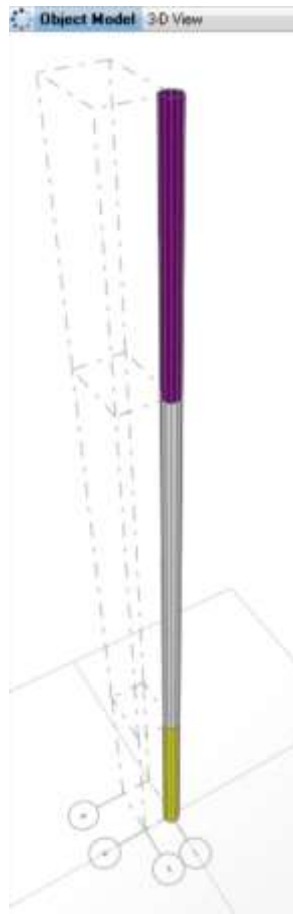


Structural Calculation Report

Project Information

- Structure Type: Polygonal Steel Pole
 - Total Height: 25 meters
 - Application: lightning protection
- Location: Wind speed base 130 km/h
 - Material: Steel ST37
- Hot Dip Galvanized According To ASTM A123

3D View lighting Pole



1- LOADING

1-1 Dead Load

The weight of ladder and cage are considered equal to 300 Kg at top of pole.

1-2 Live load

The weight of a maintenance operator with tools is considered equal to 200 Kg.

1-3 Wind Load calculations (based on INBR-06-1398)

q , is the reference wind pressure (kg/m^2)

Where:

$$V=130(\text{km/h}) \longrightarrow q=0.80 (\text{kN/m}^2)= 80 (\text{kg/m}^2)$$

$$F= I_w \cdot C_f \cdot q \cdot C_g \cdot C_e \cdot A$$

A = Diameter (m)

I_w , is the important factor and from clause 6-1-2 is equal to 1 for main structure.

C_e , is the wind loading coefficient and from clause 5-10-6-1 is equal to $C_e= (z/10)^{0.2} \geq 0.9$

$$z=0.0\text{m to } z=5.9\text{m} \longrightarrow C_e= 0.9$$

$$z=5.9\text{m to } z=10.0\text{m} \longrightarrow C_e= 1.0$$

$$z=10.0\text{m to } z=20.0\text{m} \longrightarrow C_e= 1.1$$

$$z=20.0\text{m to } z=25.0\text{m} \longrightarrow C_e= 1.2$$

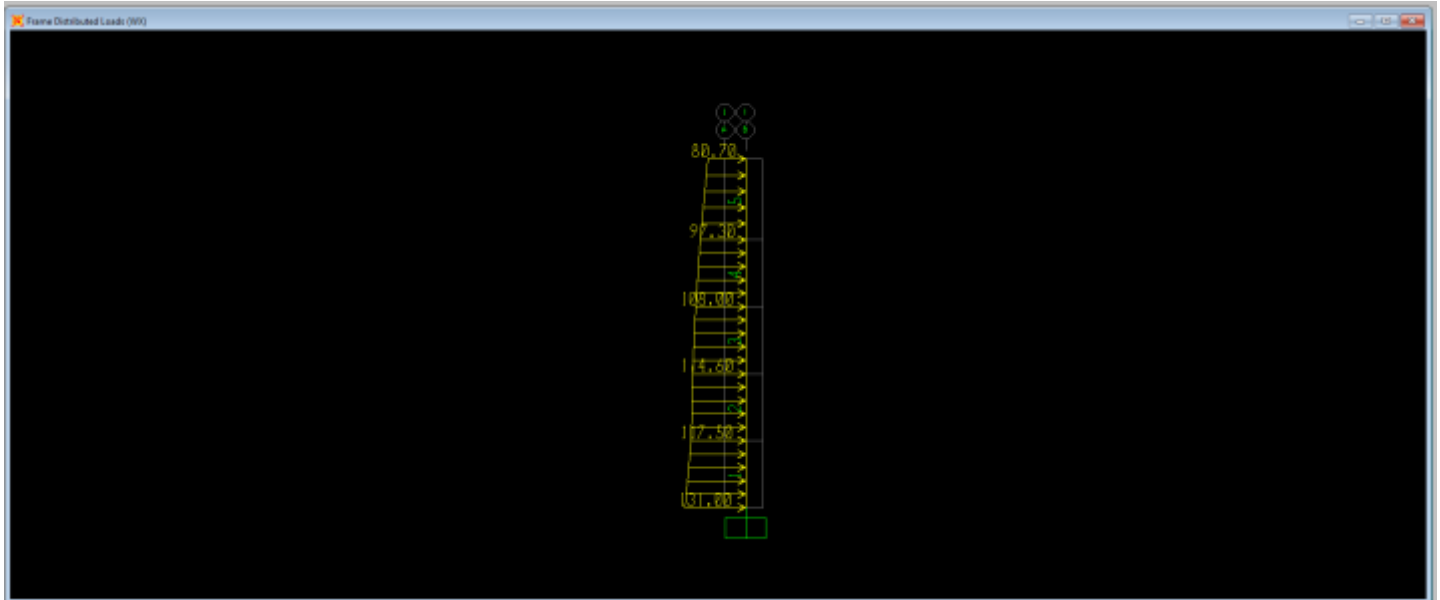
C_g , is the wind gust effect coefficient from clause 1-8-10-6 is equal to 2

$$F(1)=1*1.4*80*2*0.9*0.65= 131 (\text{Kg/m})$$

$$F(2)=1*1.4*80*2*1*0.52= 114.6 (\text{Kg/m})$$

$$F(3)=1*1.4*80*2*1.1*0.45= 108 (\text{Kg/m})$$

$$F(4)=1*1.4*80*2*1.2*0.30= 80.7 (\text{Kg/m})$$



Wind Load (Kg/m)

2- Load Combinations

TABLE: Combination Definitions						
Combo Name	ComboType	AutoDesign (Yes/No)	CaseType	CaseName	ScaleFactor (Unitless)	SteelDesign
D+0.75(L+W)	Linear Add	No	Linear Static	DEAD	1	Strength
D+0.75(L+W)			Linear Static	WX	0.75	
D+0.75(L+W)			Linear Static	LIVE	0.75	
Drift	Linear Add	No	Linear Static	DEAD	1	None
Drift			Linear Static	WX	1	
Drift			Linear Static	LIVE	1	
D+L	Linear Add	No	Linear Static	DEAD	1	Strength
D+L			Linear Static	LIVE	1	
D	Linear Add	No	Linear Static	DEAD	1	Strength
D+W	Linear Add	No	Linear Static	DEAD	1	Strength
D+W			Linear Static	WX	1	
0.6D+W	Linear Add	No	Linear Static	WX	1	Strength
0.6D+W			Linear Static	DEAD	0.6	

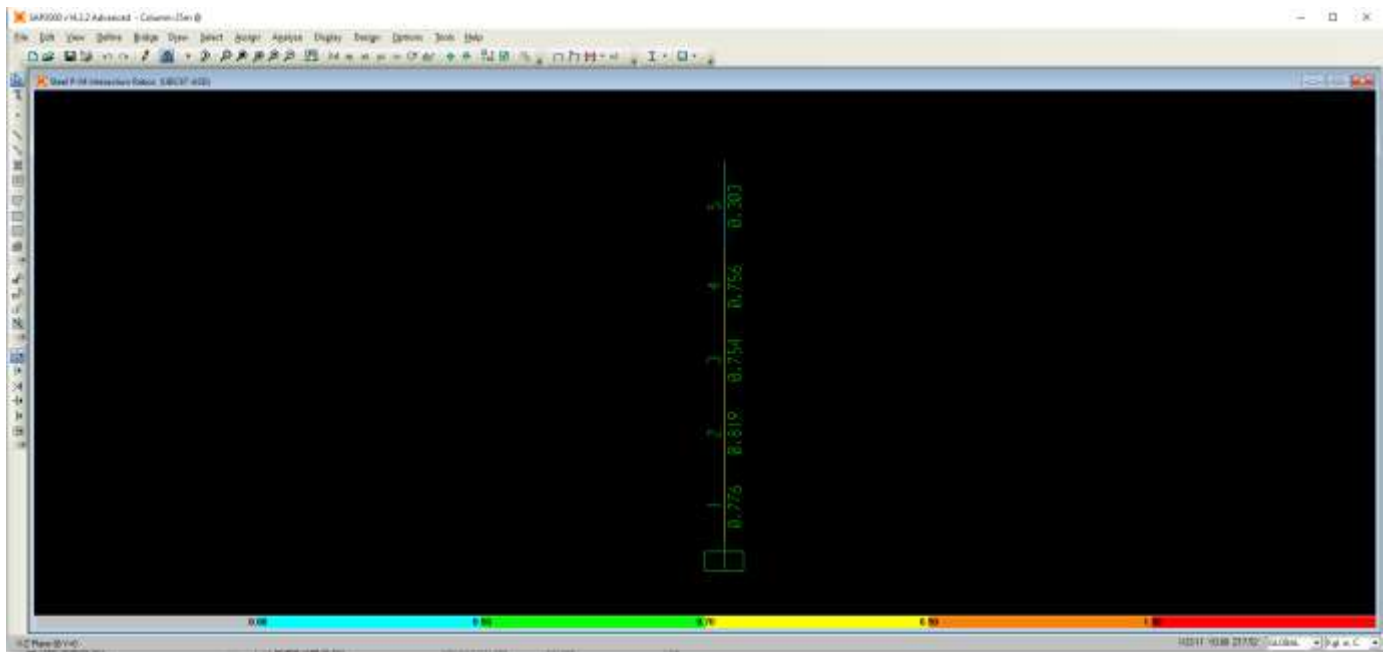
3- Load Pattern

TABLE: Load Pattern Definitions		
Load Pattern	Design Type	SelfWtMult Unitless
DEAD	DEAD	1.1
WX	WIND	0
LIVE	LIVE	0

4- Structure Analysis & Design

4-1 Stress Ratio

Steel members stress check is carried out in accordance with INBR 10-1401 for mentioned load combinations. Following figure show the stress ratio of main members for the most critical case.

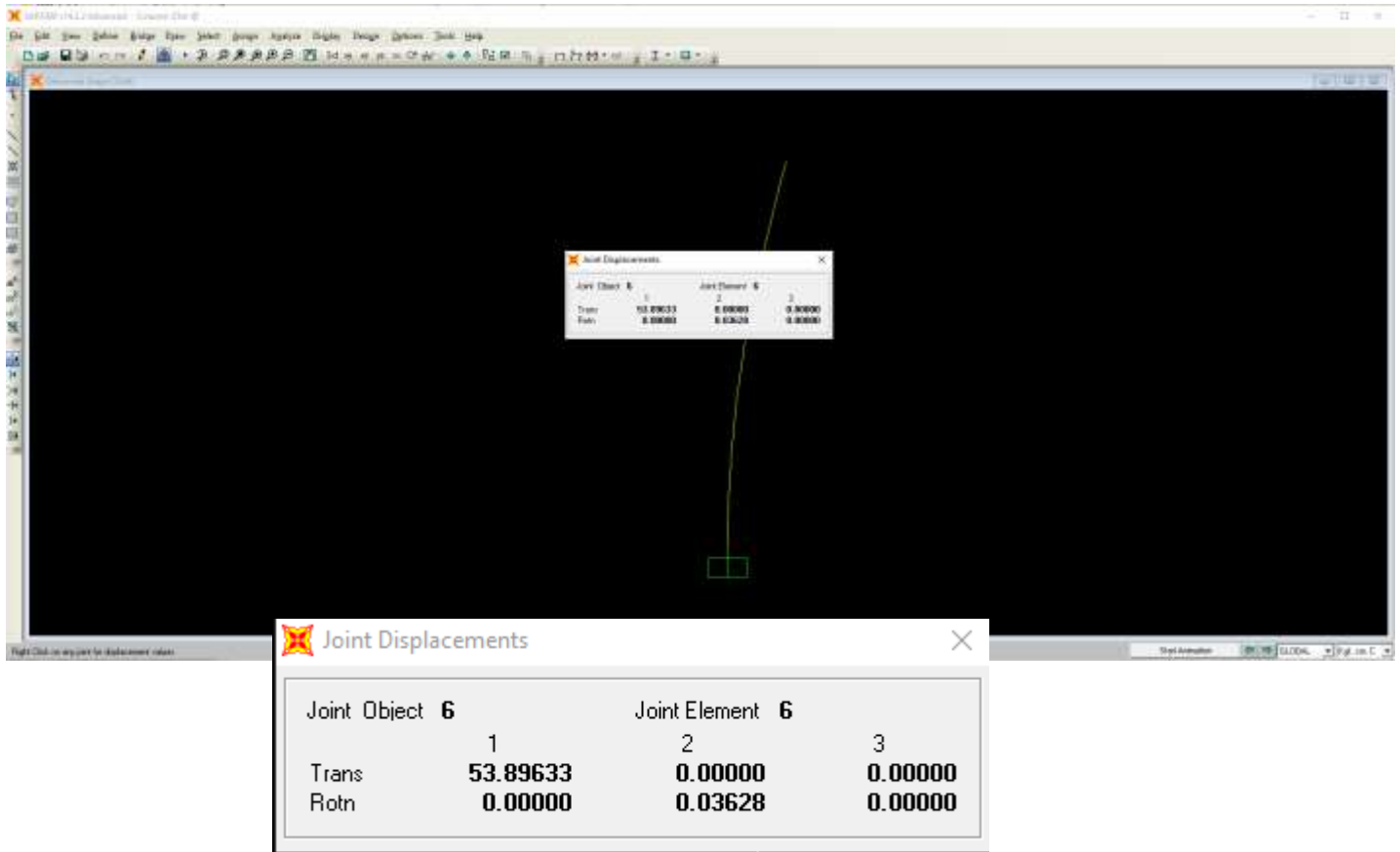


Stress Ratio of Main Pole

The best design stress ratio should be between 0.7 and 0.8; less than 0.7 is considered over-design & higher than 1.0 is not accepted.

4-2 Displacement & Drift

Considering maximum allowable lateral drift ratio of $0.04 \times (h+w)$ in accordance with article 6.5.1 of “BS EN 40-3-3:2013” code, drift is in allowable range, as follows:



Drift of Main Pole (cm)

$$\Delta_{all} = 0.04 \times (2500 + 54) = 102 \text{ cm} > 53.89633 \rightarrow \text{OK}$$

TABLE: Frame Section Properties 05 - Nonprismatic

SectionName	Text	Col 1	Col 2	Col 3	COL 4	COL 5
NumSegments	Unitless	1	1	1	1	1
SegmentNum	Unitless	1	1	1	1	1
StartSect	Text	D65	D58-T	D52-T	D45-T	D38-T
EndSect	Text	D58-B	D52-B	D45-B	D38-B	D30
LengthType	Text	Variable	Variable	Variable	Variable	Variable
AbsLength	m					
VarLength	Unitless	1	1	1	1	1
EI33Var	Text	Cubic	Cubic	Cubic	Cubic	Cubic
EI22Var	Text	Cubic	Cubic	Cubic	Cubic	Cubic

TABLE: Frame Section Properties 01 - General

SectionName	Material	Shape	t3	tw	Area	TorsConst	I33	I22
Text	Text	Text	m	m	m2	m4	m4	m4
Arm	STEEL	Pipe	0.0381	0.003	0.000331	1.026E-07	5.132E-08	5.132E-08
Col 1		Nonprismatic						
Col 2		Nonprismatic						
Col 3		Nonprismatic						
COL 4		Nonprismatic						
COL 5		Nonprismatic						
D0	STEEL	Pipe	0.46	0.003	0.004307	0.000225	0.000112	0.000112
D00	STEEL	Pipe	0.46	0.003	0.004307	0.000225	0.000112	0.000112
D30	STEEL	Pipe	0.3	0.003	0.002799	0.000062	0.000031	0.000031
D38-B	STEEL	Pipe	0.38	0.003	0.003553	0.000126	0.000063	0.000063
D38-T	STEEL	Pipe	0.38	0.003	0.003553	0.000126	0.000063	0.000063
D45-B	STEEL	Pipe	0.45	0.005	0.00699	0.000346	0.000173	0.000173
D45-T	STEEL	Pipe	0.45	0.003	0.004213	0.00021	0.000105	0.000105
D52-B	STEEL	Pipe	0.52	0.006	0.009689	0.00064	0.00032	0.00032
D52-T	STEEL	Pipe	0.52	0.005	0.00809	0.000536	0.000268	0.000268
D58-B	STEEL	Pipe	0.58	0.008	0.014376	0.001176	0.000588	0.000588
D58-T	STEEL	Pipe	0.58	0.006	0.01082	0.000891	0.000446	0.000446
D65	STEEL	Pipe	0.65	0.008	0.016135	0.001663	0.000831	0.000831

TABLE: Material Properties 03a - Steel Data		
Material	Text	STEEL
Fy	Tonf/m2	24000
Fu	Tonf/m2	37000
EffFy	Tonf/m2	38668.83
EffFu	Tonf/m2	50269.48
SSCurveOpt	Text	Simple
SSHysType	Text	Kinematic
SHard	Unitless	0.015
SMax	Unitless	0.11
SRup	Unitless	0.17
FinalSlope	Unitless	-0.1

TABLE: Auto Wave 3 - Wave Characteristics - General						
WaveChar	WaveType	KinFactor	SWaterDepth	WaveHeight	WavePeriod	WaveTheory
Text	Text	Unitless	m	m	Sec	Text
Default	From Theory	1	45	18	12	Linear

TABLE: Groups 3 - Masses and Weights					
GroupName	SelfMass	SelfWeight	TotalMassX	TotalMassY	TotalMassZ
Text	Tonf-s2/m	Tonf	Tonf-s2/m	Tonf-s2/m	Tonf-s2/m
ALL	0.16	1.5362	0.16	0.16	0.16

TABLE: Frame Section Properties 05 - Nonprismatic								
SectionName	NumSegments	SegmentNum	StartSect	EndSect	LengthType	VarLength	EI33Var	EI22Var
Text	Unitless	Unitless	Text	Text	Text	Unitless	Text	Text
Col 1	1	1	D65	D58-B	Variable	1	Cubic	Cubic
Col 2	1	1	D58-T	D52-B	Variable	1	Cubic	Cubic
Col 3	1	1	D52-T	D45-B	Variable	1	Cubic	Cubic
COL 4	1	1	D45-T	D38-B	Variable	1	Cubic	Cubic
COL 5	1	1	D38-T	D30	Variable	1	Cubic	Cubic

TABLE: Assembled Joint Masses						
Joint	U1	U2	U3	R1	R2	R3
Text	Tonf-s2/m	Tonf-s2/m	Tonf-s2/m	Tonf-m-s2	Tonf-m-s2	Tonf-m-s2
1	0.02987	0.02987	0.02987	0	0	0
2	0.04881	0.04881	0.04881	0	0	0
3	0.03417	0.03417	0.03417	0	0	0
4	0.0218	0.0218	0.0218	0	0	0
5	0.01491	0.01491	0.01491	0	0	0
6	0.007081	0.007081	0.007081	0	0	0

TABLE: Base Reactions						
OutputCase	CaseType	GlobalFX	GlobalFZ	GlobalMY	XCentroidFX	XCentroidFZ
Text	Text	Tonf	Tonf	Tonf-m	m	m
D+0.75(L+W)	Combination	-2.0224	0.15	-23.79555	1.125	1.125
D+L	Combination	0	0.2	-0.3	0	1.5

TABLE: Element Forces - Frames

Frame	Station	OutputCase	CaseType	P	V2	M3	FrameElem	ElemStation
Text	m	Text	Text	Tonf	Tonf	Tonf-m	Text	m
1	0	D+0.75(L+W)	Combination	-0.15	2.0224	23.57055	1-1	0
1	2.4	D+0.75(L+W)	Combination	-0.15	1.7927	18.99477	1-1	2.4
1	4.8	D+0.75(L+W)	Combination	-0.15	1.5751	14.95575	1-1	4.8
1	0	D+L	Combination	-0.2	0	0	1-1	0
1	2.4	D+L	Combination	-0.2	0	0	1-1	2.4
1	4.8	D+L	Combination	-0.2	0	0	1-1	4.8
2	0	D+0.75(L+W)	Combination	-0.15	1.5751	14.95575	2-1	0
2	2.4	D+0.75(L+W)	Combination	-0.15	1.365	11.42815	2-1	2.4
2	4.8	D+0.75(L+W)	Combination	-0.15	1.1574	8.40188	2-1	4.8
2	0	D+L	Combination	-0.2	0	0	2-1	0
2	2.4	D+L	Combination	-0.2	0	0	2-1	2.4
2	4.8	D+L	Combination	-0.2	0	0	2-1	4.8
3	0	D+0.75(L+W)	Combination	-0.15	1.1574	8.40188	3-1	0
3	2.4	D+0.75(L+W)	Combination	-0.15	0.9541	5.86935	3-1	2.4
3	4.8	D+0.75(L+W)	Combination	-0.15	0.7567	3.81764	3-1	4.8
3	0	D+L	Combination	-0.2	0	0	3-1	0
3	2.4	D+L	Combination	-0.2	0	0	3-1	2.4
3	4.8	D+L	Combination	-0.2	0	0	3-1	4.8
4	0	D+0.75(L+W)	Combination	-0.15	0.7567	3.81764	4-1	0
4	2.4	D+0.75(L+W)	Combination	-0.15	0.5671	2.23101	4-1	2.4
4	4.8	D+0.75(L+W)	Combination	-0.15	0.3872	1.08783	4-1	4.8
4	0	D+L	Combination	-0.2	0	0	4-1	0
4	2.4	D+L	Combination	-0.2	0	0	4-1	2.4
4	4.8	D+L	Combination	-0.2	0	0	4-1	4.8
5	0	D+0.75(L+W)	Combination	-0.15	0.3871	1.08783	5-1	0
5	2.9	D+0.75(L+W)	Combination	-0.15	0.1845	0.26323	5-1	2.9
5	5.8	D+0.75(L+W)	Combination	-0.15	-4.4E-15	2.72E-14	5-1	5.8
5	0	D+L	Combination	-0.2	0	0	5-1	0
5	2.9	D+L	Combination	-0.2	0	0	5-1	2.9
5	5.8	D+L	Combination	-0.2	0	0	5-1	5.8