DESIGNING A 332' CROSSING TOWER

Using PLS-TOWER 11.16

By: George Watson, Consulting Engineer

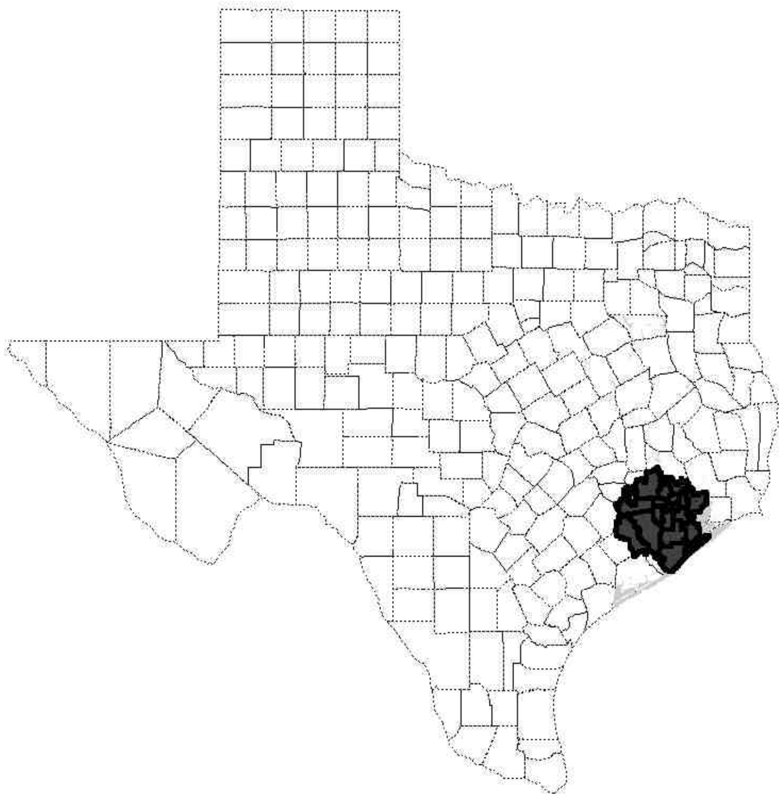
CenterPoint Energy

formerly Reliant Energy

formerly Houston Industries Inc.

formerly Houston Lighting & Power

Small Service Area (2.5%)
Big Electrical Load (25%)



Texas Peak Load for 2010 was 66,000mw

CNP Peak Load for 2010 was 16,100mw

(25% of Texas Total)

233 Substations

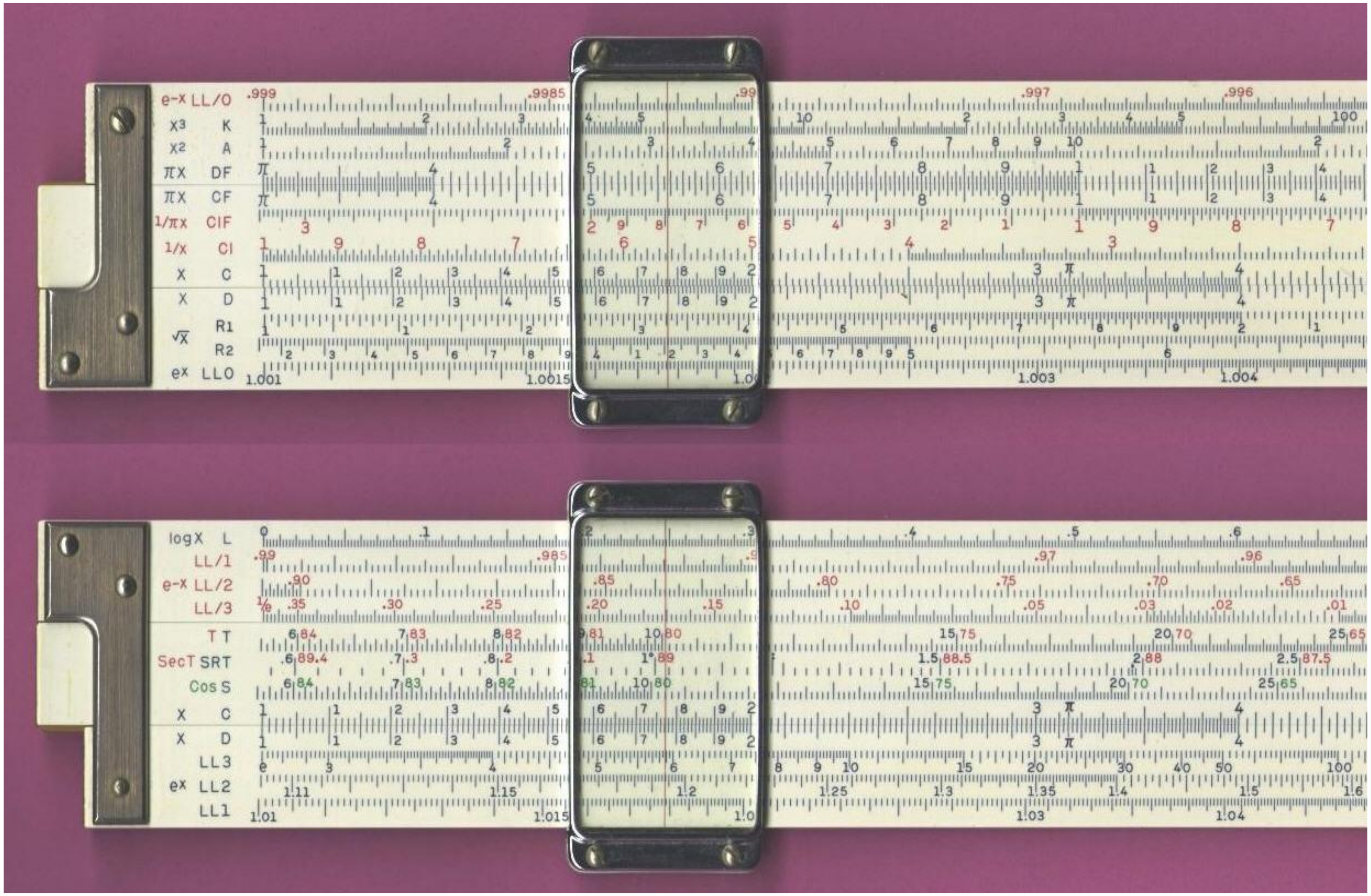
3800 Miles of T-Lines

Typical Houston house

with 11 Car Garage

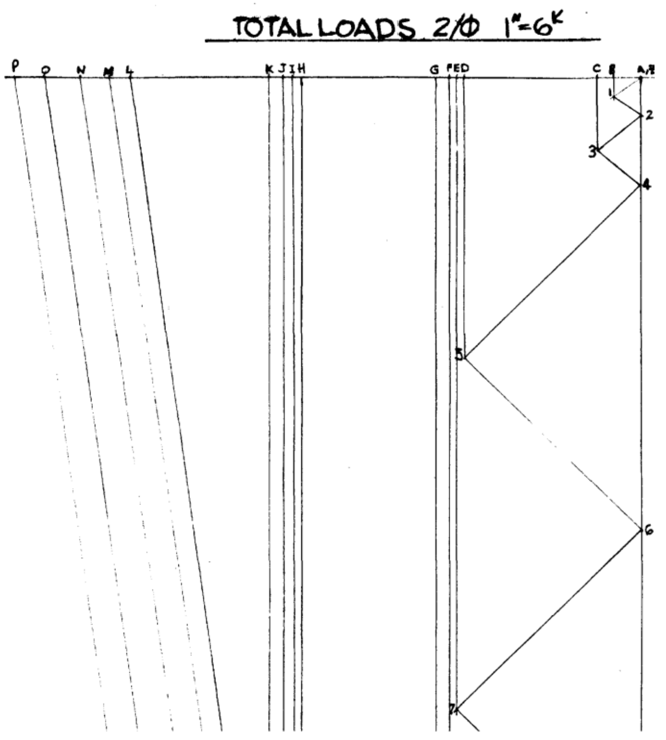
61,000 Square Feet on an 11 Acre Lot

Ancient Tower Design Tools



Early Stress Analysis

- Graphical Method of Joints
- Many Assumptions to Allow Analysis
- Multiple Load Cases Very Time Consuming



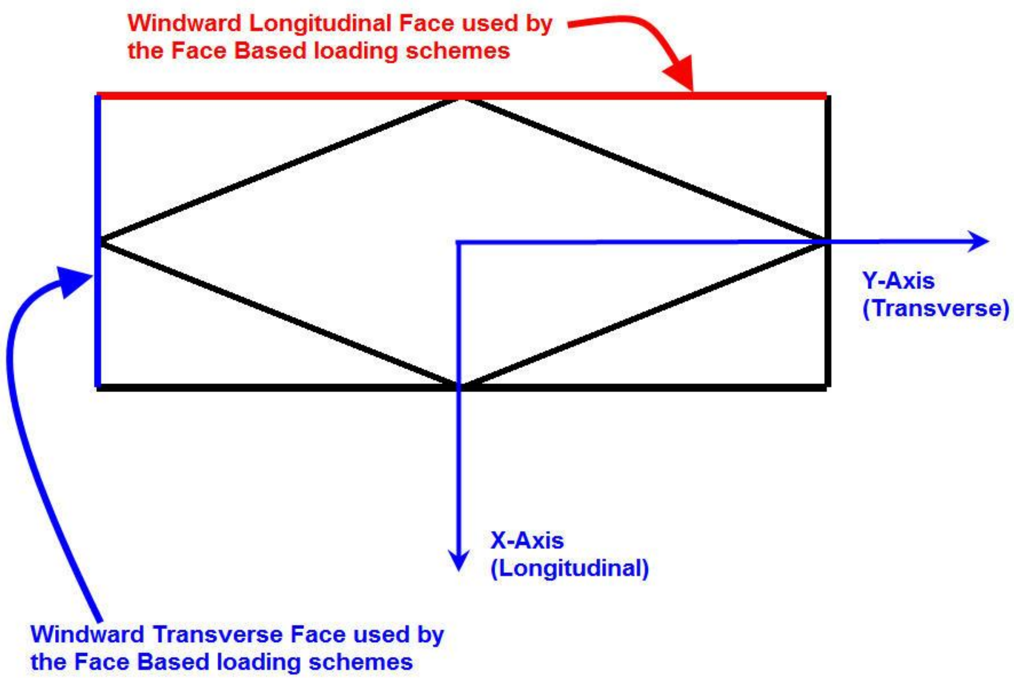
Calculator from 1973 ($2,000)

1976 Tower Design on CDC 6600

Tower hit by a barge of scrap

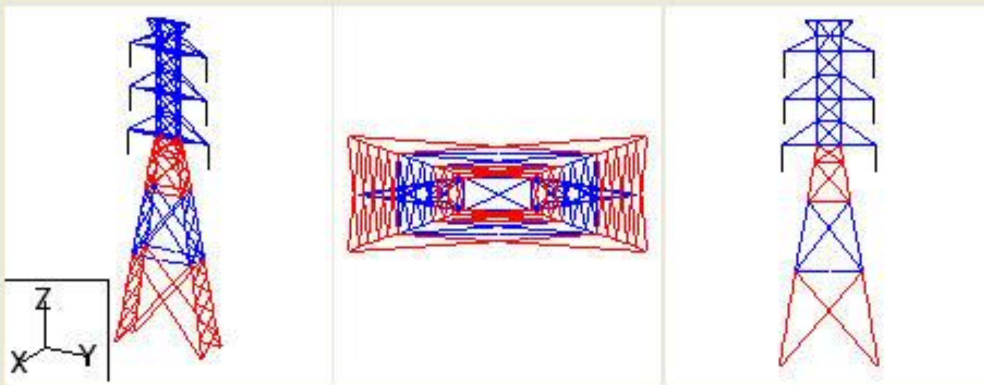
PLS-TOWER Face Designation

The windward transverse face is that on which a positive transverse wind (in the positive Y-direction) would blow.



Adjust Drag Factors

Sections



Model Check Report

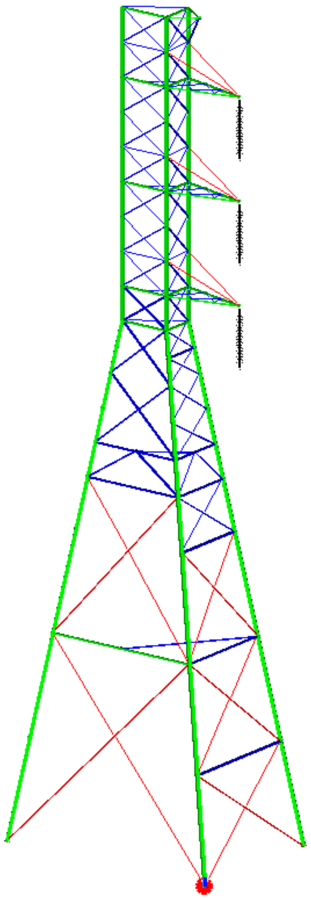
No errors or relevant warnings detected.

Adjust Drag Factors

	Section Label	Section Color	Joint Defining Section Bottom	Dead Load Adjust. Factor	Transverse Drag x Area Factor For Face	Longitudinal Drag x Area Factor For Face	Transverse Area Factor (CD From Code)	Longitudinal Area Factor (CD From Code)
1	Cage		11P	1.310	3.200	3.200	1.000	1.000
2	Body3		14S	1.310	3.200	3.636	1.000	1.136
3	Body2		17S	1.310	3.200	4.114	1.000	1.286
4	Body1		22P	1.310	3.200	4.960	1.000	1.550
5								

Start with a basic geometry

All Redundants must be accounted for in the Drag Area Calculations, either by adding to the model or adjusting the factors

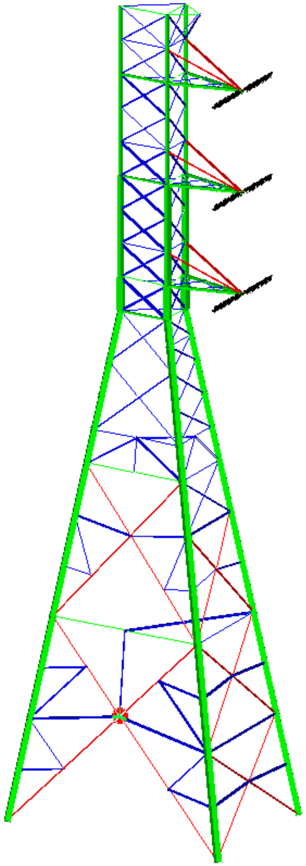


Tower Base is 27’ x 18’

Start with a basic geometry

Redundants added and Leg Members split

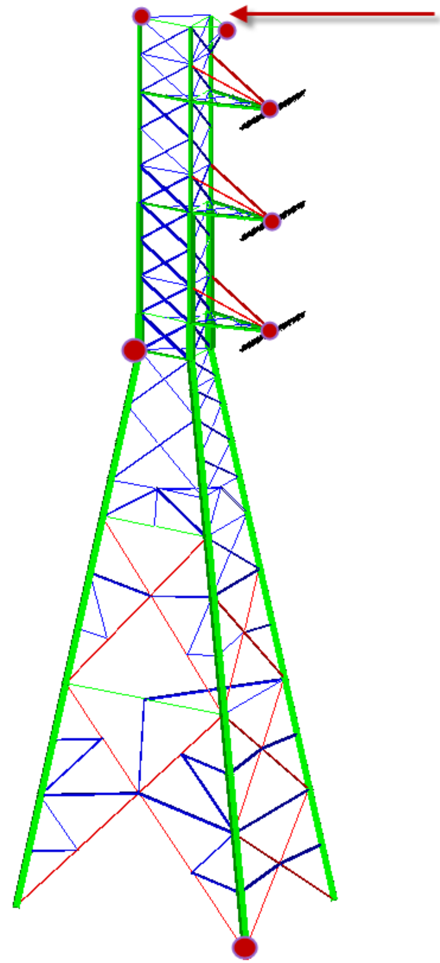
Crossing Diagonals joint added



Tower Base is 27’ x 18’

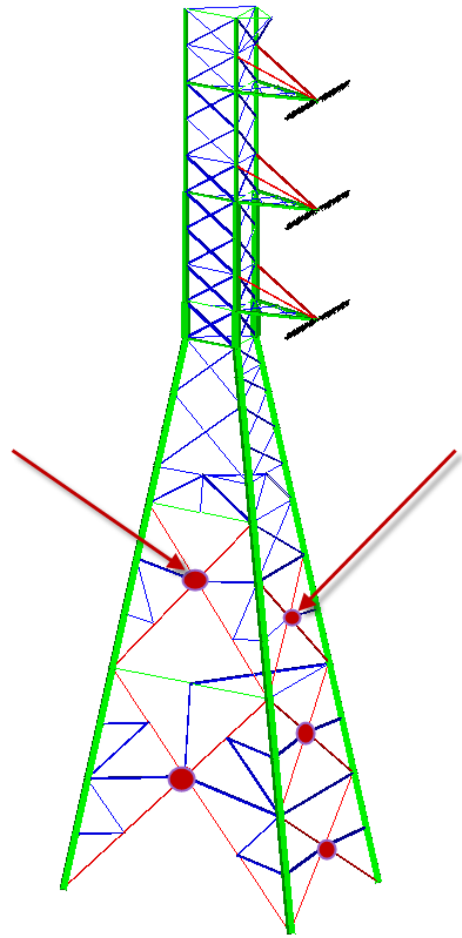
Start with a basic geometry

The 7 Joints shown are the Primary Joints



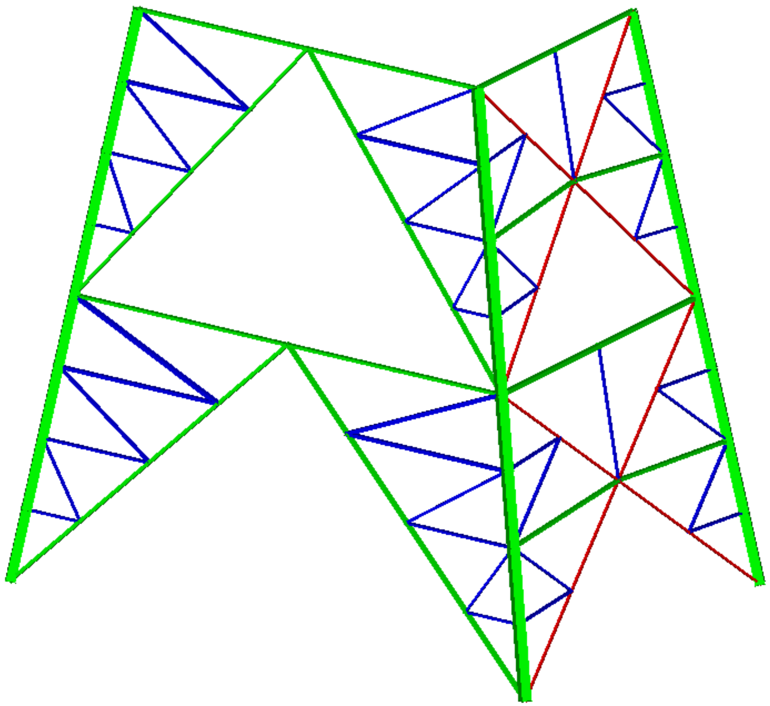
Start with a basic geometry

The Crossing Diagonal Joints must be re-calculated if the leg slope is changed



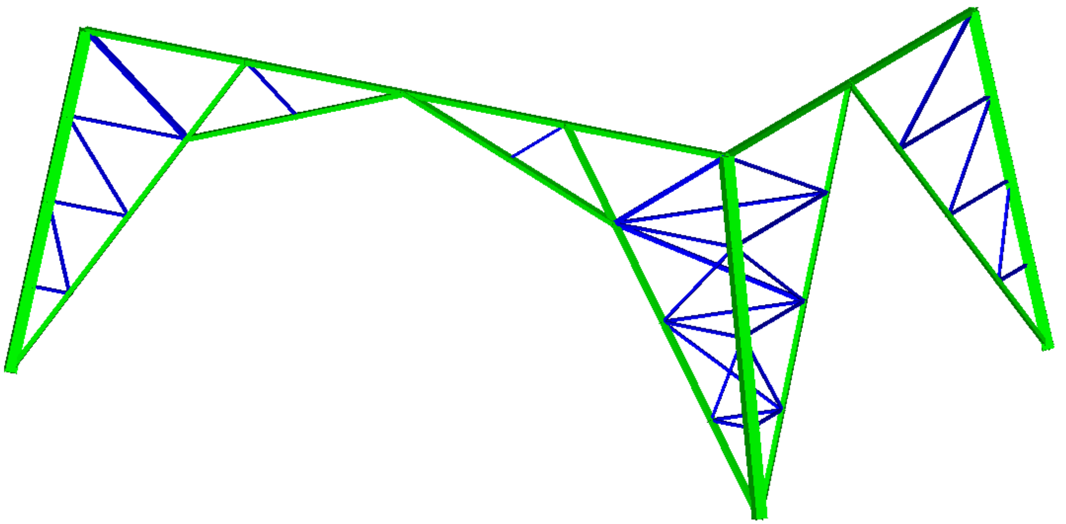
Add Some Extensions

Add a 40 foot Extension



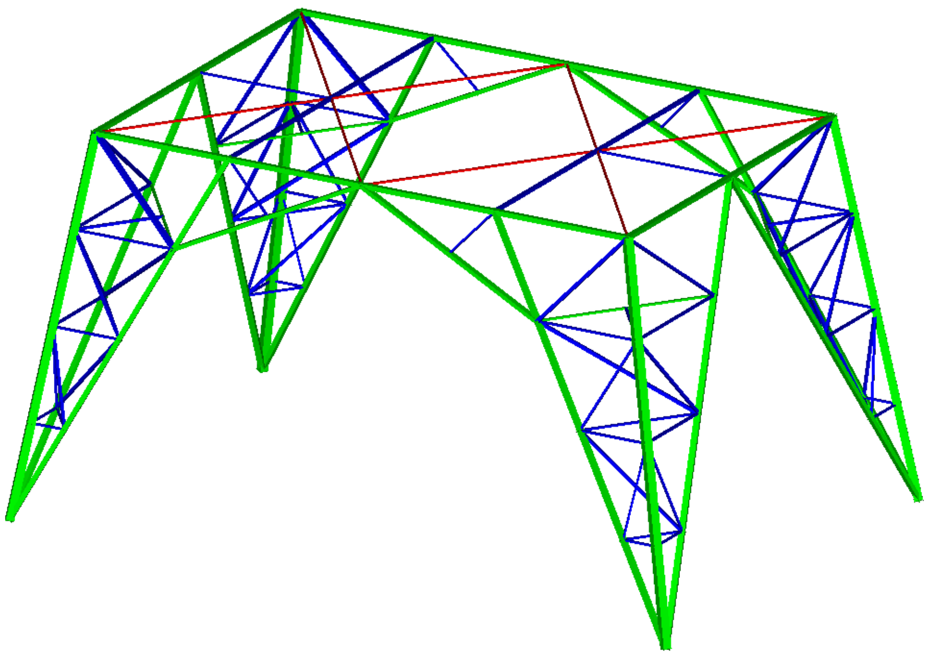
Add Some Extensions

Add a 20 foot Extension



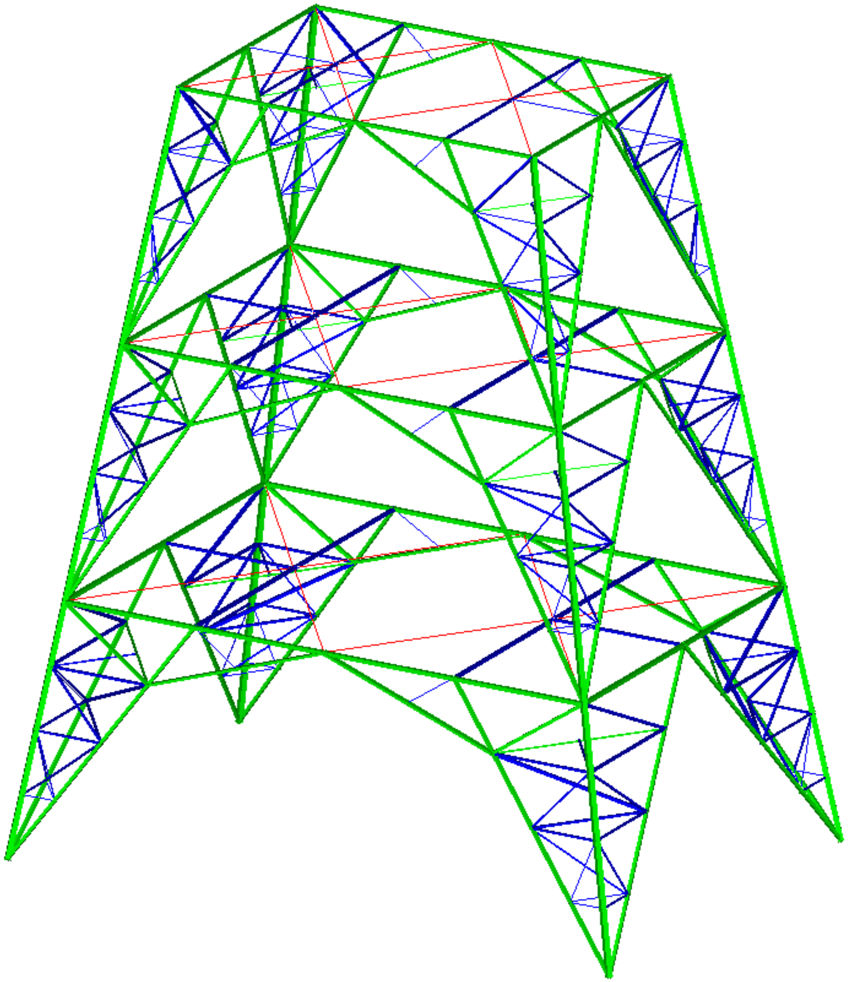
Add Some Extensions

Add a 32 foot Extension



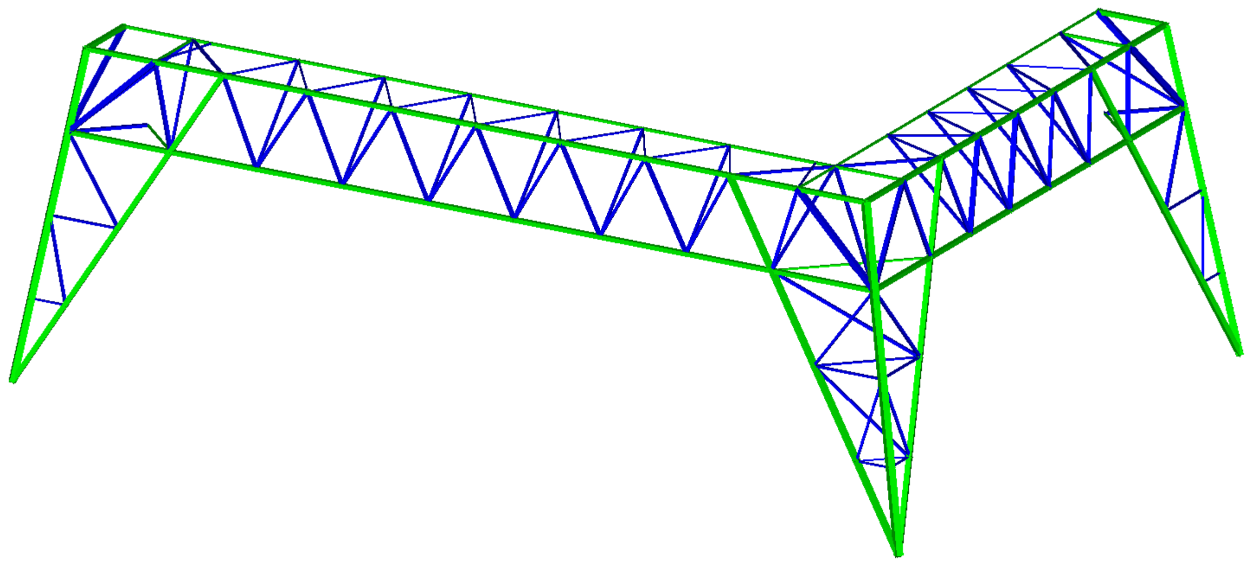
Add Some Extensions

Add 3 more
32 foot
Extensions



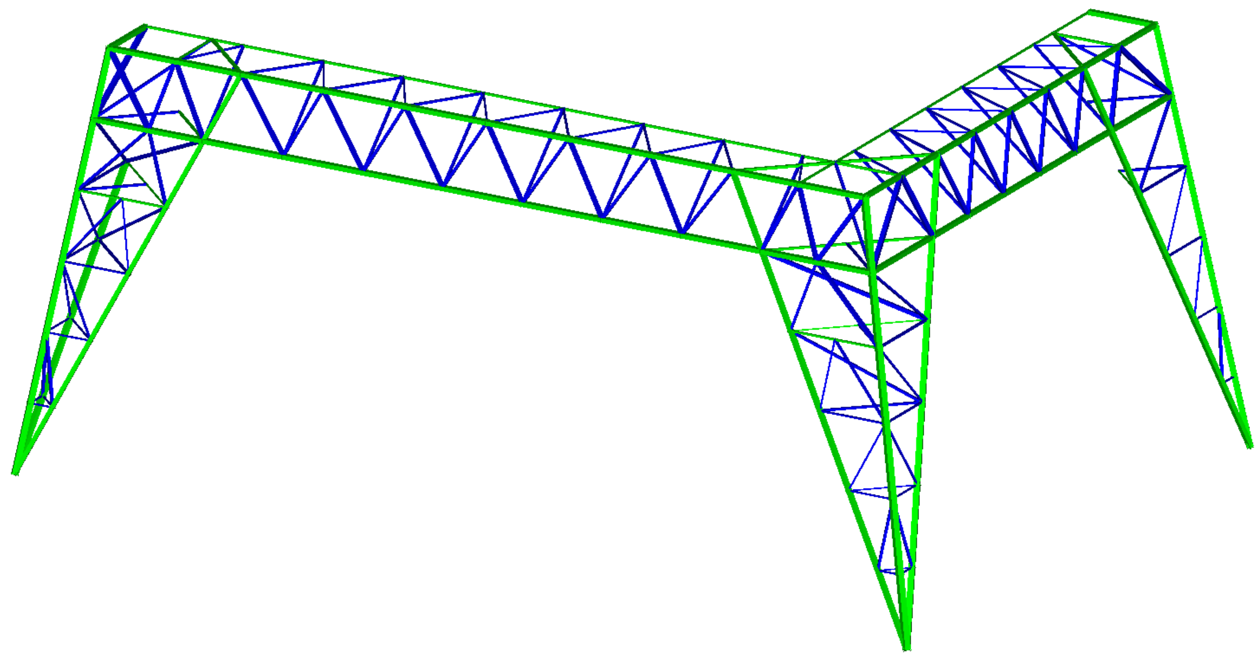
Add Some Extensions

Add another 32 foot Extension



Add Some Extensions

Add a 48 foot Extension



The Final Starting Geometry

332'-0 Tall

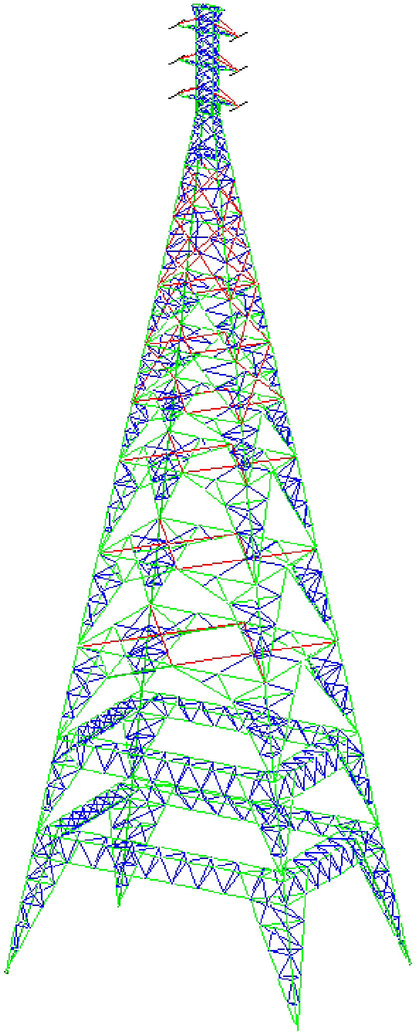
109.6' Wide

73.1' Deep

7 Primary Joints

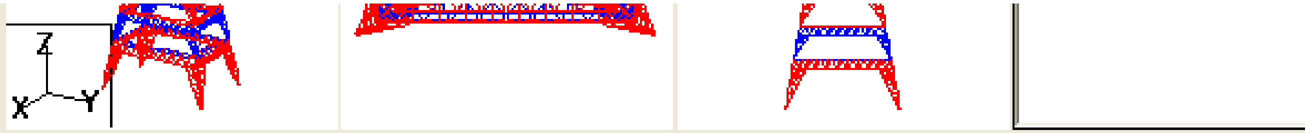
214 Secondary Joints

384 Member Groups



Evaluate Different Base Spreads

Change One Joint



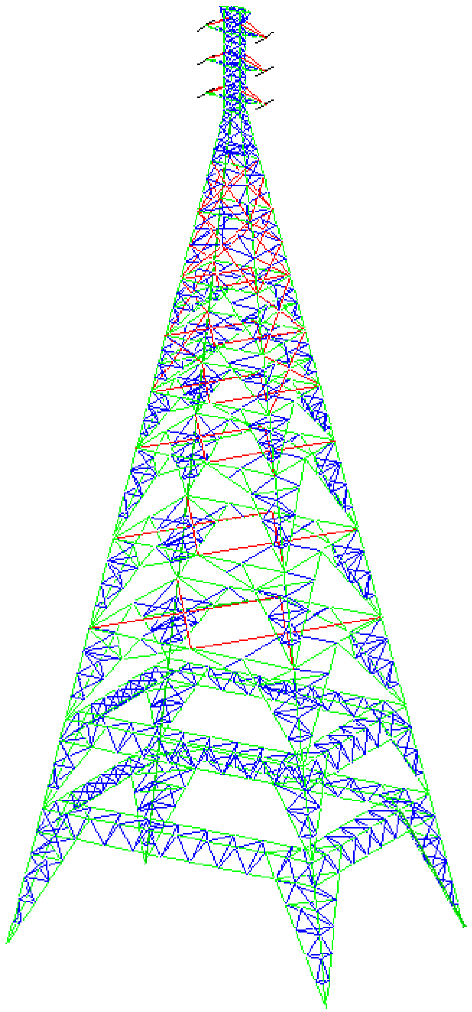
	Joint Label	Symmetry Code	X Coord. (ft)	Y Coord. (ft)	Z Coord. (ft)
1	1	XY-Symmetry	2	3	0
2	10	XY-Symmetry	2	3	-36
3	19	XY-Symmetry	9	13.5	-96
4	20	X-Symmetry	0	6	0
5	21	X-Symmetry	0	11.5	-8
6	22	X-Symmetry	0	11.5	-20
7	23	X-Symmetry	0	11.5	-32
8					

Make the Base Wider

332'-0 Tall

124.4' Wide

92.8' Deep

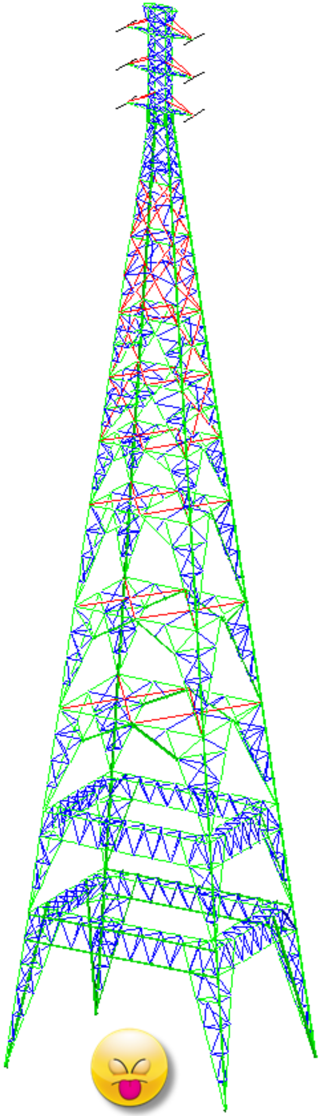


Make the Base Narrower

332'-0 Tall

75.1' Wide

53.3' Deep



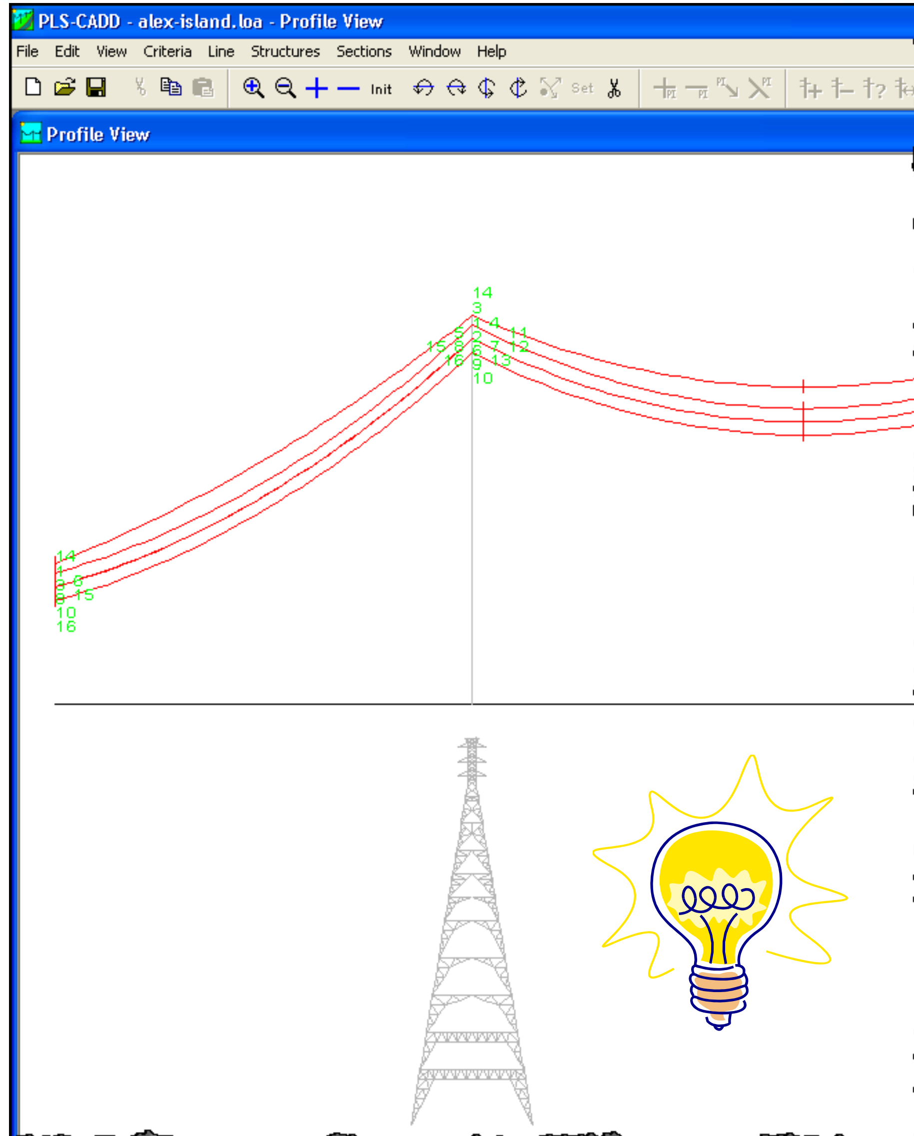
Use PLS-CADD Lite

Max Line Angle

Max Span

Min Line Angle

Min Span



Generate Design Load Cases

Max Line Angle

Max Span

Min Line Angle

Min Span

Structure Loads Criteria

	Description	Weather case	Cable condition	Wind Direction	Bisector Wind Dir (deg)
132	STRINGING 2-1	Construction	Initial RS	NA+	NA
133	STRINGING 10-1	Construction	Initial RS	NA+	NA
134	STRINGING 10-2	Construction	Initial RS	NA+	NA
135	STRINGING 10-3	Construction	Initial RS	NA+	NA
136	COLD STRINGING 1-1	Cold Stringing	Initial RS	NA+	NA
137	COLD STRINGING 9-1	Cold Stringing	Initial RS	NA+	NA
138	COLD STRINGING 9-2	Cold Stringing	Initial RS	NA+	NA
139	COLD STRINGING 9-3	Cold Stringing	Initial RS	NA+	NA
140	COLD STRINGING 2-1	Cold Stringing	Initial RS	NA+	NA
141	COLD STRINGING 10-1	Cold Stringing	Initial RS	NA+	NA
142	COLD STRINGING 10-2	Cold Stringing	Initial RS	NA+	NA
143	COLD STRINGING 10-3	Cold Stringing	Initial RS	NA+	NA
144					NA
145					NA
146					NA
147					NA
148					NA
149					NA

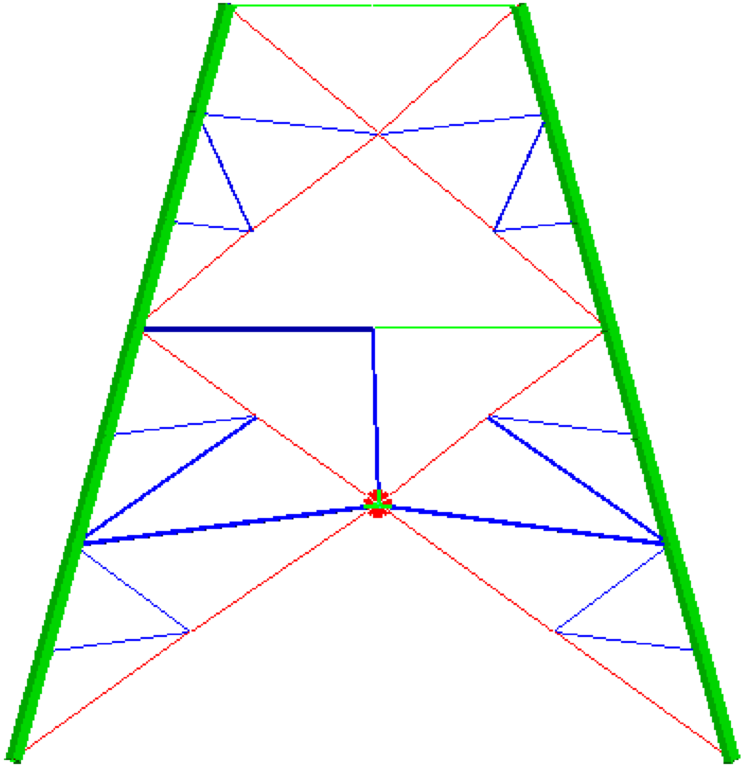
143 Load Cases

New Tower Version 11.16

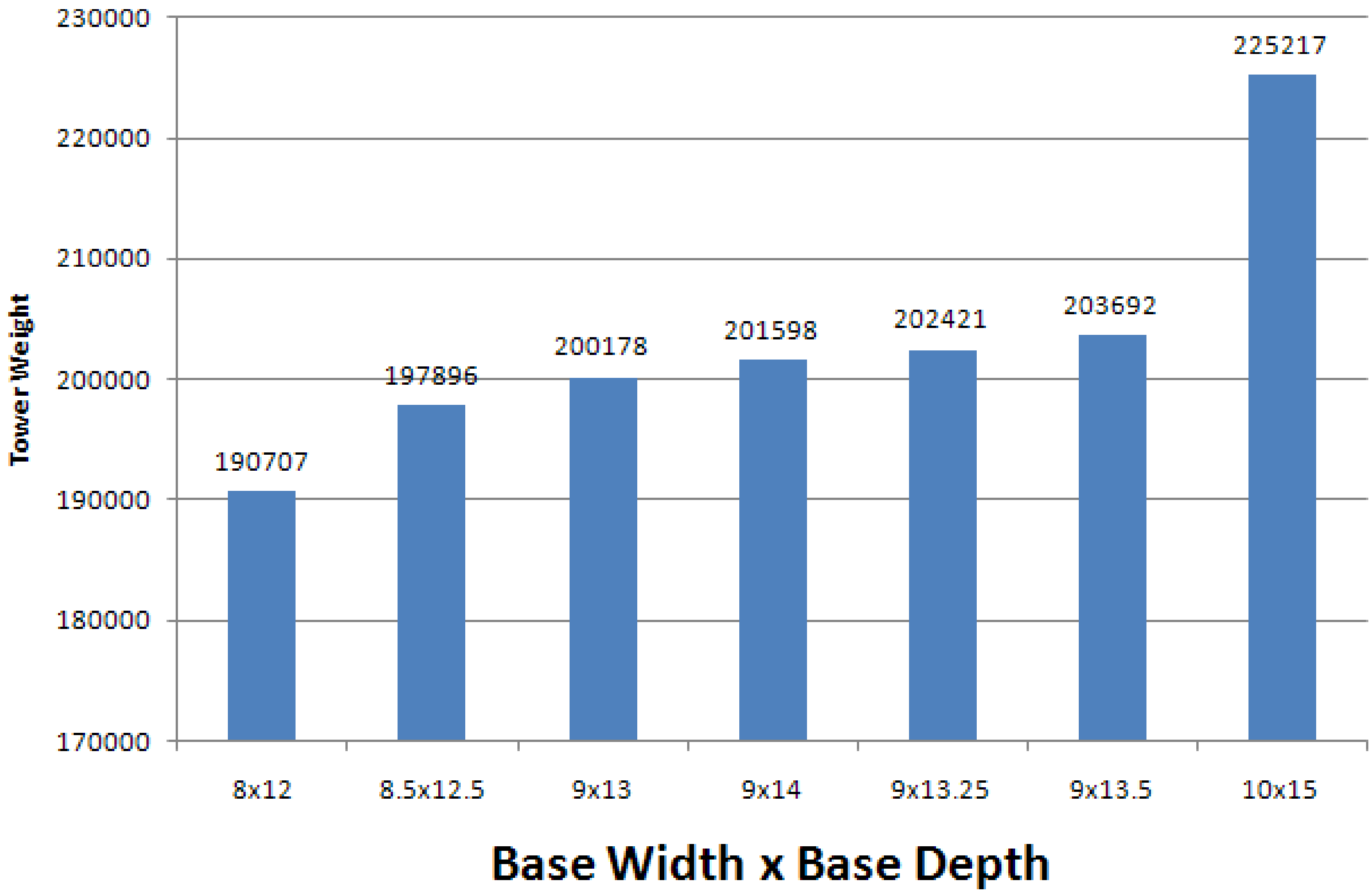
- Redundant Check and Design
- Included Angle Check
- Climbing Load Check and Design

Evaluate the Best Leg Slope

The Crossing Diagonal Joints must be re-calculated if the leg slope is changed



Evaluate the Best Leg Slope



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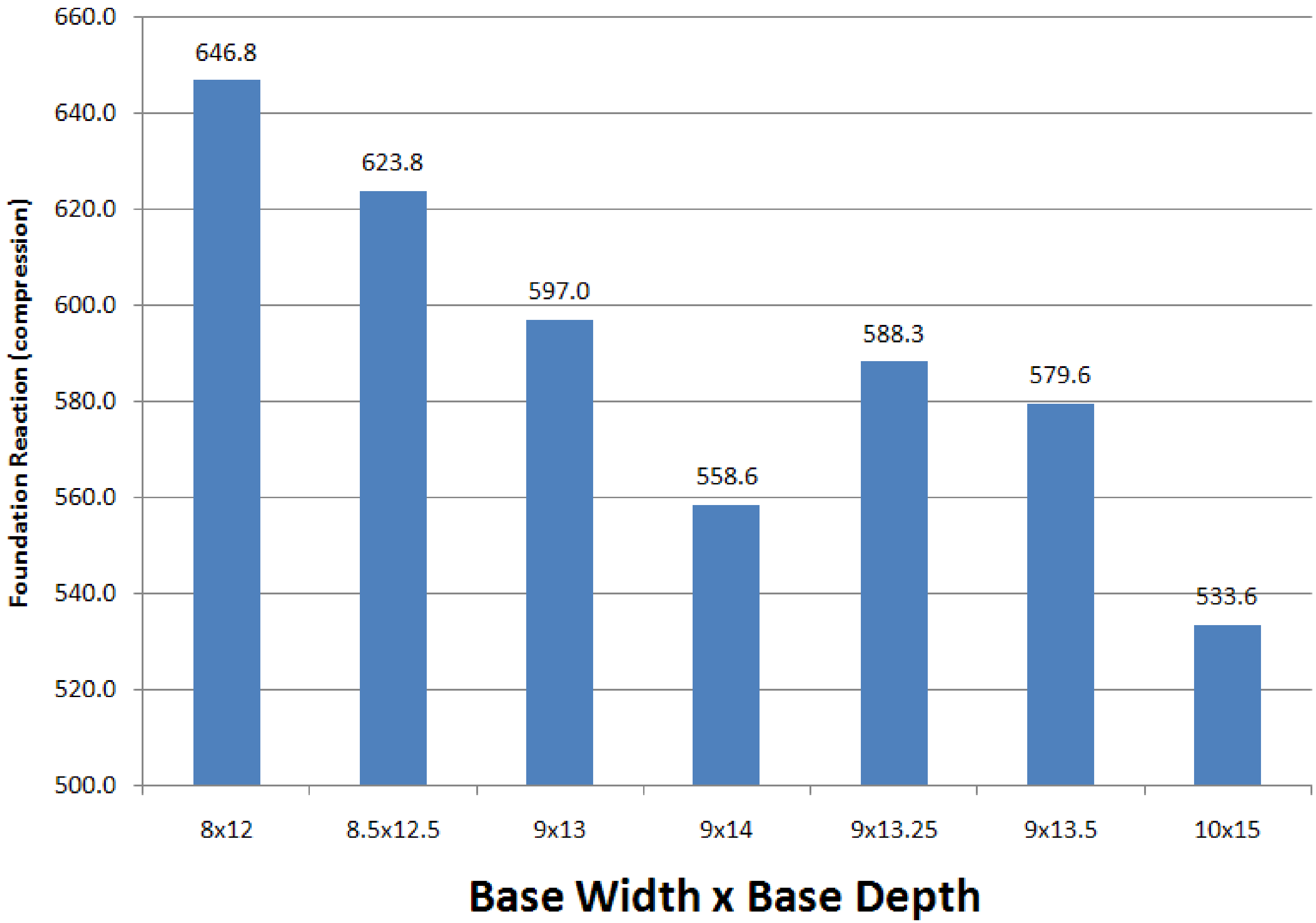
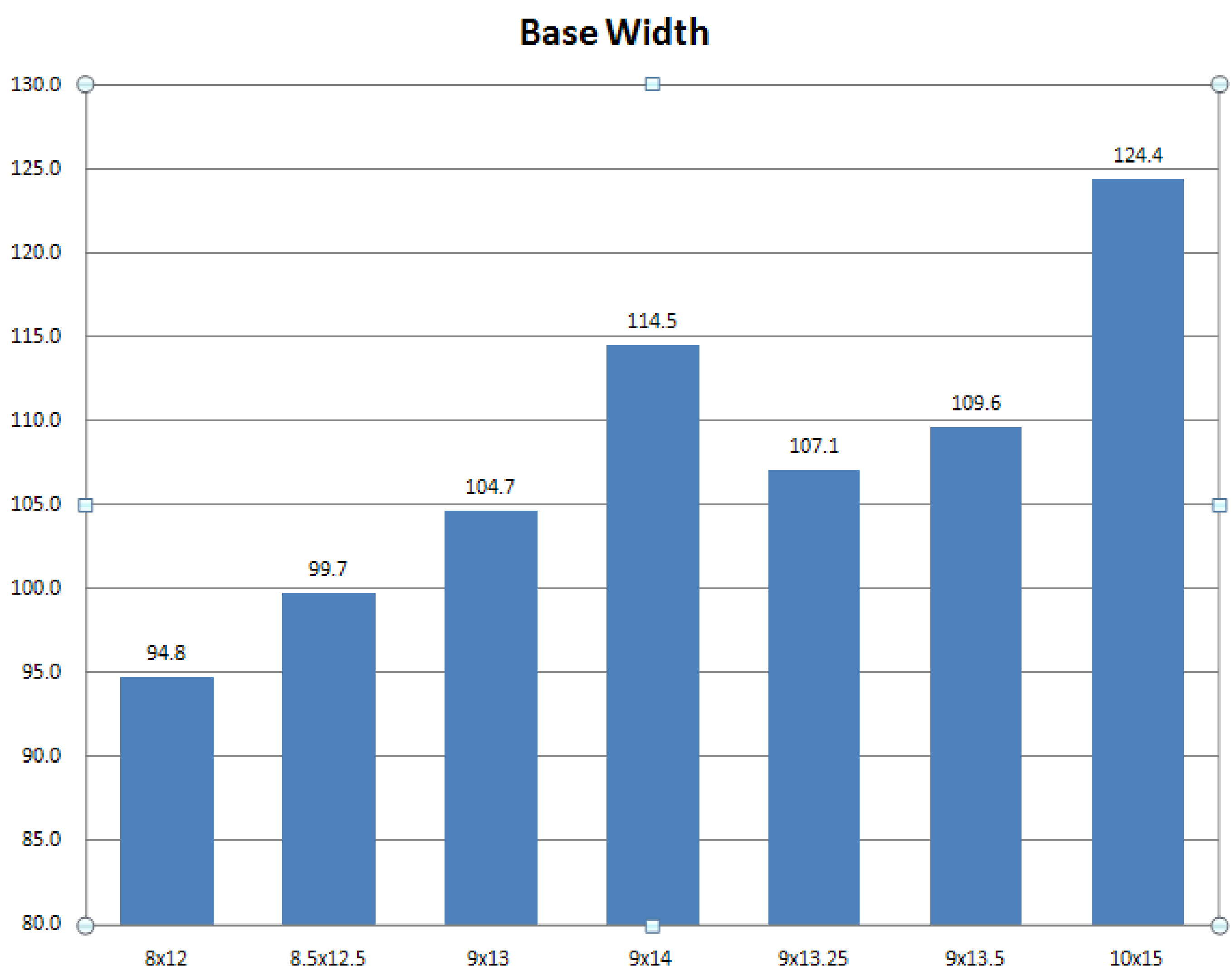


Evaluate the Best Leg Slope



Crossing Tower Statistics

- Crossing Span is 1700’
- Anchor Span is 1200’
- Line Angle is 20°
- Wind Speed is 120 MPH
- Wind on Structure accounts for 77% of Foundation Load

Observation

In the days prior to PLS-CADD and Tower, these "What-If" permutations were not possible without massive manpower and many weeks or months of Engineering calculations.

Questions?