DYNAMIC ANALYSIS OF WPE CONCRETE UTILITY POLES

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Project background

- American Society of Civil Engineers (ASCE) Guidelines for Electrical Transmission Line Structural Loading needed updating
- Focus on fundamental frequencies of pole structures made of concrete
- Use Wood Pole Equivalent (WPE) designs for testing parameters.

Methodology

- Using the ANSYS analysis software, model and test concrete pole designs
- Pole geometries taken from actual poles in production
- Code framework for ANSYS provided by Dr. Dai needing only slight modifications for each pole design
- Run code through ANSYS, obtain modal frequencies, save results in Excel

Process

- Spreadsheet of all the pole geometries

Pole Name	Total Height (ft)	Total Height (in)	Bury Height (in)	Height Above GL (in)	Tip OD (in)	Tip ID (in)	Butt OD at GL (in)	Butt ID at GL (in)	Butt OR (in)	Butt IR (in)	Tip OR (in)	Tip IR (in)	Outer Taper (in/ft)	Inner Taper (in/ft)	Division length (in)	Number of Divisions (#)
pole_30_1	30	360	60	300	7.75	2.75	13.15	8.15	6.575	4.075	3.875	1.375	0.18	0.18	3	120
pole_30_H1	30	360	60	300	7.75	2.75	13.15	8.15	6.575	4.075	3.875	1.375	0.18	0.18	3	120
pole_30_H2	30	360	60	300	9.55	4.55	14.95	9.95	7.475	4.975	4.775	2.275	0.18	0.18	3	120
pole_30_H3	30	360	60	300	9.55	4.55	14.95	9.95	7.475	4.975	4.775	2.275	0.18	0.18	3	120
pole_30_H4	30	360	60	300	9.55	4.55	14.95	9.95	7.475	4.975	4.775	2.275	0.18	0.18	3	120
pole_30_H5	30	360	60	300	11.35	6.35	16.75	11.75	8.375	5.875	5.675	3.175	0.18	0.18	3	120
pole_30_H6	30	360	60	300	11.35	6.35	16.75	11.75	8.375	5.875	5.675	3.175	0.18	0.18	3	120
pole_30_H7	30	360	60	300	11.35	6.35	16.75	11.75	8.375	5.875	5.675	3.175	0.18	0.18	3	120
pole_30_H8	30	360	60	300	13.15	8.15	18.55	13.55	9.275	6.775	6.575	4.075	0.18	0.18	3	120
pole_30_H9	30	360	60	300	13.23	8.23	19.71	14.686	9.855	7.343	6.615	4.115	0.216	0.192	3	120
pole_30_H10	30	360	60	300	13.23	8.23	19.71	14.686	9.855	7.343	6.615	4.115	0.216	0.192	3	120

Process

- Alter the code provided for each pole type

```
H=840 !total height
BH=108 !burry height (10%*H+2 feet)
j=140 !the number of element
L=H/j
Rb1=12.015 !outer butt radius
Rb2=9.503  !inner butt radius
Rt1=4.455  !outer tip radius
Rt2=1.955  !inner tip radius

!-----boundary conditions-----
*DO,i,3,38 !nodes at the bury part of the pole
D,i,all
*ENDDO
```

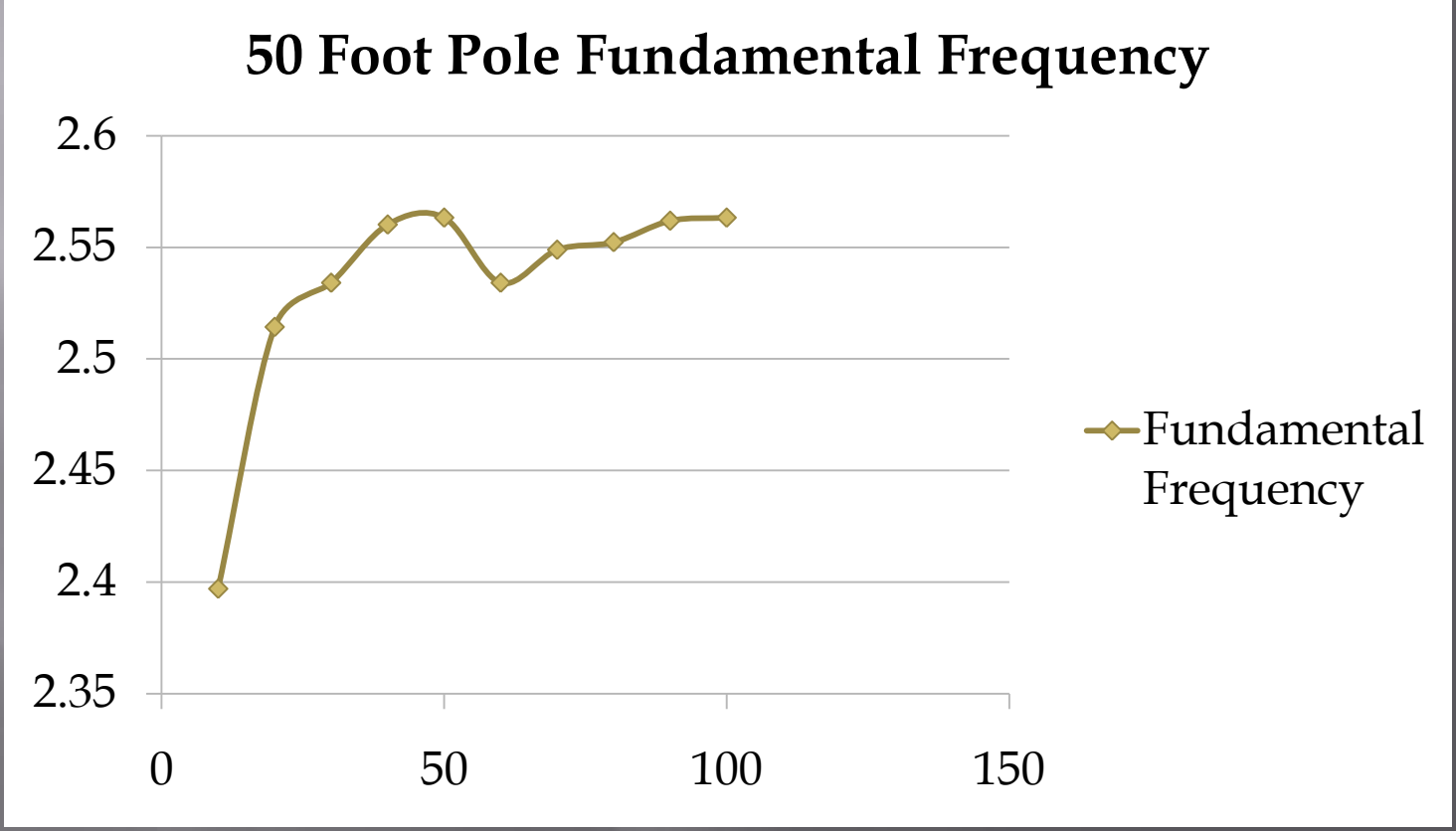
Troubleshooting

- Originally, testing was performed on each pole 10 times using elements 10 to 100 in 10 element intervals

```
H=840 !total height
BH=108 !burry height (10%*H+2 feet)
j=140 !the number of elements
L=H/j
Rb1=12.015 !outer butt radius
Rb2=9.503  !inner butt radius
Rt1=4.455  !outer tip radius
Rt2=1.955  !inner tip radius
```

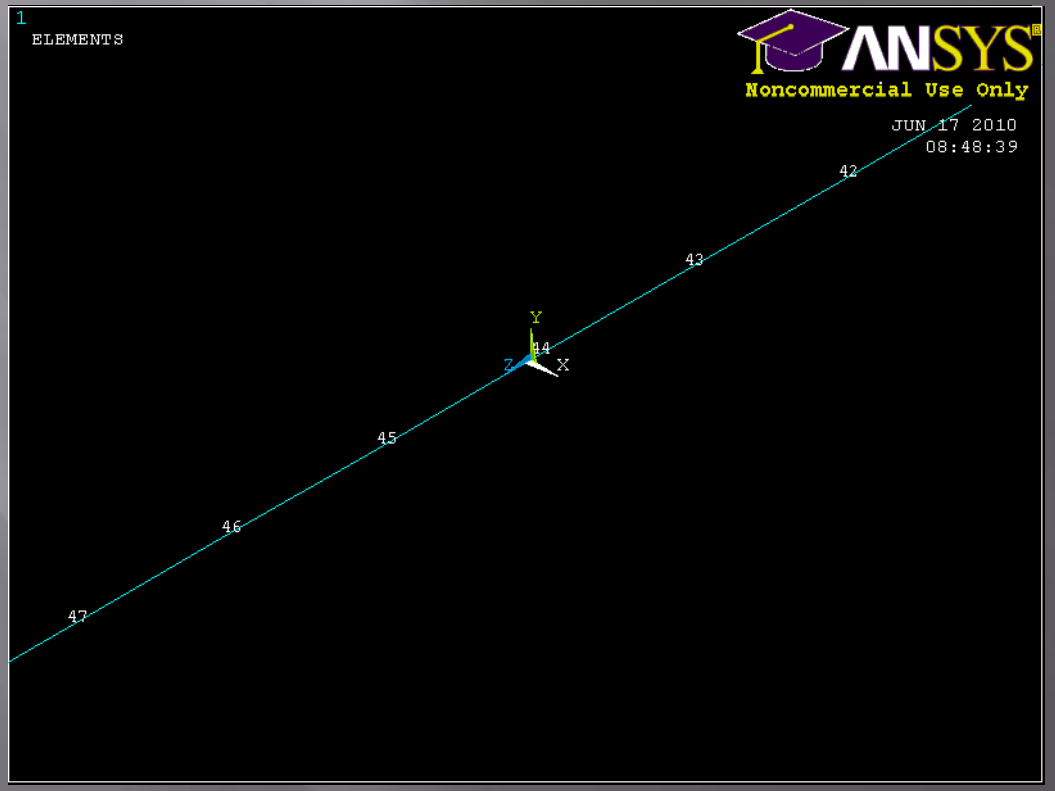
Troubleshooting

- Flaw found in the results from the first few poles tested under this original method



Troubleshooting

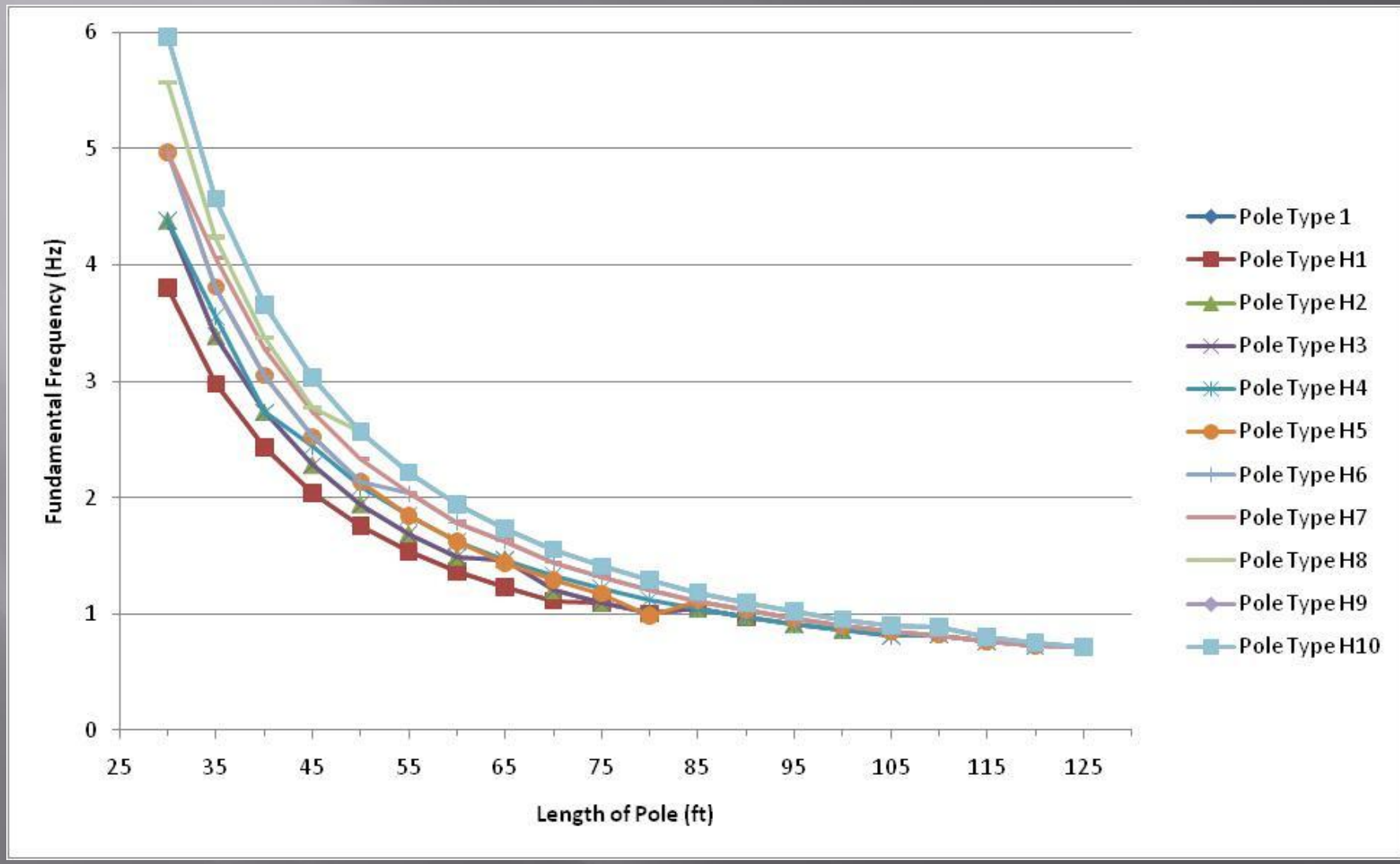
- Problem lies not in the number of elements used but in the location of the element nodes



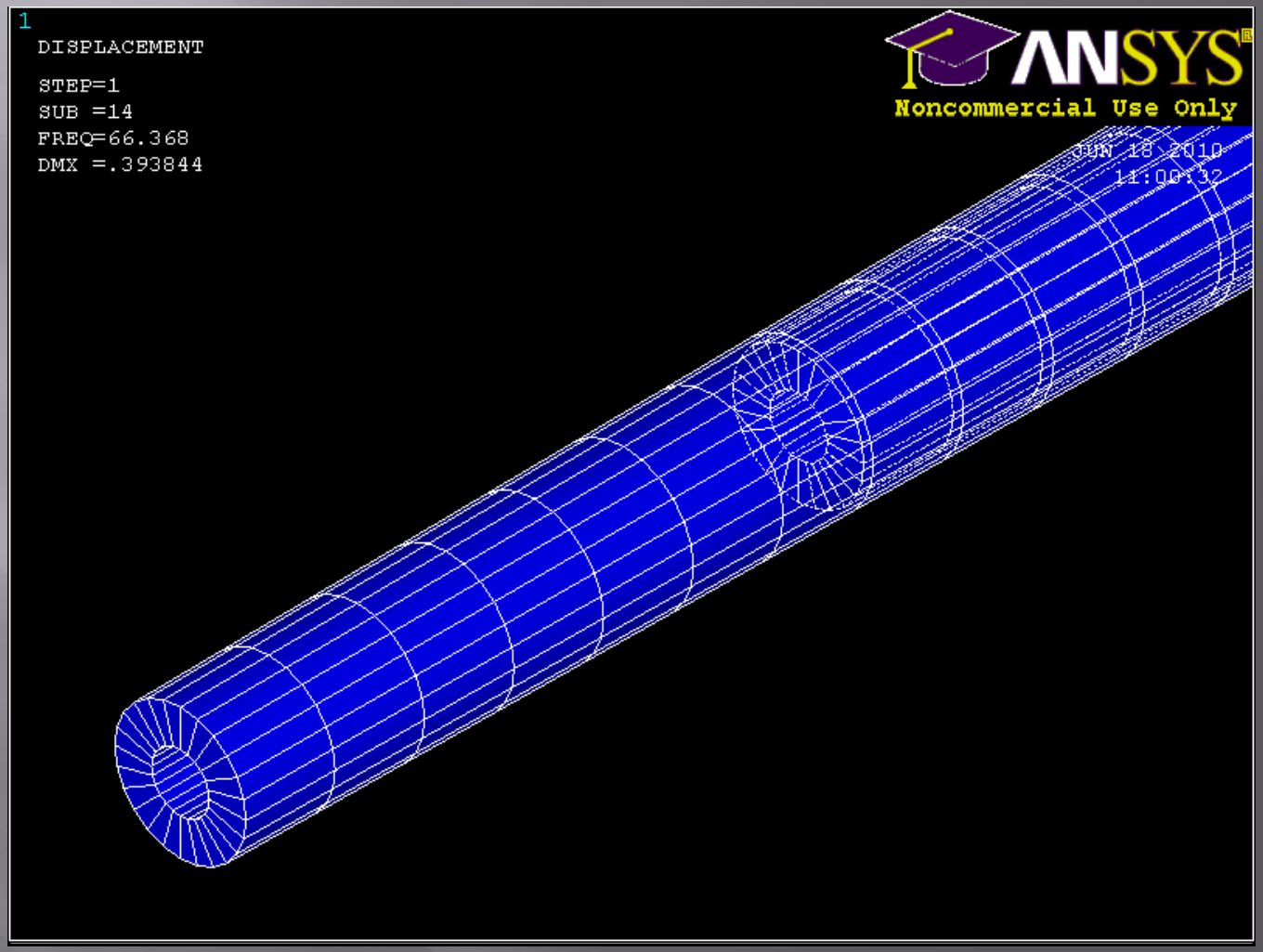
Solution

- With all the codes modified, solutions were calculated
- Fundamental Frequencies recorded and graphed, remaining 14 modes recorded
- Modal deformed shapes plotted

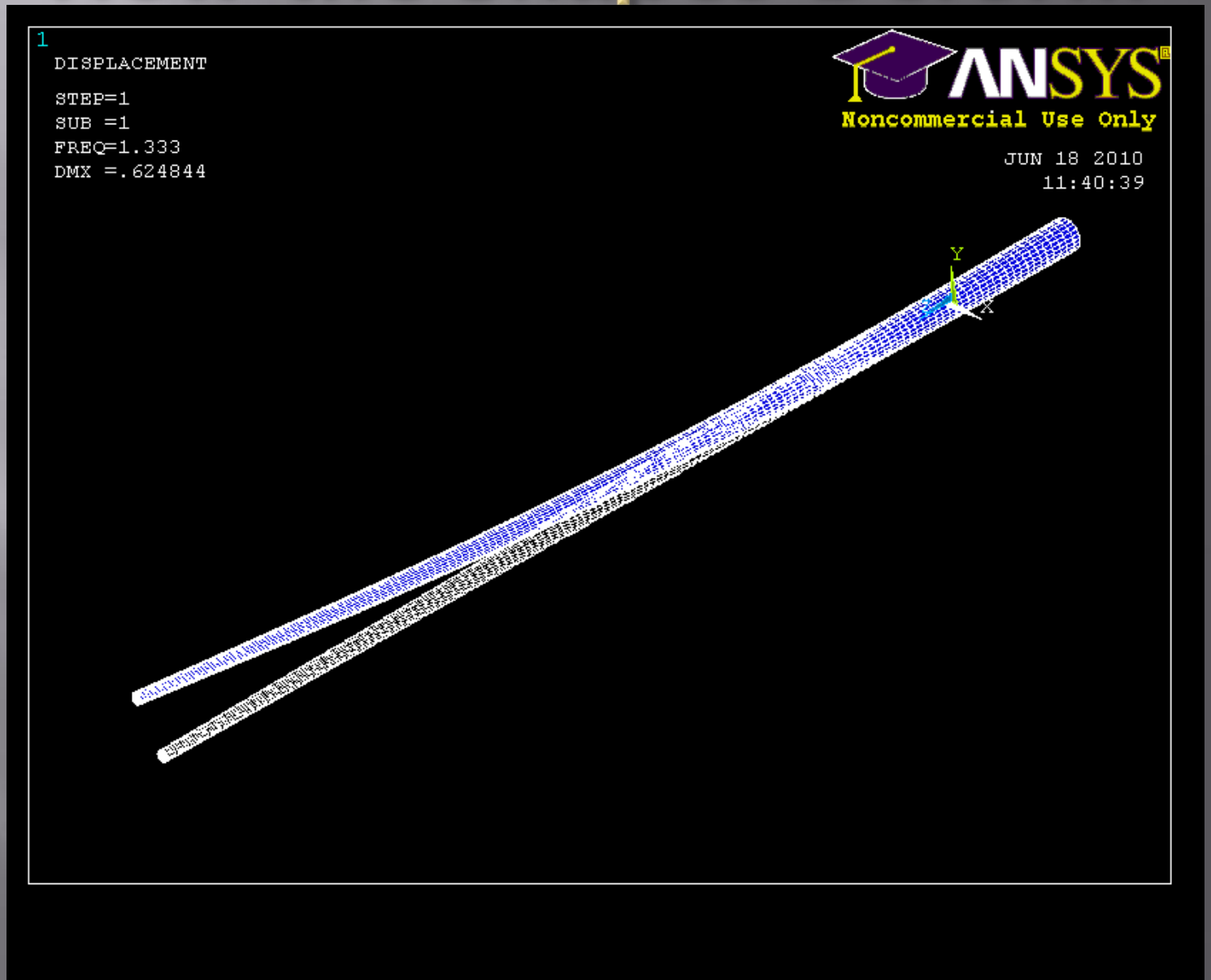
Fundamental Frequencies



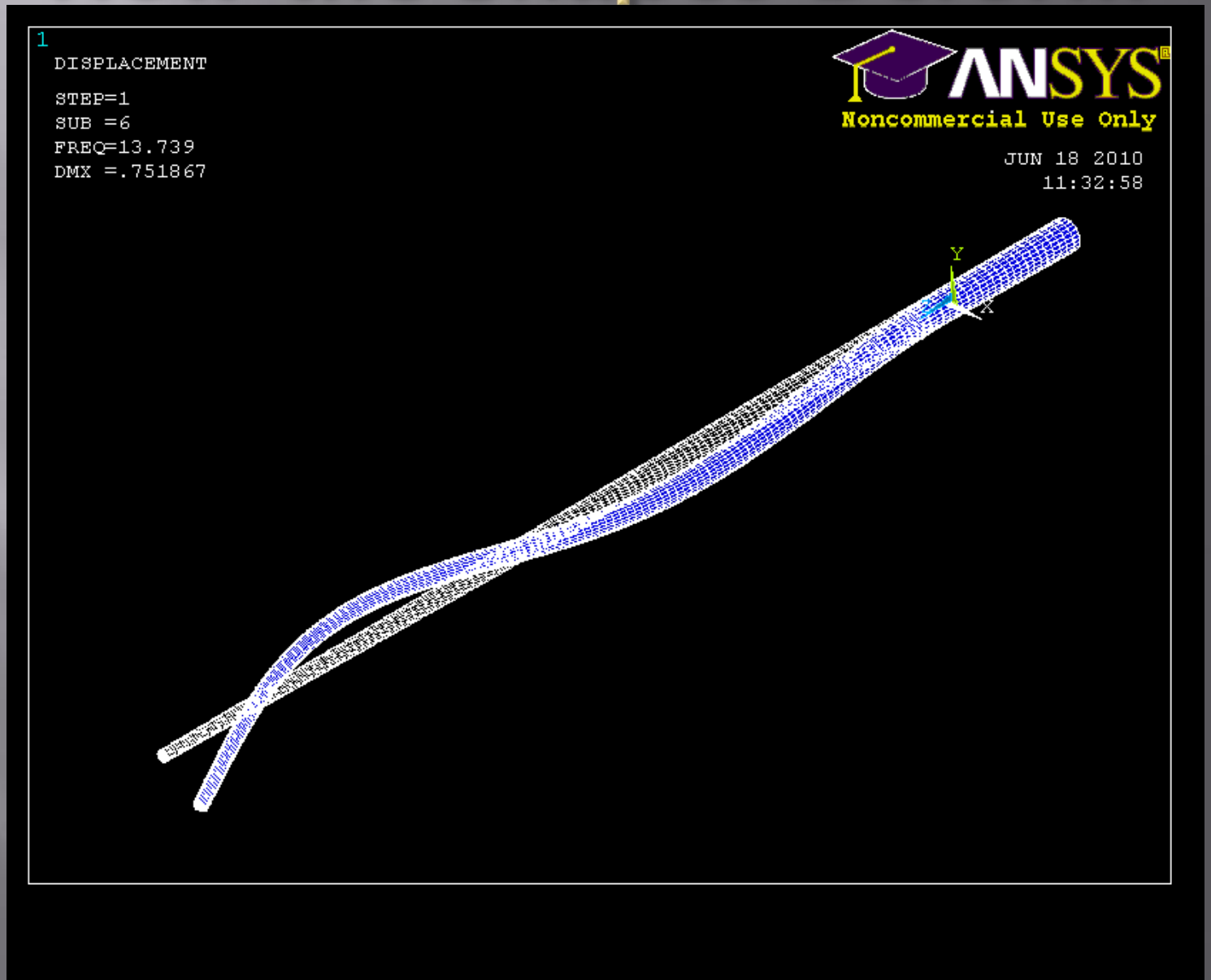
Modal Deformed Shapes



How the Shapes Deform



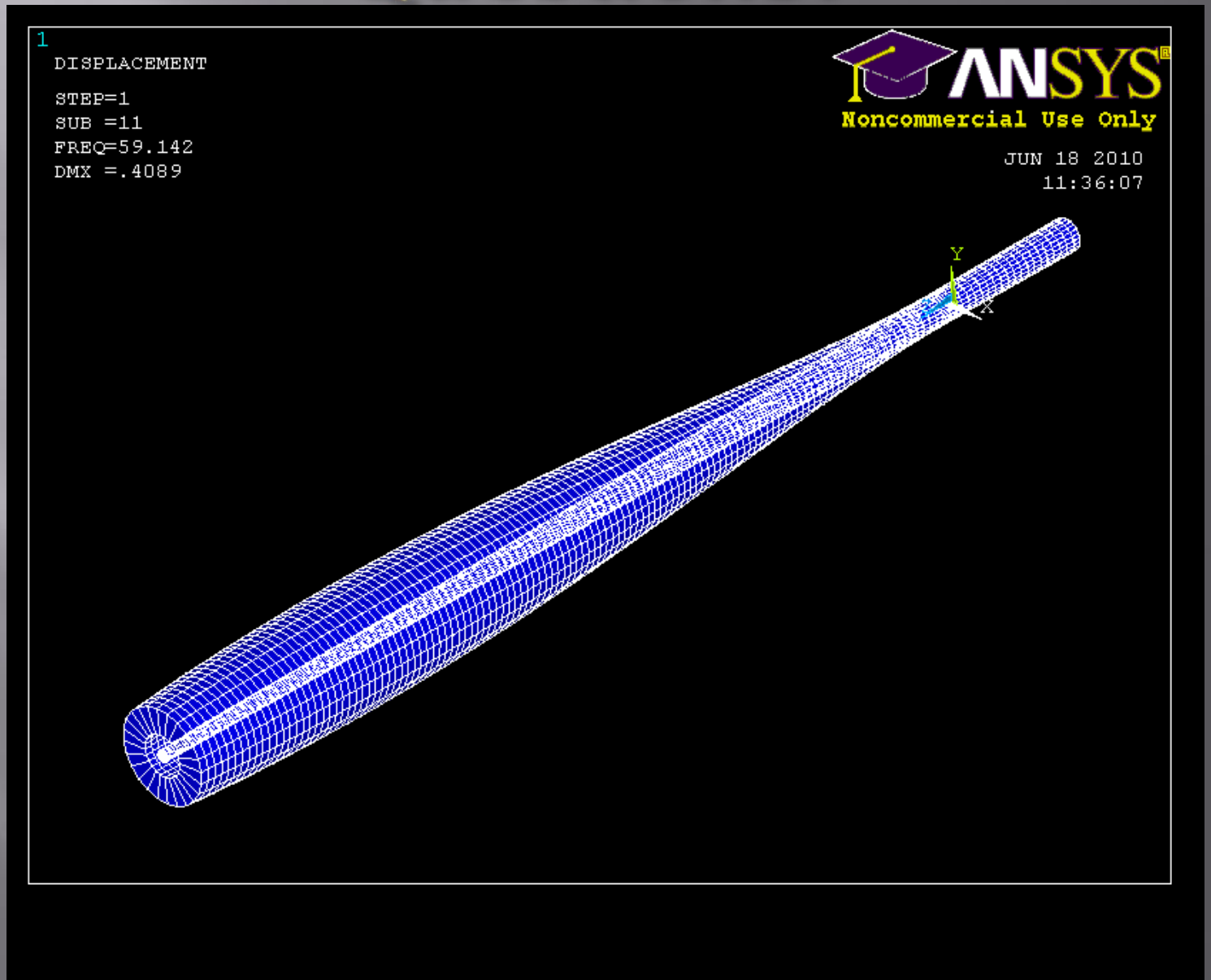
How the Shapes Deform



Summary

- The ASCE guidelines are non-specific and based on limited review.
- Using ANSYS, WPE spun concrete poles were modeled and tested for dynamic properties
- Results show fundamental frequencies ranging from 6.0 to 0.70 Hz

Questions?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SUB =11
FREQ=59.142
DMX =.4089
ANSYS
Noncommercial Use Only
JUN 18 2010
11:36:07
Y