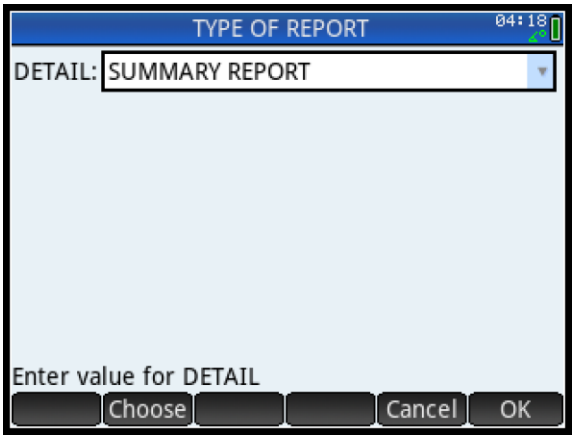
Preliminary Results for the revised design will then be displayed. ***Press any key to continue***.



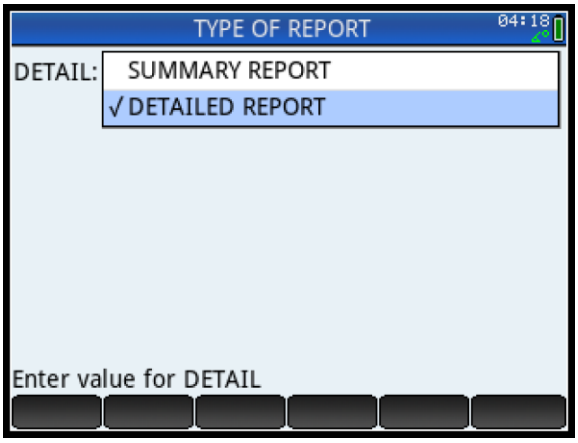
The next screen will allow the user to finalize the design if the preliminary results are acceptable. Select Final Design from drop down menu or Revise Design if additional design revisions are desired.



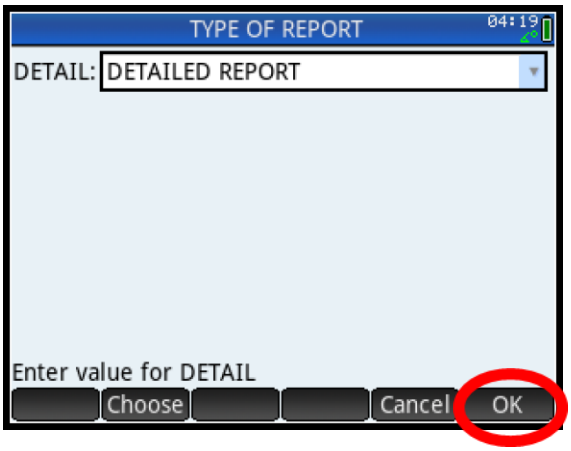
Once Final Design is selected, select ***OK*** to continue.



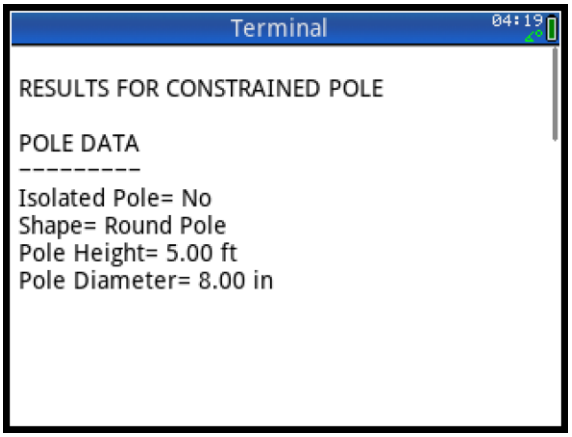
The user is given an opportunity to select any a Summary or Detailed Report of the results of the analysis.



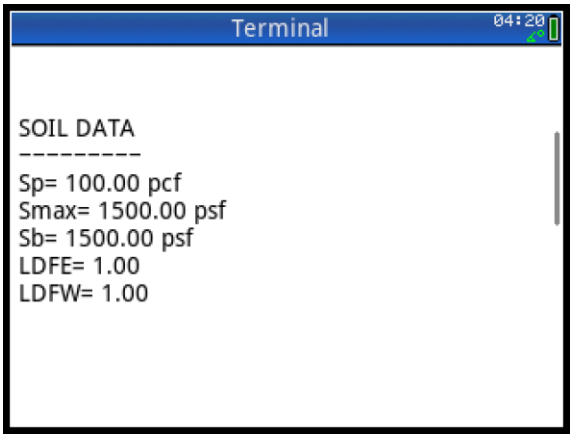
For the example a Detailed Report will be selected from the drop down menu.



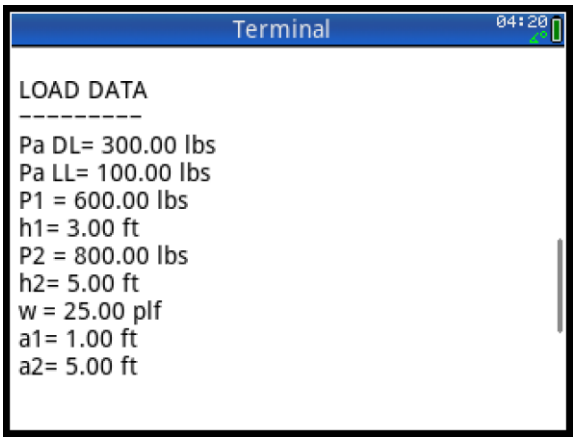
Select ***OK*** on to continue.



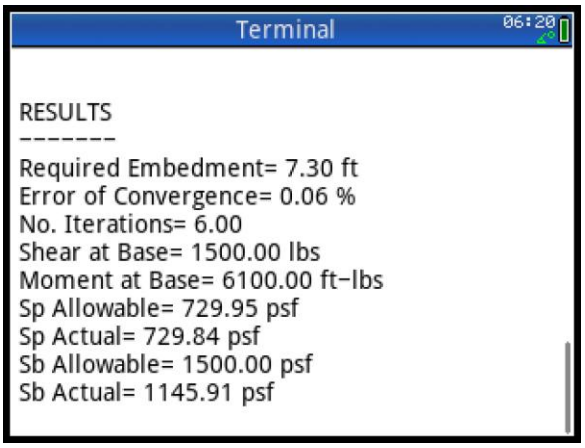
The results of the analysis will be displayed starting with the POLE DATA. Use the interactive touch screen on the calculator to scroll through the report.



SOIL DATA



LOAD DATA



RESULTS OF ANALYSIS

Robertson and Associates
Professional Engineering and Project Management
19744 Beach Blvd. #431
Huntington Beach, CA 92648
robnassoc@sbcglobal.net

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AAR					

SHEET INDEX

1. APPROACH

The Pole Embedment Program is based upon the approach presented in Chapter 18 of the International Building Code (IBC). This approach provides for two basic pole configurations, i.e. Non-Constrained Poles and Constrained Poles. Additionally, the IBC provides provision for Isolated Poles, e.g. billboards and signs. The Program allows the User to specify two concentrated lateral loads and one partial or full uniformly distributed lateral load.

To validate the Program numerous design conditions were analyzed using both the Program and manual calculations. The results of these analyses were then compared.

2. METHODOLOGY

Constrained Pole

When adequate lateral constraint is provided at the ground surface (e.g. rigid floor or ridged structural pavement) the IBC constrained pole provisions can be used. The IBC Constrained Pole equation is as follows:

$$d = \sqrt{4.25Ph/S3b} \qquad \text{Equation (1)}$$

Where: d = Required Pole Embedment Depth (ft)
P = Lateral Load on Pole (lbs)
h = Distance from Ground Surface to P (ft)
b = Diameter of Round Pole or Diagonal of Rectangular Pole (ft)
S3 = Allowable Lateral Soil Bearing Capacity Based on a Depth Equal to the Depth of Embedment (psf)

Non-Constrained Pole

When adequate lateral constraint is not provided at the ground surface the IBC non-constrained pole provisions are to be used. The IBC Non-Constrained Pole equation is as follows:

$$d = 0.5A[1 + (1 + \sqrt{4.36h/A})] \qquad \text{Equation (2)}$$

Where: A = 2.34P/S1b
b = Diameter of Round Pole or Diagonal of Rectangular Pole (ft)
d = Required Pole Embedment Depth but not Greater Than 12 feet for Purpose of Computing Lateral Pressure (ft)
P = Lateral Load on Pole (lbs)
h = Distance from Ground Surface to P (ft)
S1 = Allowable Lateral Soil Bearing Capacity Based on a Depth Equal to One-Third the Depth of Embedment (psf)

Maximum Allowable Lateral Soil Pressure

The program uses the IBC specified limits for establishing the maximum allowable lateral soil pressure on the embedded pole as follows:

Constrained Poles

Allowable Lateral Soil Pressure < Maximum Allowable Soil Pressure Capacity
< S3 x d
< S3 x 12

Non-Constrained Poles

Allowable Lateral Soil Pressure < Maximum Allowable Soil Pressure Capacity
< S1 x d/3
< S3 x 4

Isolated Pole

For isolated poles, e.g. signs and billboards, where they are not affected by a 1/2 –inch motion at the ground surface due to short-term lateral loads, the IBC allows for a 100 percent increase in allowable lateral bearing pressures.

3. NUMERICAL ANALYSIS

The program uses the Bisection Method to achieve a solution to both Equations 1 and 2. Typical analyses require five to six iterations for a solution. The acceptable error of convergence used in the program is set at 0.20% or less.

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Huntington Beach, CA 92648
robnassoc@sbcglobal.net

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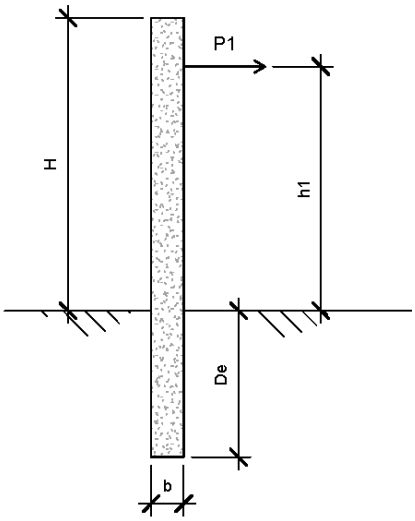
ROUND CONSTRAINED POLE

Not Isolated

H = 8 ft
P1 = 600 lbs
Sp = 100 pcf
Sb = 1500 psf
LDFE = 1.00

b = 12 in
h1 = 8 ft
Smax = 1500 psf

LDFW = 1.00



V =600 lbs
M=600 x 8 = 4,800 ft-lbs

From Numerical Analysis, Check d= 5.89 ft

Sp Allow < Smax = 1500 psf
< Sp x d = 100 x 5.89 = 589 psf ***CONTROLS***
< Sp x 12 = 100 x 12 = 1200 psf

Req'd d = $\sqrt{4.25Ph/Spb} = \sqrt{4.25 \; x \; 600 \; x \; 8 / 589 \; x \; 1}$ = 5.89 ft

Actual Sp = $4.25Ph/d^2b$ = 4.25 x 600 x $8/5.89^2$ x 1 = 588.03 psf ≈ 589 psf

REQ'D d = 5.89 FT

HP PRIME POLE EMBEDMENT PROGRAM RESULTS

d = 5.89 ft
Shear = 600.00 lbs
Sp Allowable = 588.64 psf
Sb Allowable = 1500.00 psf

Error of Convergence = 0.07%
Moment = 4,800.00 ft-lbs
Sp Actual = 588.74 psf
Sb Actual = 0.00 psf

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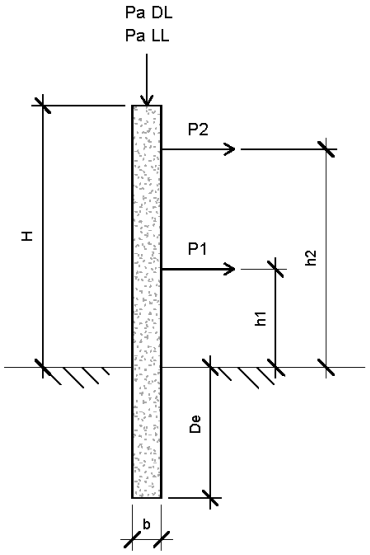
RECTANGULAR CONSTRAINED POLE



Not Isolated

H = 10 ft	b x d = 5.5 in x 7.25 in
P1 = 400 lbs	h1 = 10 ft
P2 = 600 lbs	h2 = 3 ft
Pa DL = 100 lbs	Pa LL = 300 lbs
Sp = 150 pcf	Smax = 2000 psf
Sb = 1500 psf	
LDFE = 1.00	LDFW = 1.00

V =1,000 lbs
M=400 x 10 + 600 x 3 = 5,800 ft-lbs
P = 1000 lbs
h = 5.80 ft
$b = \sqrt{5.5^2 + 7.25^2}/12 = 0.7583$ ft

From Numerical Analysis, Check d= 6.01 ft

Sp Allow < Smax = 2000 psf
< Sp x d = 150 x 6.01 = 901.50 psf ***CONTROLS***
< Sp x 12 = 150 x 12 = 1800 psf

Req'd d = $\sqrt{4.25Ph/Spb} = \sqrt{4.25\ x\ 1000\ x\ 5.80/901.50\ x\ 0.7583}$ = 6.01 ft

Actual Sp = $4.25Ph/d^2b$ = 4.25 x 1000 x 5.80/6.01^2 x 0.7583 = 899.97 psf ≈ 901.50 psf

REQ'D d = 6.01 FT

HP PRIME POLE EMBEDMENT PROGRAM RESULTS

d = 6.01 ft	Error of Convergence = 0.05%
Shear = 1,000.00 lbs	Moment = 5,800 ft-lbs
Sp Allowable = 900.93 psf	Sp Actual = 901.05 psf
Sb Allowable = 1,500.00 psf	Sb Actual = 1,444.51 psf

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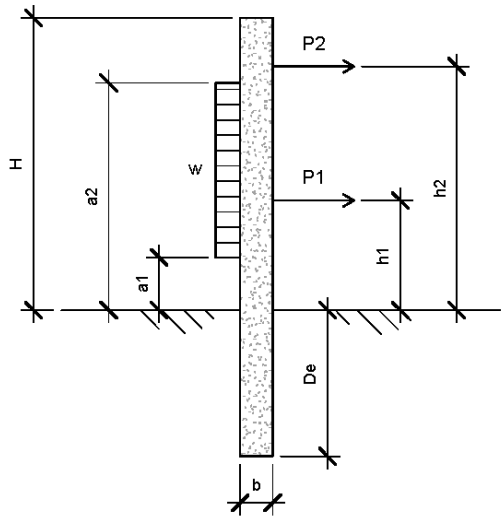
ROUND CONSTRAINED POLE

Not Isolated

H = 7 ft	b = 6 in
P1 = 800 lbs	h1 = 5 ft
P2 = 500 lbs	h2 = 2 ft
w = 50 plf	
a1 = 0	a2 = 7 ft
Sp = 200 pcf	Smax = 3000 psf
Sb = 1500 psf	
LDFE = 1.00	LDFW = 1.00



V =1,650 lbs
M=800 x 5 + 500 x 2 + 50 x $7^2/2$ = 6,225 ft-lbs
P = 1650 lbs
h = 3.773 ft

From Numerical Analysis, Check d= 6.42 ft

Sp Allow < Smax = 3000 psf
< Sp x d = 200 x 6.42 = 1284 psf ***CONTROLS***
< Sp x 12 = 200 x 12 = 2400 psf

Req'd d = $\sqrt{4.25Ph/Spb} = \sqrt{4.25\ x\ 1650\ x\ 3.773/1284\ x\ 0.5}$ = 6.42 ft

Actual Sp = 4.25Ph/d^2b = 4.25 x 1650 x 3.773/6.42^2 x .5 = 1283.87psf ≈ 1284 psf

REQ'D d = 6.42 FT

HP PRIME POLE EMBEDMENT PROGRAM RESULTS

d = 6.42 ft	Error of Convergence = 0.12%
Shear = 1.650 lbs	Moment = 6,225.00 ft-lbs
Sp Allowable = 1283.80 psf	Sp Actual = 1284.18 psf
Sb Allowable = 1500.00 psf	Sb Actual = 0.00 psf

Robertson and Associates
Professional Engineering and Project Management
19744 Beach Blvd. #431
Huntington Beach, CA 92648
robnassoc@sbcglobal.net

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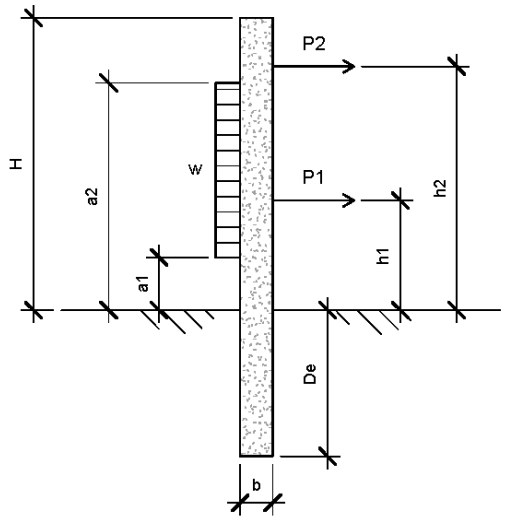
Calc. by	Date	Chk'd by	Date	App'd by	Date
AAR					

RECTANGULAR CONSTRAINED POLE – SEISMIC LOADS

Not Isolated

H = 12 ft	b x d = 4 in x 4 in
P1 = 300 lbs	h1 = 12 ft
P2 = 500 lbs	h2 = 3 ft
w = 100 plf	
a1 = 2 ft	a2 = 9 ft
Sp = 250 pcf	Smax = 3000 psf
Sb = 1500 psf	
LDFE = 1.40	LDFW = 1.00



V =300 + 500 + 700 = 1,500 lbs
M=300 x 12 + 500 x 3 + 100 x 7 x 5.5 = 8,950 ft-lbs
P = 1499.9 lbs
h = 5.967 ft
b = $\sqrt{4^2 + 4^2}/12 = 0.471$ ft

From Numerical Analysis, Check d= 6.13 ft

Sp Allow < Smax = 3000 x 1.4 = 4200 psf
< Sp x d = 250 x 6.13 x 1.4= 2145.50 psf ***CONTROLS***
< Sp x 12 = 250 x 12 x 1.4 = 4200 psf

Req'd d = $\sqrt{4.25Ph/Spb} = \sqrt{4.25\ x\ 1499.9\ x\ 5.967/2145.50\ x\ 0.471} = 6.13$ ft

Actual Sp = $4.25Ph/d^2b = 4.25 \times 1499.9 \times 5.967/6.13^2 \times .471 =$ 2149.1psf ≈ 2145.5 psf

REQ'D d = 6.13 FT

HP PRIME POLE EMBEDMENT PROGRAM RESULTS

d = 6.13 ft	Error of Convergence = 0.15%
Shear = 1.500 lbs	Moment = 8,950.00 ft-lbs
Sp Allowable = 2145.84 psf	Sp Actual = 2145.64 psf
Sb Allowable = 1500.00 psf	Sb Actual = 0.00 psf

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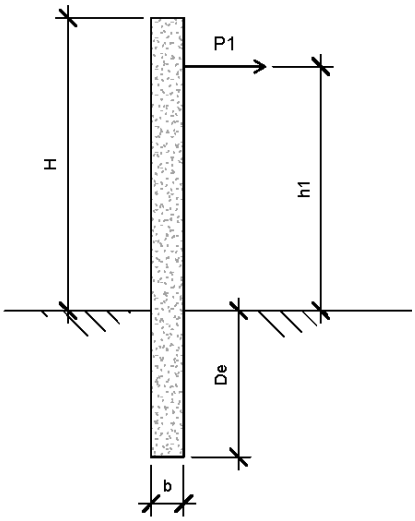
AAR					

ROUND NON-CONSTRAINED POLE

Not Isolated

H = 8 ft b = 12 in
P1 = 600 lbs h1 = 8 ft
Sp = 100 pcf Smax = 1500 psf
Sb = 1500 psf
LDFE = 1.00 LDFW = 1.00



V =600 lbs
M=600 x 8 = 4,800 ft-lbs

From Numerical Analysis, Check d= 9.09 ft

Sp Allow < Smax = 1500 psf
< Sp x d/3 = 100 x 9.09/3 = 303 psf ***CONTROLS***
< Sp x 12 = 100 x 12/3 = 400 psf

A = 2.34P/Spb = 2.34 x 600/303 x1 =4.634 ft

Req'd d = $0.5A[1+\{1+((4.36h)/A)\}^{0.5}] = 0.5 \times 4.634[1+((4.36 \times 8)/4.634)\}^{0.5}] = 9.09$ ft
Actual Sp = $(2.34P((4.36h+(4d)))/(4d^2b)$
= $(2.34 \times 600 \times ((4.36 \times 8 + (4 \times 9.09)))/(4 \times 9.09^2 \times 1)$
= 302.62 psf ≈ 303 psf

REQ'D d = 9.09 FT

HP PRIME POLE EMBEDMENT PROGRAM RESULTS

d = 9.09 ft Error of Convergence = 0.15%
Shear = 600.00 lbs Moment = 4,800.00 ft-lbs
Sp Allowable = 302.89 psf Sp Actual = 302.78 psf
Sb Allowable = 1500.00 psf Sb Actual = 0.00 psf

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Huntington Beach, CA 92648
robnassoc@sbcglobal.net

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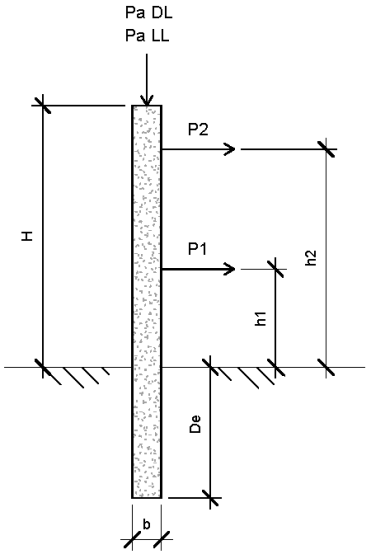
AAR					

RECTANGULAR NON-CONSTRAINED POLE



Not Isolated

H = 10 ft	b x d = 5.5 in x 7.25 in
P1 = 400 lbs	h1 = 10 ft
P2 = 600 lbs	h2 = 3 ft
Pa DL = 100 lbs	Pa LL = 300 lbs
Sp = 150 pcf	Smax = 2000 psf
Sb = 1500 psf	
LDFE = 1.00	LDFW = 1.00

V =1,000 lbs
M=400 x 10 + 600 x 3 = 5,800 ft-lbs
P = 1000 lbs
h = 5.80 ft
$b = \sqrt{5.5^2 + 7.25^2}/12 = 0.7583$ ft

From Numerical Analysis, Check d= 10.03 ft

Sp Allow < Smax = 2000 psf
< Sp x d/3 = 150 x 10.03/3 = 501.50psf ***CONTROLS***
< Sp x 12 = 100 x 12/3 = 400 psf

A = 2.34P/Spb = 2.34 x 1000/501.50 x 0.7583 =6.15 ft

Req'd $d = 0.5A[1+\{1+((4.36h)/A)\}^{0.5}] = 0.5 \times 6.15[1+((4.36 \times 5.80)/6.15)\}^{0.5}] = 10.03$ ft
Actual $Sp = (2.34P((4.36h+(4d)))/(4d^2b)$
$= (2.34 \times 1000 \times ((4.36 \times 5.80 + (4 \times 10.03)))/(4 \times 10.03^2 \times 0.7583)$
= 501.58 psf ≈ 501.50 psf

REQ'D d = 10.03 FT

HP PRIME POLE EMBEDMENT PROGRAM RESULTS

d = 10.03 ft	Error of Convergence = 0.16%
Shear = 1,000.00 lbs	Moment = 5,800 ft-lbs
Sp Allowable = 501.59 psf	Sp Actual = 501.43 psf
Sb Allowable = 1,500.00 psf	Sb Actual = 1,444.51 psf

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Huntington Beach, CA 92648
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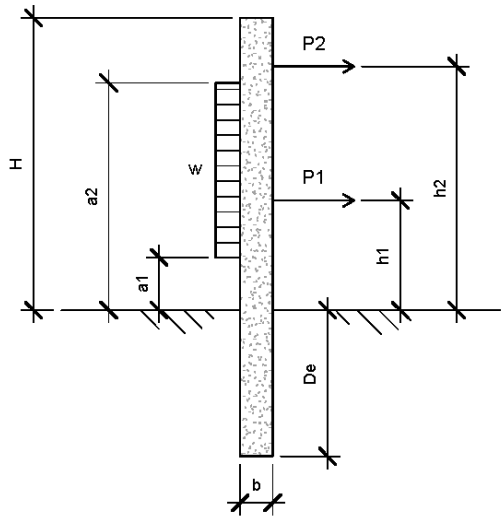
AAR					

ROUND NON-CONSTRAINED POLE

Not Isolated

H = 7 ft
P1 = 800 lbs
P2 = 500 lbs
w = 50 plf
a1 = 0
Sp = 200 pcf
Sb = 1500 psf
LDFE = 1.00

b = 6 in
h1 = 5 ft
h2 = 2 ft
a2 = 7 ft
Smax = 3000 psf
LDFW = 1.00



V =1,650 lbs
M=800 x 5 + 500 x 2 + 50 x $7^2/2$ = 6,225 ft-lbs
P = 1650 lbs
h = 3.773 ft

From Numerical Analysis, Check d= 12.77 ft

Sp Allow < Smax = 3000 psf
< Sp x d/3 = 200 x 12.77/3 = 851.33 psf
< Sp x 12 = 200 x 12/3 = 800 psf ***CONTROLS***

A = 2.34P/Spb = 2.34 x 1650/800 x 0.50 = 9.65 ft

Req'd d = $0.5A[1+\{1+((4.36h)/A)\}^{0.5}]$ = $0.5 \times 9.65[1+((4.36 \times 3.773)/9.65)\}^{0.5}]$ = 12.77 ft
Actual Sp = $(2.34P((4.36h+(4d)))/(4d^2b)$
= $(2.34 \times 1650 \times ((4.36 \times 3.773 + (4 \times 12.77)))/(4 \times 12.77^2 \times 0.500)$
= 799.24 psf ≈ 800 psf

REQ'D d = 12.77 FT

HP PRIME POLE EMBEDMENT PROGRAM RESULTS

d = 12.77 ft
Shear = 1,650.00 lbs
Sp Allowable = 800.00 psf
Sb Allowable = 1,500.00 psf
Error of Convergence = 0.15%
Moment = 6,225.00 ft-lbs
Sp Actual = 799.25 psf
Sb Actual = 0.00 psf

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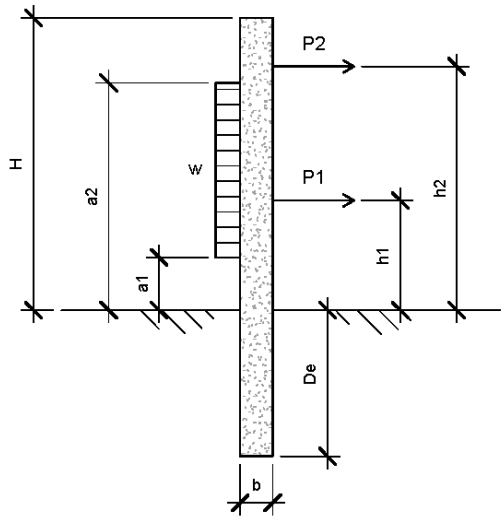
AAR					

RECTANGULAR NON-CONSTRAINED POLE – SEISMIC LOADS

Not Isolated

H = 12 ft	b x d = 4 in x 4 in
P1 = 300 lbs	h1 = 12 ft
P2 = 500 lbs	h2 = 3 ft
w = 100 plf	
a1 = 2 ft	a2 = 9 ft
Sp = 250 pcf	Smax = 3000 psf
Sb = 1500 psf	
LDFE = 1.40	LDFW = 1.00



V =300 + 500 + 700 = 1,500 lbs
M=300 x 12 + 500 x 3 + 100 x 7 x 5.5 = 8,950 ft-lbs
P = 1500 lbs
h = 5.967 ft
b = $\sqrt{4^2 + 4^2}/12$ = 0.471 ft

From Numerical Analysis, Check d= 10.22 ft

Sp Allow < Smax = 3000 x 1.4 = 4,200 psf
< Sp x d/3 = 1.4 x 250 x 10.22/3 = 1192.33 psf ***CONTROLS***
< Sp x 12 = 1.4 x250 x 12/3 = 1400 psf

A = 2.34P/Spb = 2.34 x 1500/1192 x 0.471 = 6.252 ft

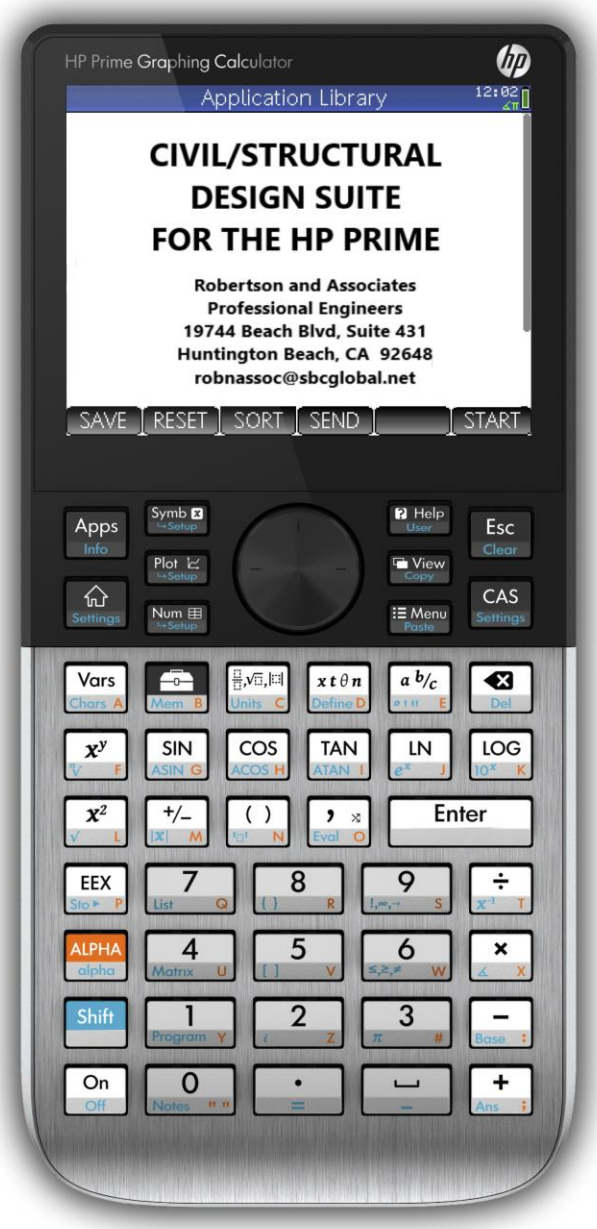
Req'd d = 0.5A[1+{1+((4.36h)/A)}$^{0.5}$] = 0.5 x 6.252[1+((4.36 x 5.967)/6.252)}$^{0.5}$] = 10.22 ft
Actual Sp = (2.34P((4.36h+(4d)))/(4d^{2}b)
= (2.34 x 1500 x ((4.36 x 5.967 + (4 x 10.22)))/(4 x 10.22^2 x 0.471)
= 1193.23 psf ≈ 1192.33 psf

REQ'D d = 10.22 FT

HP PRIME POLE EMBEDMENT PROGRAM RESULTS

d = 10.22 ft	Error of Convergence = 0.11%
Shear = 1.500 lbs	Moment = 8,950.00 ft-lbs
Sp Allowable = 1192.38 psf	Sp Actual = 1192.12 psf
Sb Allowable = 1500.00 psf	Sb Actual = 0.00 psf

CIVIL/STRUCTURAL DESIGN SUITE FOR THE HP PRIME CALCULATOR



- Structural Steel Beam and Column Design and Analysis in Accordance with AISC 360
- Steel Frame Stability Analysis in Accordance with AISC 360
- Reinforced Concrete Beam Design and Analysis in Accordance with ACI 318
- Reinforced Masonry Design and Analysis in Accordance With TMS-402
- Analysis of Beams for Various Support and Loading Conditions
- Section Properties For Common Shapes and Built Up Sections
- Seismic Force Calculator
- Open Channel Hydraulics
- Surveying Toolkit
- Detailed Output of Variables and Results
- Valuable Tools for University Students and Engineers Preparing for the Professional Engineer and Structural Engineer Exams
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ROBERTSON AND ASSOCIATES
19744 Beach Blvd, Suite 431
Huntington Beach, CA 92648
robnassoc@sbcglobal.net
714-504-3984

CIVIL/STRUCTURAL DESIGN SUITE FOR THE HP PRIME CALCULATOR CAPABILITIES

PROGRAM	CAPABILITIES
REINFORCED CONCRETE BEAM	Design and Analysis of Singly and Doubly Reinforced Rectangular Concrete Beams
CONCRETE TEE BEAM	Design and Analysis of Concrete Tee Beams
STEEL BEAM	Design and Analysis of Steel WF, C, HSS, WT and Hybrid Sections
STEEL FRAME STABILITY	Analysis of Steel Frame for Stability Requirements Using the Direct Analysis, Effective Length, First Order and Approximate Second Order Methods
CMU BEAM	Design and Analysis of Singly and Doubly Reinforced Masonry Beams
SECTION PROPERTIES	Calculation of Section Properties of Angle, Channel, Tee, HSS, WF, Zee, and Built-Up Sections
BEAM EQUATIONS	Calculation of Support Reactions, Shear, Moment and Deflection of Beams for Various Loading and Support Conditions
CONTINUOUS BEAM	Analysis of Multiple Span Continuous Beams
OPEN CHANNEL HYDRAULICS	Analysis of Open Channel for Uniform Flow Conditions Using Manning's Equation
WATER SURFACE PROFILE	Calculation of Water Surface Profile for Gradually Varied Flow in Open Channel Using the Standard Step and Direct Step Methods
SURVEYING TOOLKIT	Collection of COGO Based Routines to Convert Bearing to Azimuth, Azimuth to Bearing, Inverse Between Points, Area, 2 Point and 3 Point Resection and Horizontal Curves

Each Program is Provided in a Stand Alone Format to Allow for Loading Individually on the HP Prime Calculator.