2019 PLS-CADD Advanced Training and User Group

CAISSON

by

Kevin Brzys

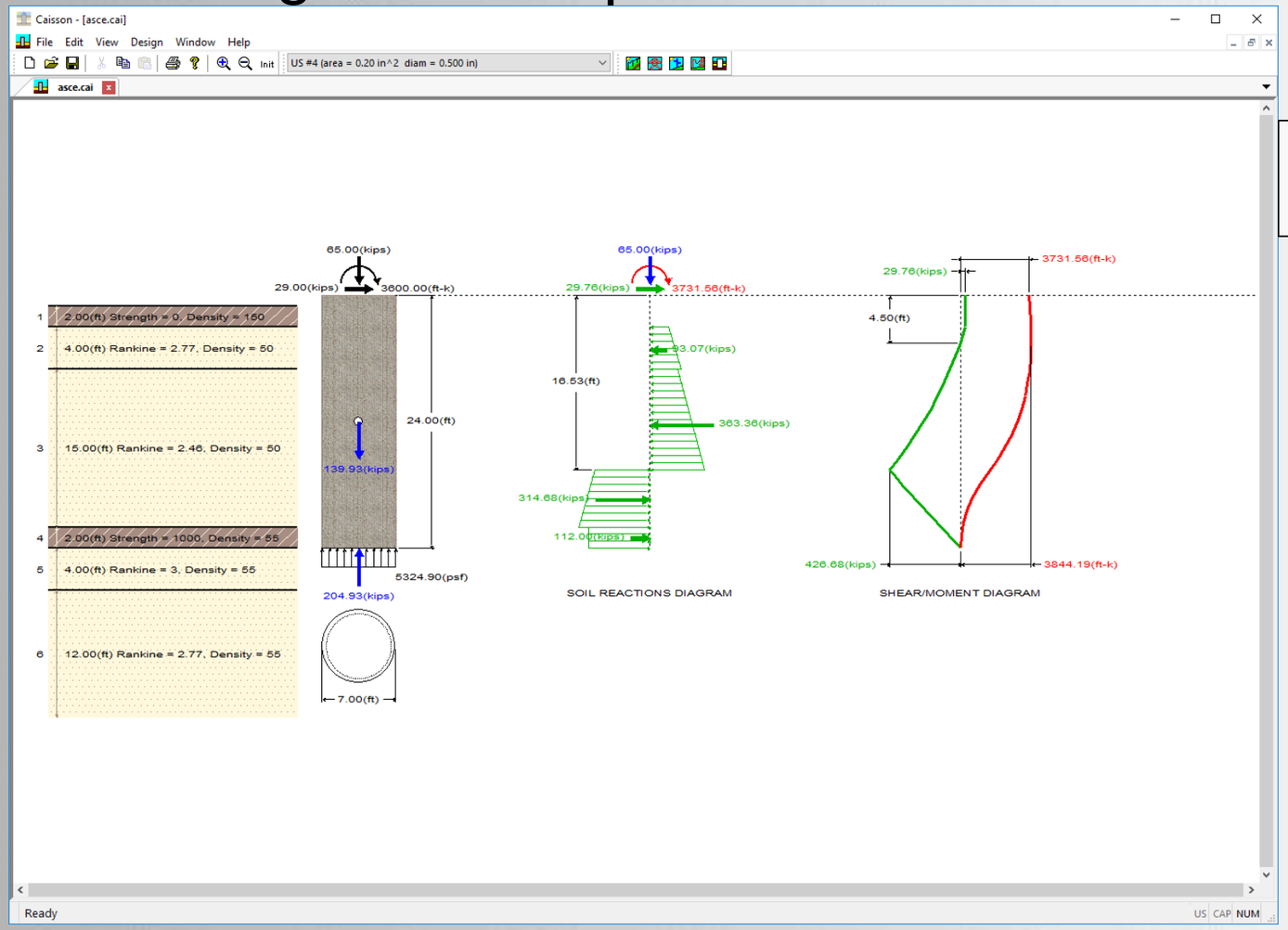
Power Line Systems

Introduction

- What is CAISSON
  - Analysis & Design Assumptions
  - Example
- CAISSON in PLS-POLE
  - How CAISSON works in PLS-POLE
  - Examples

What is CAISSON

- CAISSON is a PLS Application suited for the analysis and design of moment resisting concrete pier foundations and direct embedded poles.



Product Info Page
https://www.powerlinesystems.com/caisson

Design Method used in CAISSON

- “Analysis and Design of Laterally Loaded Piles and Caissons in a layered soil system”
- Multi-layered adaption of Broms Method.
- The failure occurs because the ultimate resistance of the soil is exceeded.
  - At ultimate loads the foundation does not fail.
  - Failure takes place when the pile rotates as a unit around a point located below the ground surface.

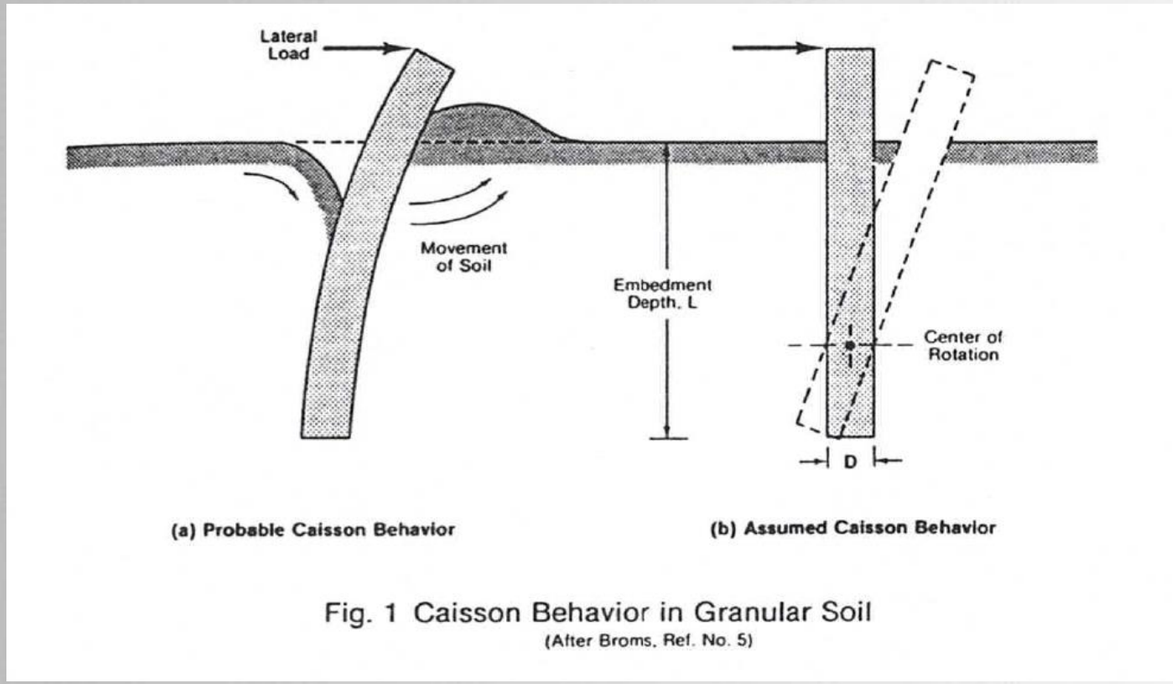
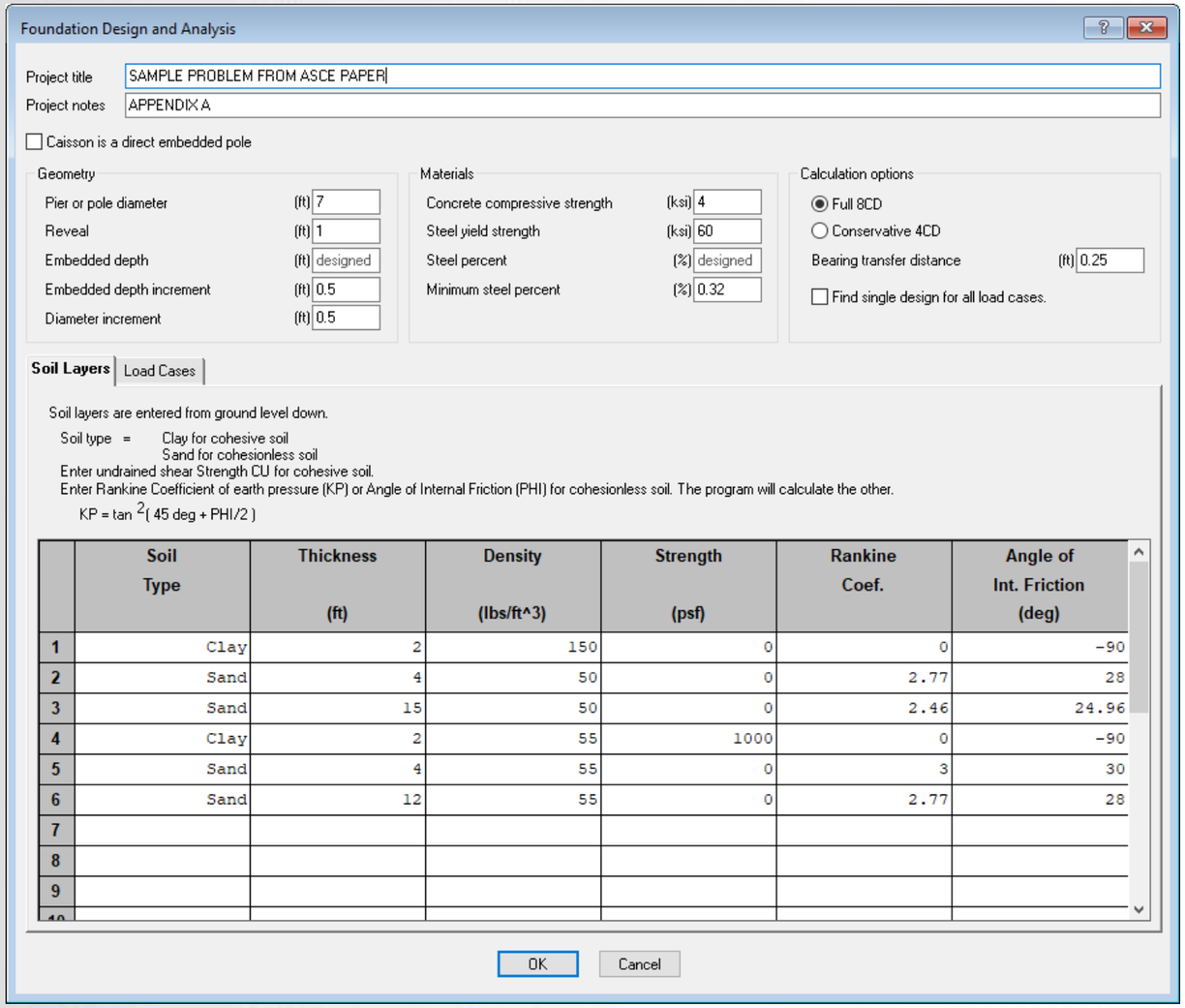


Fig. 1 Caisson Behavior in Granular Soil
(After Broms, Ref. No. 5)

Foundation Design & Analysis Inputs

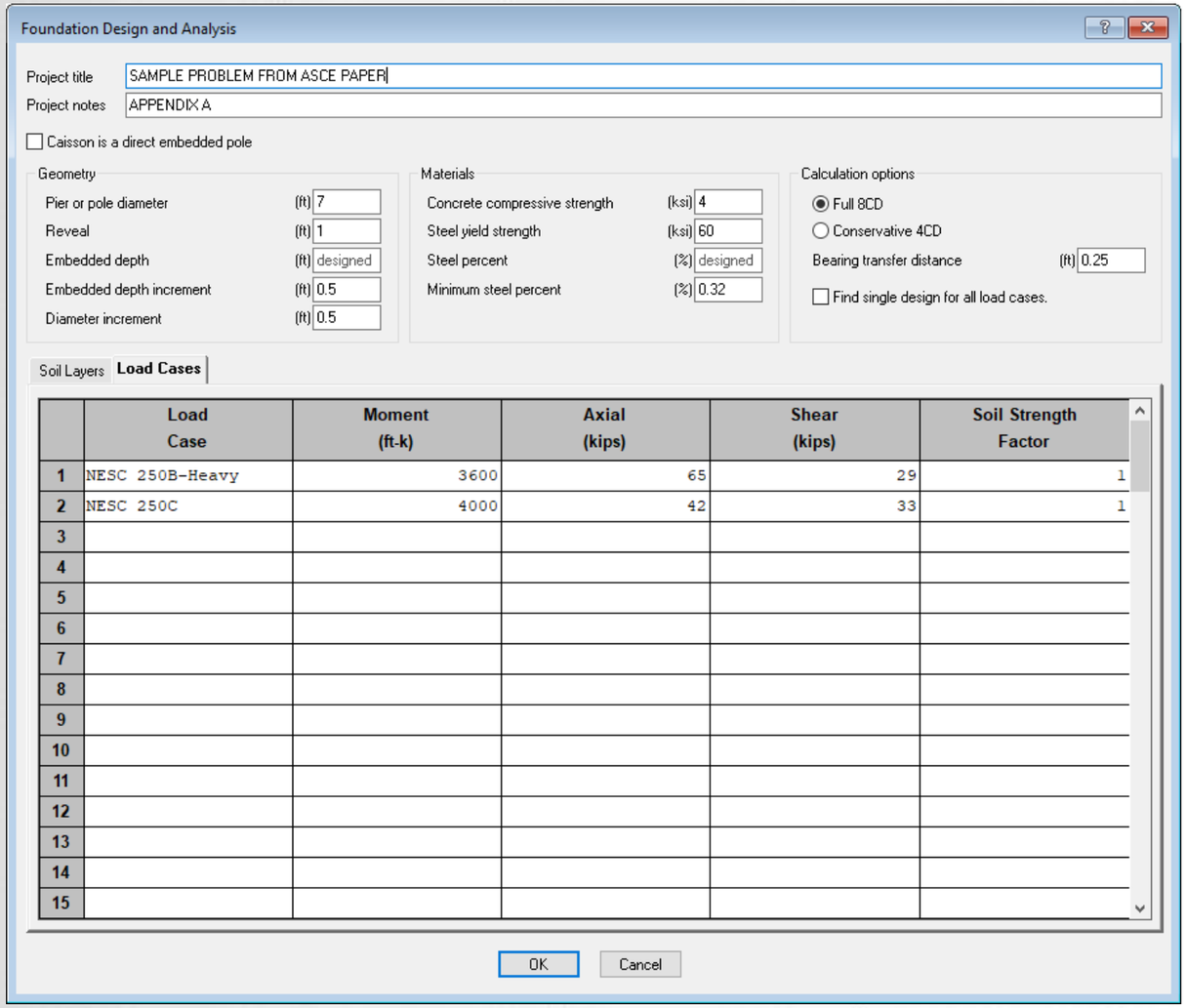
- Project Information
- Foundation parameters
  - Caisson or direct embedded pole
  - Foundation geometry and design parameters
  - Foundation material properties
  - Calculation Options
- Soil input parameters for each layer
  - Soil Type
  - Thickness of layer
  - Density of dry or submerged soils
  - Undrained shear strength for cohesive soils
  - Coefficients of internal friction for non-cohesive soils



	Soil Type	Thickness (ft)	Density (lbs/ft^3)	Strength (psf)	Rankine Coef.	Angle of Int. Friction (deg)
1	Clay	2	150	0	0	-90
2	Sand	4	50	0	2.77	28
3	Sand	15	50	0	2.46	24.96
4	Clay	2	55	1000	0	-90
5	Sand	4	55	0	3	30
6	Sand	12	55	0	2.77	28
7						
8						
9						

Design & Analysis – Load Cases

- Multiple Load Cases
  - Loads applied to top of foundation for Caisson
  - Loads applied at ground line for direct embedded pole
  - Soil Strength Factor



	Load Case	Moment (ft-k)	Axial (kips)	Shear (kips)	Soil Strength Factor
1	NESC 250B-Heavy	3600	65	29	1
2	NESC 250C	4000	42	33	1
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Analysis Results

Caisson - [Analysis Results]

File Edit View Design Window Help

US #4 (area = 0.20 in^2 diam = 0.500 in)

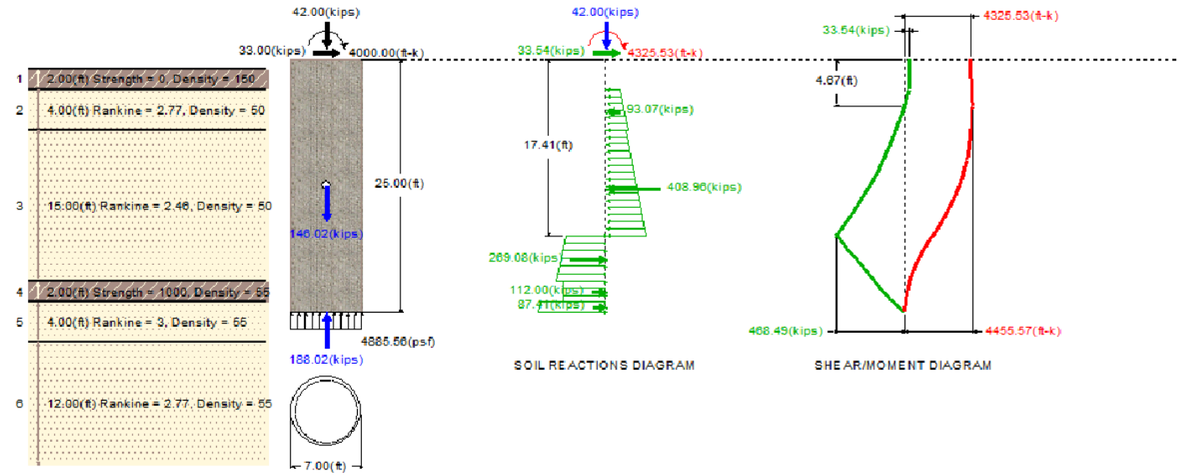
asce.cai | Analysis Results

Analysis Results

Load Case Results

Load Case	Diameter (ft)	Embedment Depth (ft)	Length (ft)	Minimum Steel Percent (%)	Minimum Steel Area (in^2)	Weight (kips)	Moment Capacity (ft-k)	Axial Capacity (kips)	Axial Load Pressure (ksf)	Weight Pressure (ksf)	End Bearing Pressure (ksf)	Maximum Pier Moment (ft-k)	Maximum Pier Shear (kips)	Total Soil Moment (ft-k)	Total Soil Shear (kips)	Soil Bearing Strength (ksf)	Status
NESC 250B-Heavy	7.00	23.000	24.000	0.440	24.38	139.926	3922.2	65.5	1.69	3.64	5.32	3844.2	426.7	3731.56	29.76	12.24	OK
NESC 250C	7.00	24.000	25.000	0.520	28.82	146.018	4478.8	42.5	1.09	3.79	4.89	4455.6	468.5	4325.53	33.54	12.74	OK

The controlling load case is "NESC 250C"



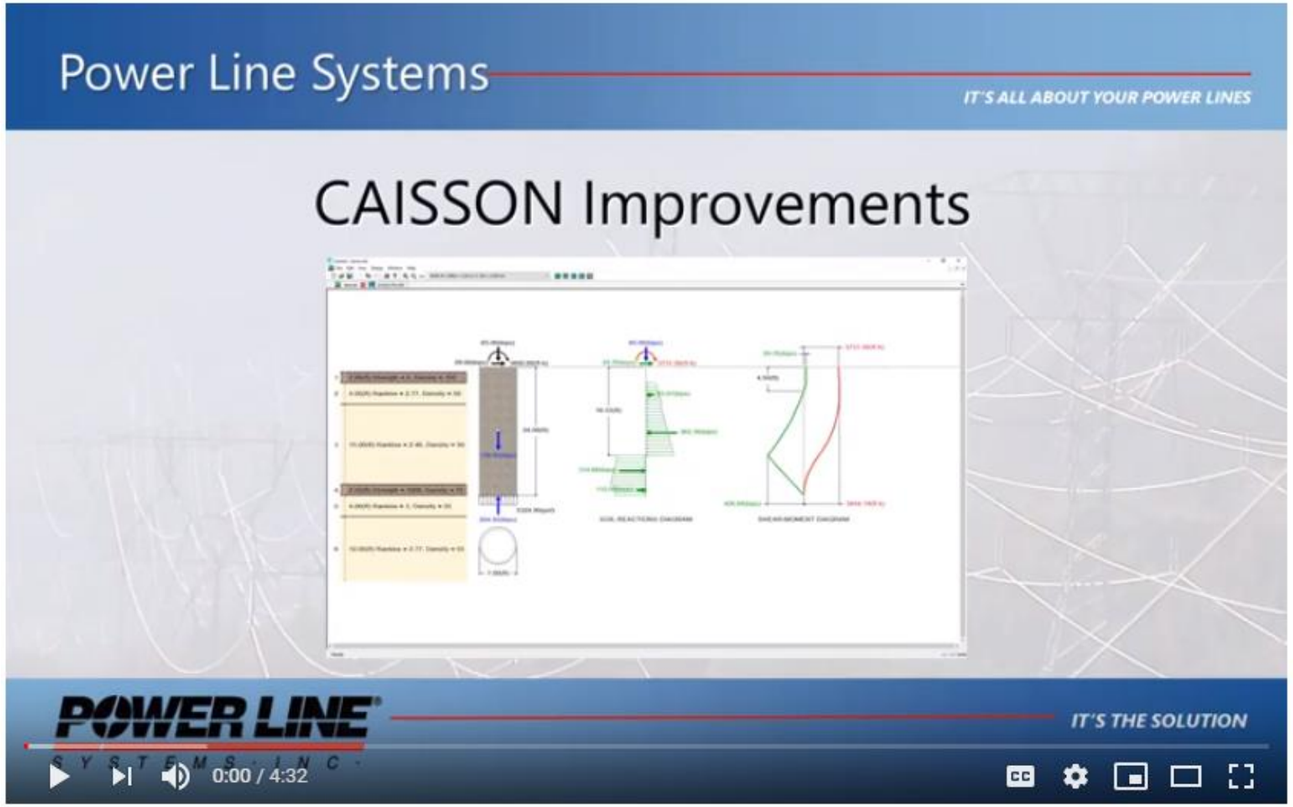
Right click to view the results in a table, export them to XML or a database, or customize table formatting including showing or hiding columns.

US CAP NUM

CAISSON Updates

- Starting in version 15.30
  - Multiple Load Cases
  - Analysis Vs. Design
  - Soil Strength Factor
  - Bearing Capacity
  - Improved Graphics

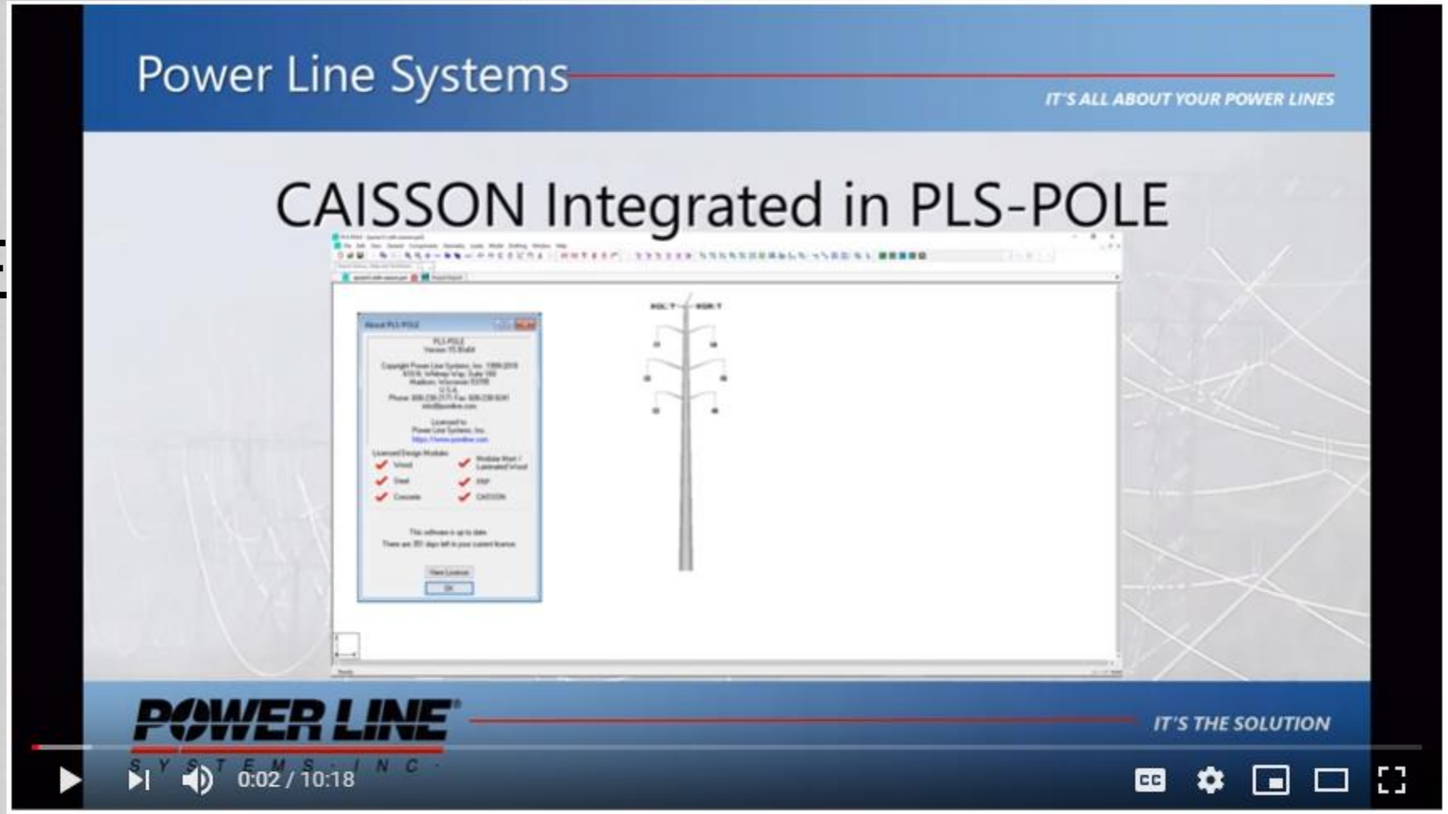
  - See the video located https://www.youtube.com/watch?v=Dh2AoH1CQy0&t=1s



CAISSON Improvements in Version 15.30

CAISSON Integrated in PLS-POLE

Starting in version 15.50 CAISSON has been integrated within PLS-POLE

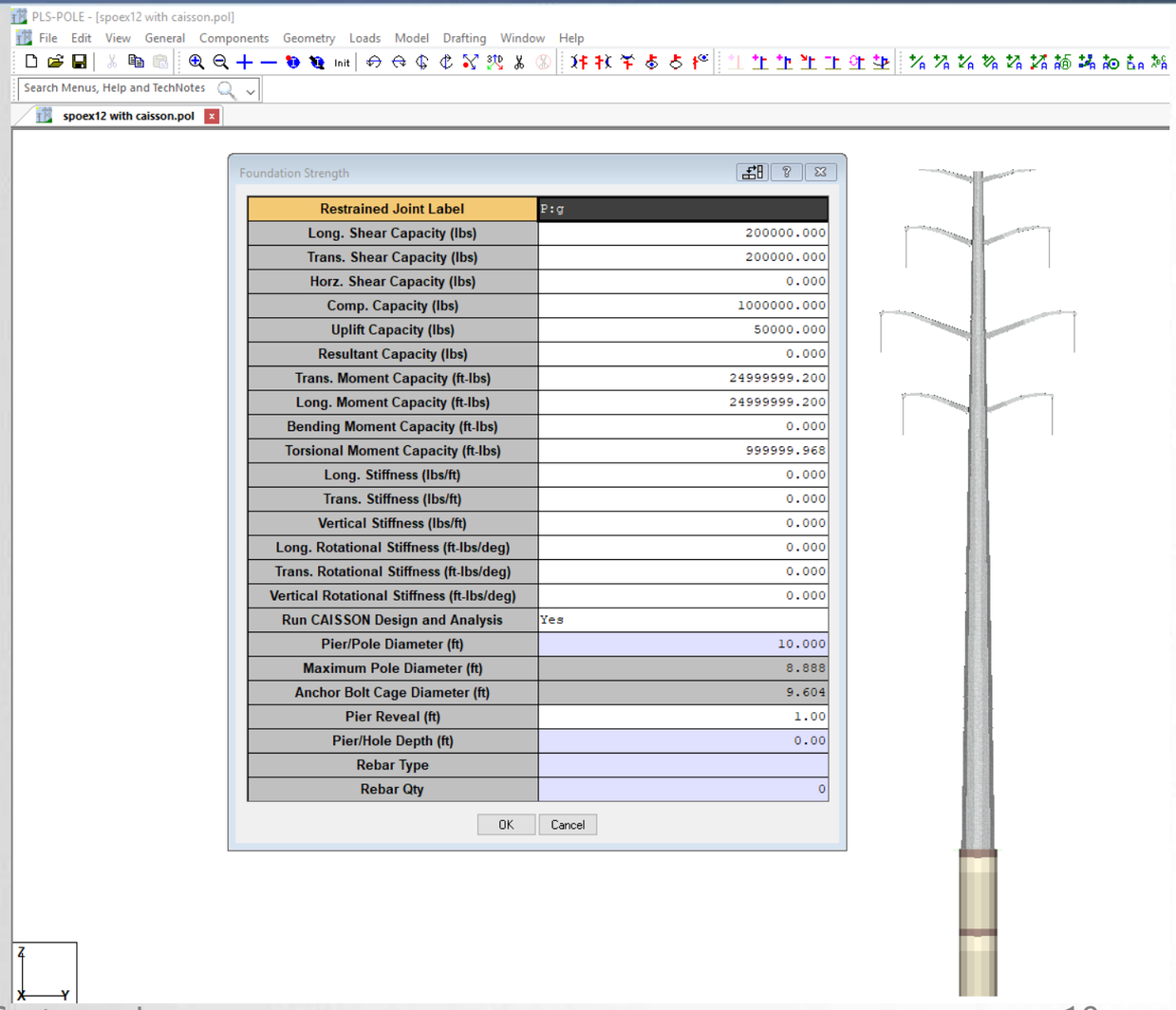


CAISSON Integrated in PLS-POLE

– See the video located https://www.youtube.com/watch?v=UYgU2SHCQOA&t=2s

CAISSON Foundation Inputs in PLS-POLE

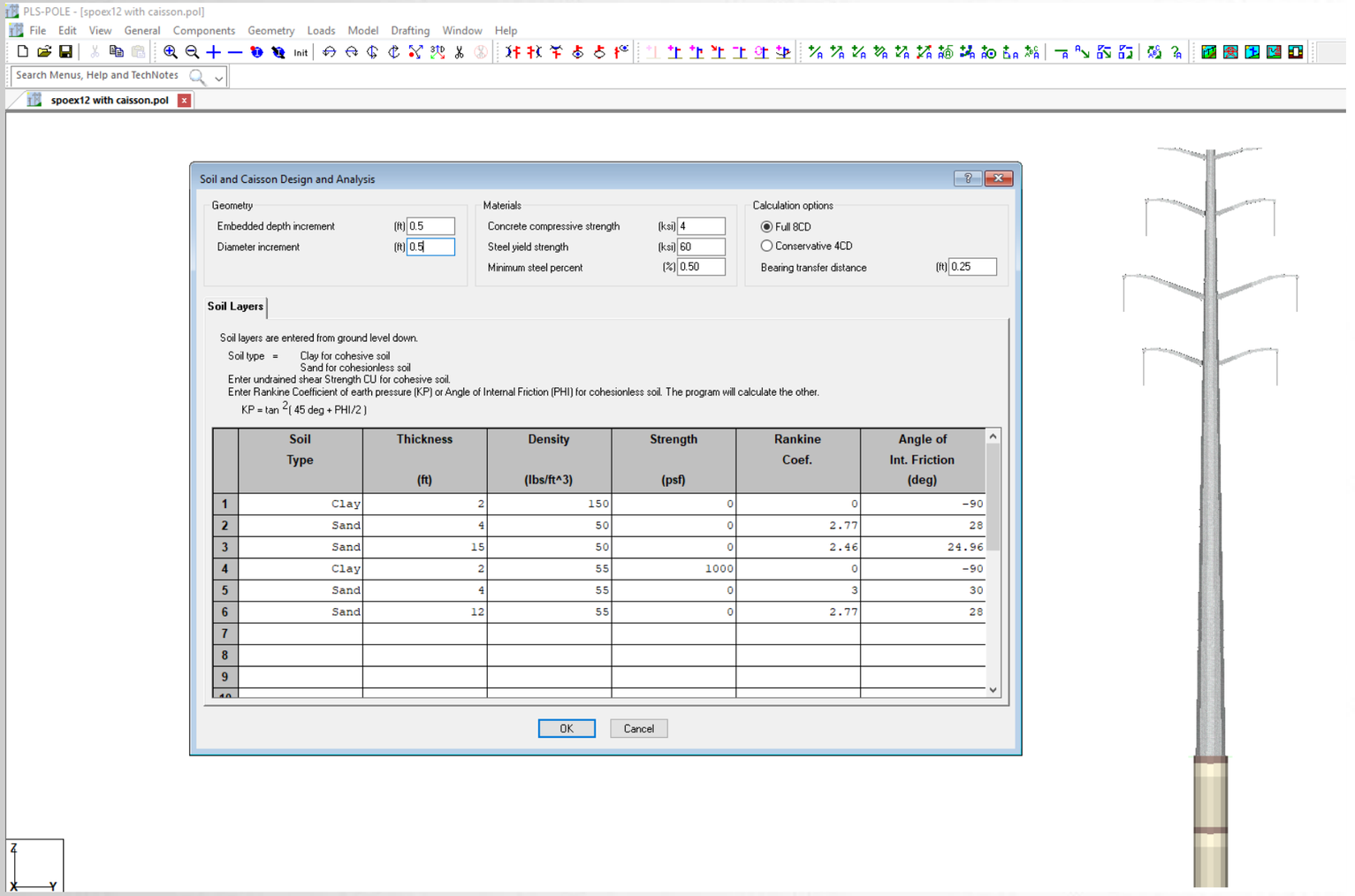
- Geometry/Miscellaneous/Foundation Strength...
  - Nominal Capacities
  - Foundation Parameters
    - CAISSON Design & Analysis
    - Yes or No to enable CAISSON
    - Inputs for foundation diameter, pier revel, embedment, rebar



Restrained Joint Label	P:g
Long. Shear Capacity (lbs)	200000.000
Trans. Shear Capacity (lbs)	200000.000
Horz. Shear Capacity (lbs)	0.000
Comp. Capacity (lbs)	1000000.000
Uplift Capacity (lbs)	50000.000
Resultant Capacity (lbs)	0.000
Trans. Moment Capacity (ft-lbs)	24999999.200
Long. Moment Capacity (ft-lbs)	24999999.200
Bending Moment Capacity (ft-lbs)	0.000
Torsional Moment Capacity (ft-lbs)	999999.968
Long. Stiffness (lbs/ft)	0.000
Trans. Stiffness (lbs/ft)	0.000
Vertical Stiffness (lbs/ft)	0.000
Long. Rotational Stiffness (ft-lbs/deg)	0.000
Trans. Rotational Stiffness (ft-lbs/deg)	0.000
Vertical Rotational Stiffness (ft-lbs/deg)	0.000
Run CAISSON Design and Analysis	Yes
Pier/Pole Diameter (ft)	10.000
Maximum Pole Diameter (ft)	8.888
Anchor Bolt Cage Diameter (ft)	9.604
Pier Reveal (ft)	1.00
Pier/Hole Depth (ft)	0.00
Rebar Type	
Rebar Qty	0

CAISSON Soil Layer Inputs in PLS-POLE

- Geometry/Miscellaneous/Soil and Caisson Settings...
  - Geometry for foundation if in design mode
  - Foundation Materials
  - Calculation Options
  - Soil input parameters for each layer
  - Loads are taken from PLS-POLE



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Analysis Results

*** Analysis Results:

Maximum element usage is 96.25% for Tubular Davit "TR" in load case "ICE + WIND"
Maximum insulator usage is 90.44% for Suspension "I1" in load case "WIND"
Maximum foundation usage is 99.65% for Foundation Design "P:g" in load case "WIND"

Foundation Design Forces For All Load Cases:

Note: loads are factored.

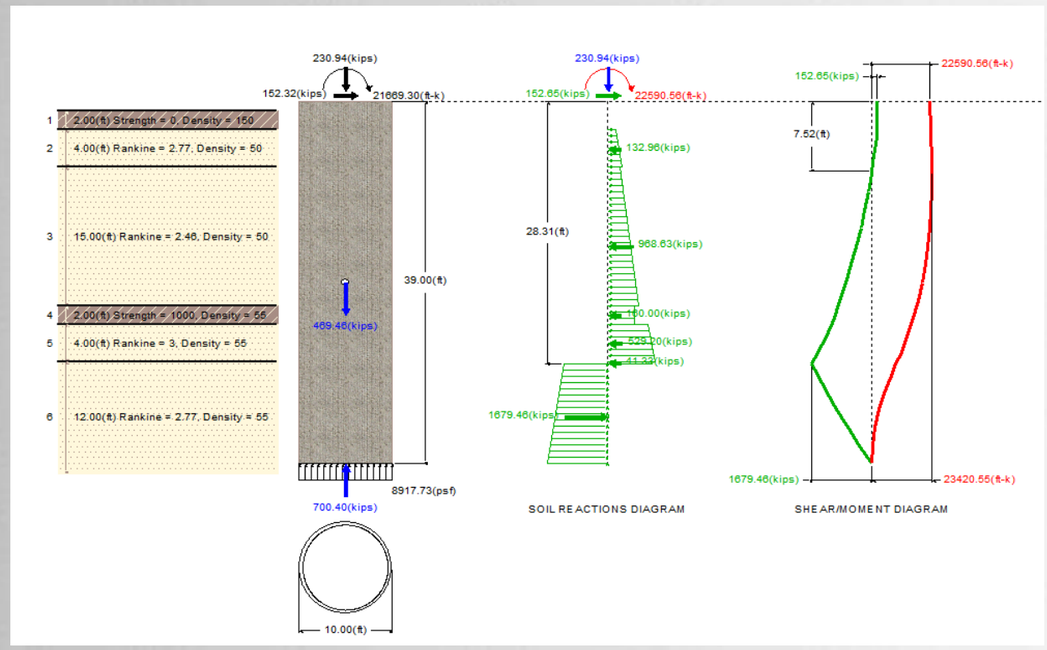
Load Case	Foundation Description	Axial Force (kips)	Shear Force (kips)	Bending Moment (ft-k)	Foundation Usage %
DEAD LOAD ONLY	P:g	108.33	0.11	8.44	98.55
WIND	P:g	230.94	152.32	21669.27	99.65
ICE + WIND	P:g	278.51	21.09	2891.57	96.69

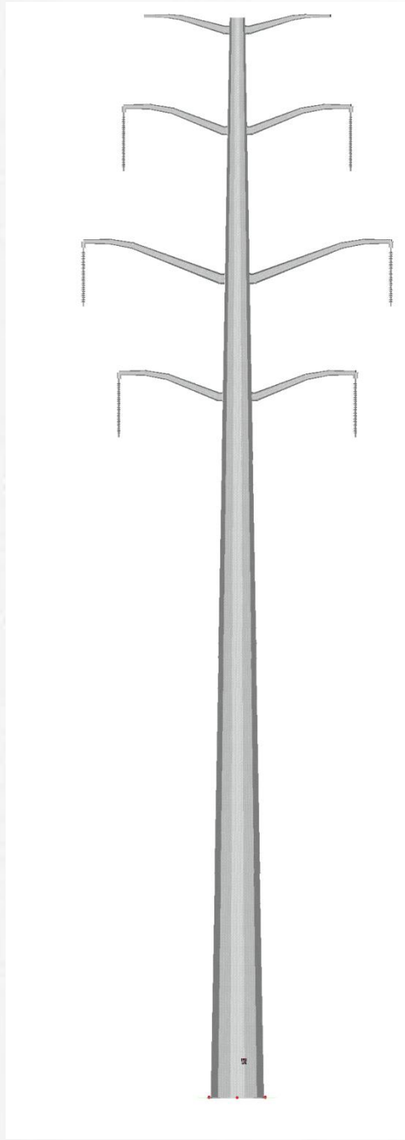
Foundation Designs for Load Case "WIND":

Joint Label	Applied Shear (kips)	Soil Shear Capacity (kips)	Soil Shear Usage (%)	Applied Moment (ft-k)	Soil Moment Capacity (ft-k)	Soil Moment Usage (%)	End Bearing Pressure: Applied Axial (ksf)	Pier Weight (ksf)	Total (ksf)	Soil Strength (ksf)	Soil Usage (%)	Pier Design: Diam. (ft)	Embed. Depth (ft)	Length (ft)	Rebar Type	Rebar Qty	Rebar Spacing (in)	Steel Area (%)	Weight (kips)	Max. Shear (kips)	Max. Moment (ft-k)	Moment Capacity (ft-k)	Moment Usage (%)	Max. Usage (%)
P:g	152.32	152.86	99.6	21669.27	22509.05	96.3	2.04	5.55	7.59	17.01	44.6	12.00	35.50	36.50	(see tables)			0.62	627.91	1766.73	23287.00	27476.57	84.8	99.65

CAISSON Example

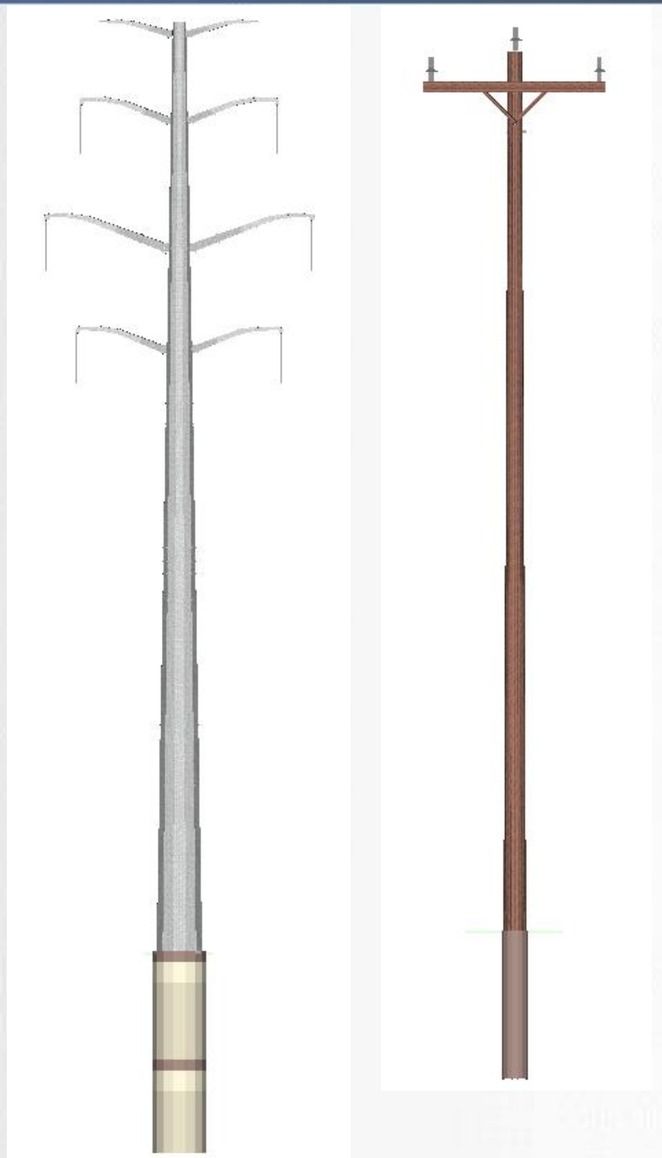
- Design a foundation within CAISSON
  - Steel pole spoex12.pol from PLS-POLE examples





CAISSON in POLE Example

- Design foundations within PLS-POLE
  - Caisson for steel pole spoex12.pol from PLS-POLE examples
  - Direct embed wood pole wpoex9.pol from PLS-POLE examples



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